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Air Quality Index – A Study to Assess the Air Quality

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Abstract - *It is fairly apparent about the rate at which the quality of air is declining in the current environment extensively in the urban areas [1]. One such city, where the poor quality of air can clearly be identified is the capital city of India, Delhi. The Air Quality Index (AQI) is a powerful tool on the basis of which the characteristics of air can be determined in a certain area. The AQI for the city of Delhi is computed by monitoring the four main pollutants namely nitrogen dioxide (NO2), sulphur dioxide (SO2), suspended particulate matter (SPM),and residual suspended particulate matter (RSPM) by calculating the air quality indices for these pollutants. With every country following a different scale for evaluation, the values provided by the Central Pollution Control Board of India are used to assess the condition of air of the region under consideration. The Seasonal and Daily calculation of AQI divulged the quality of air in the study region which could further be classified into various sections stretching across good, satisfactory, moderately polluted, poor, very poor and severe based on the AQI that was estimated. The main purpose of this research is to identify the weaknesses in the current quality of air and suggest possible steps or policies rendering it fit for human consumption.*

Index Terms—Air Quality Index.

1. INTRODUCTION

Apart from land and water, air is the prime resource for the sustenance of life. Air is an integral and essential necessity in everyday life. Whether it is agriculture, or pollination of var- ious crops, or even basic survival of numerous living species, everything everywhere is dependent on air. The importance of air cannot be overemphasized and hence the rising level of air pollution is a matter of serious concern.

Air Pollution is the inadequate change in physical, chemical or biological characteristics of air which hampers life as well as leads to potential health problems [2]. Air pollution majorly affects the eyes, lungs, nose, and throat by causing irritation. It also creates respiratory problems and exacerbates existing conditions such as asthma and emphysema. The risk of cardiovascular diseases become much higher when humans are continually exposed to air pollution. In India, air pollution is the third highest cause of death among health risks and because of this, life expectancy has gone down by 2.6 years. Hence, it has become increasingly necessary to not only control the contamination but also enlighten the people affecting the quality of air effectively in a bid to maintain a healthy standard.

A reasonable way to analyze the amount of pollution is by determining the standard of air. With technological ad- vancements, a vast amount of data on ambient air quality is generated which is used to establish the quality of air in different areas. The large monitoring data results have astronomical volumes of information that neither provides any useful insights to a decision-maker nor is intelligible to a common man who simply wants to understand how good or bad the air is. One way to describe air quality is to report the concentrations of all pollutants with acceptable levels (standards).

As for the general public, they generally will not be satisfied with raw data, time series plots, statistical analysis, and other complex findings pertaining to air quality and hence people tend to lose interest. They can neither appreciate the state of air quality nor the pollution alleviation efforts by regulatory agen- cies. Since awareness of daily levels of urban air pollution is important to those who suffer from illness caused by exposure to air pollution, the issue of air quality communication should be addressed in an effective manner. Further, the success of a nation to improve the air quality depends on the support of its citizens who are well informed about local and national air pollution problems and about the progress of mitigation efforts.

To address the aforementioned concerns, many developed countries over the past three decades have devised and utilized effectively, the concept of the Air Quality Index (AQI). Air Quality Index is defined as a strategy that involves the transformation of weighted values of individual air pollution parameters (Sulphur Dioxide (SO2), Carbon Dioxide (CO2), visibility, etc.) into a single number or set of numbers. The challenge of communicating with the people in a comprehensible manner has two dimensions: (i) Translate the complex scientific and medical information into simple and precise knowledge and (ii) communicate with citizens in the historical, current and futuristic sense. Addressing these challenges and thus developing an efficient and comprehensible AQI scale is required for citizens and policymakers to make decisions and to prevent and minimize air pollution exposure and the ailments induced by the exposure.

2. LITERATURE SURVEY

2.1 A Comparative Study of Air Quality Index Based on Factor Analysis and US-EPA Methods for an Urban Environment

Bishoi et al posited the EPA method for the computation of AQI (EPAQI). This technique involved the calculation of the index value for each pollutant (SO2, NO2, carbon monoxide, Ozone, Particulate Matter). The EPAQI was then evaluated by determining the maximum index value of the single pollutant which provided a rough estimate of the impact on the quality of air on human health. Furthermore, the research involved the Factor Analysis method to calculate the New AQI (NAQI) encompassing the Principal Component Analysis (PCA) [3], which was used to ascertain whether the air quality has worsened or improved over the months.

2.2 Air Quality Index A Comparative Study for Assessing the Status of Air Quality

Shivam et al carried out a comparative study, wherein the various formulas and methodologies used in the computation of AQI were assessed [4]. The study included an analysis of five different techniques to determine the most precise calculation methodology to provide accurate results for further scrutinization.

2.3 Forecasting of Air Quality in Delhi Using Principal Component Regression Technique

Anikender et al proposed a forecasting model to predict the AQI value which implemented the technique of Multiple Linear Regression and Principal Component Regression model. This research model included the usage of the past days' AQI values[5]. These values were computed using the EPA, 1999 formula.

2.4 A Review on Air Quality Indexing System

Kanchan et al calculated and compared AQI values. The AQI value is defined with respect to five main air pollutants: carbon monoxide (CO), ozone (O3), Sulphur dioxide (SO2), nitrogen dioxide (NO2), and particulate matter (PM10 and PM2.5)[6]. The major differences among these indices were aggregation function, type of pollutants, number of index classes (and their associated colors) and related descriptive terms.

2.5 Impact Analysis of Air Pollutants on the Air Quality Index in Jinan Winter

Song studied the effect of air pollutants on the Air Quality Index by using correlation analysis and path analysis. The correlation values revealed the direct effect of pollutants on AQI with a positive value indicating a direct proportionality and a negative value representing an indirect proportionality. The path analysis revealed a more in-depth dependency of AQI on the pollutants by giving both the direct and the indirect dependency (ie; changes in concentration due to other pollutants' concentration)[7].

3. METHODOLOGY

Nowadays general citizens have become more aware of the surroundings. They are well informed about their adverse health effects of poor air quality so it is important for people to know about the air they breathe. This information can be apprehended by society by assessing the daily air pollution levels. AQI is one such tool to canvass the air we breathe which is used to calculate the overall results based on standards and policies followed by the country. In India, these standards are set by the Central Board of Pollution Control (CPCB) under the law Air (Prevention and Control of Pollution) Act, 1981[4].

There are primarily three steps involved in the calculation of AQI:

Firstly, the air pollution index for each pollutant (Q) is calculated. In this step, the concentration value of the pollutants is related to the Indian air quality standards and then the concentration of each pollutant is converted into a percentage of each standard (Here the Indian standards Si are taken as per table 1. Then the pollution index of each pollutant is obtained.

In this study, NO2, SO2, SPM, and RSPM are the pollutants under consideration. Pollution index is obtained by using the following formula:

$$Qi = (Ci * Si)/100 \quad \ldots\ldots(1)$$

where Qi is the air pollution index for the pollutant "i", Ci is the corresponding concentration of the pollutant "i" in the air (calculated from the dataset) and Si is the air quality standard for the pollutant as prescribed by the Indian Pollution Control Association (IPCA).

Secondly, using (2) the aggregation of pollution index is computed using weighted additive form.

$$wi = Wi/Wi \quad \ldots\ldots(2)$$

where Wi is the mass of pollutant "i".

Table -1: National Ambient Air Quality Concentration [8]

S.No.	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area
1	Sulphur Dioxide (SO2), µg/m³	Annual	50	20
		24 hours	80	80
2	Nitrogen Dioxide (NO2), µg/m³	Annual	40	30
		24 hours	80	80
3	Residual Suspended Particulate Matter or PM10, µg/m³	Annual	60	60
		24 hours	100	100
4	Suspended Particulate Matter or PM2.5, µg/m³	Annual	40	40
		24 hours	60	60

Finally, the AQI is estimated using the Fenstock Air Quality Index formula [9] as follows:

$$AQI = \sum (Wi * Qi) \quad \text{.....(3)}$$

4. RESULT AND DISCUSSION

The correlation coefficient results are tabulated as shown in table 2.

Table -2: Correlation matrix between pollutants

	SO2	NO2	RSPM	SPM	AQI
SO2	1.0000	0.2655	0.2561	0.2777	0.3007
NO2	0.2655	1.0000	0.2879	0.4516	0.4365
RSPM	0.2561	0.2879	1.0000	0.5957	0.8401
SPM	0.2777	0.4516	0.5956	1.0000	0.9361
AQI	0.3007	0.4365	0.8401	0.9361	1.0000

As observed, all four pollutants (NO2, SO2, SPM, RSPM) have a positive correlation with the AQI. The significant correlation values of SPM and RSPM indicate that the AQI primarily depends on these two factors. Furthermore, all the pollutants have a positive correlation with each other indicating that a rise in the concentration of any of the pollutants will increase the concentration of all the other pollutants as well.

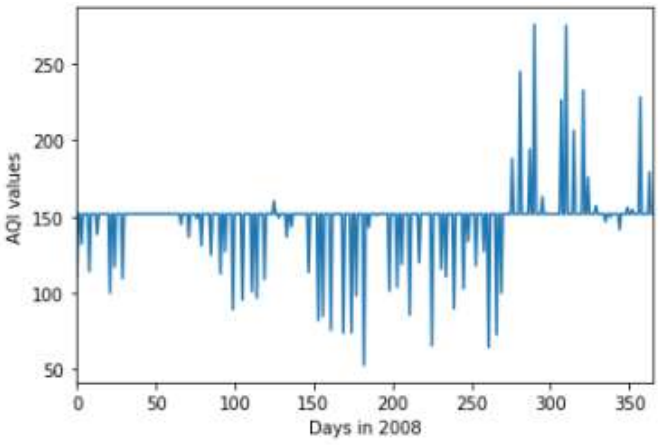

Chart -1: Everyday AQI plot for the year 2008

Over the span of three years (2008-2010), the AQI has been observed to be in the range of 100-200 (deemed unhealthy by IPCA). However, there exist some anomalies. In mid-August 2008, as per chart 1 the AQI goes as low as 50. This could be because of the less frequency of vehicles on roads owing to the long weekend with the Independence Day (15th August) falling on Friday. However, there was a severe increase in the AQI value with it reaching its zenith of 300 by the end of October. Diwali (28th October) and the pollution associated with it is the factor that explains this irregularity. By March of 2009, the country's capital was proclaimed as the Asthma Capital of India with the AQI reaching 350 as shown in chart 2. A number of agents were deemed responsible viz; rapidly expanding city, transportation, energy generation, construction, domestic burning, and industrial activity.

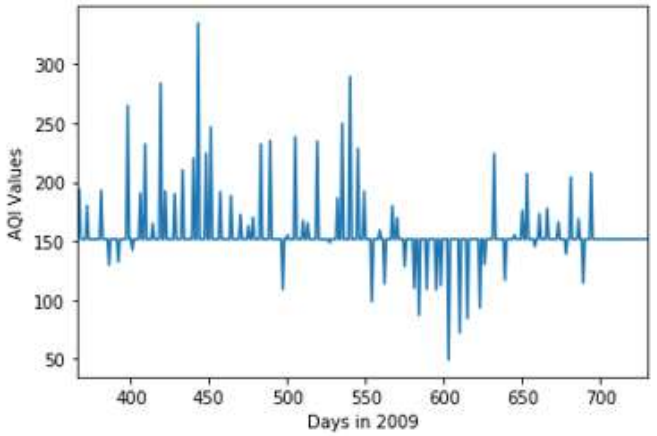

Chart -2: Everyday AQI plot for the year 2009

Following this, the CPCB took strict preventive measures like traffic control which led to a gradual decline in the AQI value reaching 50 by September 2009, seen in chart 3. Nevertheless, these measures proved to be just a temporary solution as the AQI value shot back up over 250 regularly at the fag-end of 2009 and the first half of 2010 inputs.

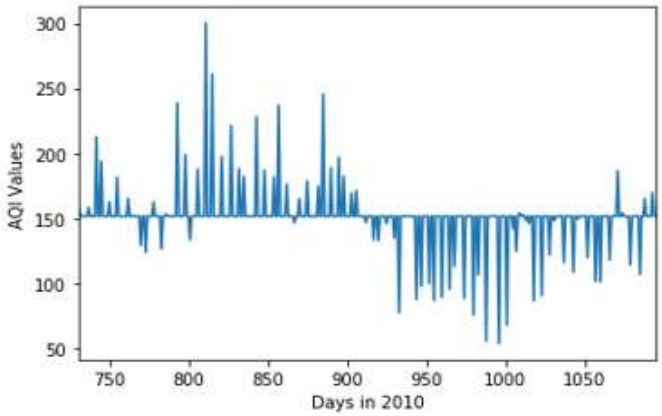

Chart -3: Everyday AQI plot for the year 2010

Table - 3: Air Quality Index Inferences [10]

Air Quality Index Level of Health Concern	Numerical Value	Meaning
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	50-100	Air quality is acceptable; however some people unusually sensitive to air pollution may have moderate health concerns.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. General public are largely unaffected.
Unhealthy	151-200	Everyone may begin to experience health effects, severe effects in sensitive groups.
Very Unhealthy	201-300	Health alert; everyone may experience severe health effects.
Hazardous	301-500	Emergency situation. The entire population is under threat.

5. CONCLUSIONS

In this research, the day-to-day AQI values were calculated for three years straight. In addition to this, the correlation coefficient of each pollutant was computed. This gave a valuable insight into the quality of air and the challenges that we are facing in a bid to improve the air quality.

The AQI value on an average was found consistently around 200 which is rendered unhealthy by the CPCB, see table II.

With the main contributing factors in contamination of air being SPM and RSPM, there is an urgent need to address their rising concentration. Some plausible reasons

for their increase might be industrial activities, agricultural malpractices and so on. Although SO2 and NO2 look seemingly under control, there has been a steady rise in their concentration levels that need further monitoring.

As cited earlier, air pollution is one of the deadly contributors hampering human life causing numerous life-threatening diseases. Moreover, the dire state of the capital city portrays a poor reflection of the country as a whole in the global sector. Hence, it has become quintessential to address this issue with a top priority to enhance the standard of living.

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REFERENCES

[1] Prashant Rajput, Gyanesh Kumar Singh and Tarun Gupta, "Indices Used for Assessment of Air Quality", Centre for Agriculture and Bioscience International, 2019.

[2] R. W. Gore and D. S. Deshpande, "An approach for classification of health risks based on air quality levels," 2017 1st International Conference on Intelligent Systems and Information Management (ICISIM), Aurangabad, pp. 58-61, 2017.

[3] Biswanath Bishoi, Amit Prakash, and V.K.Jain, "A Comparative Study Of Air Quality Index Based On Factor Analysis And US-EPA Methods for an Urban Environment", Bishoi et al., Aerosol and Air Quality Research, Vol. 9, No. 1, pp. 1-17, 2009.

[4] Shivangi Nigam, B. P. S. Rao, Navneet Kumar,and V. A. Mhaisalkar, "Air Quality Index – A Comparative Study for Assessing the Status of Air Quality", Research Journal of Engineering and Technology, pp. 267-274, 2016.

[5] Anikender Kumar and Pramila Goyal, "Forecasting of air quality in Delhi using principal component regression technique", Atmospheric Pollution Research, Vol. 2 , pp. 436-444, 2011.

[6] Kanchan Prasad, Amit Gorai, and Pramila Goyal "A review on air quality indexing system", Asian Journal of Atmospheric Environment, Vol. 9-2, pp. 101-113, June 2015.

[7] L. Song, "Impact Analysis of Air Pollutants on the Air Quality Index in Jinan Winter," 2017 IEEE International Conference on Computational Science and Engineering (CSE) and IEEE International Conference on Embedded and Ubiquitous Computing (EUC), Guangzhou, pp. 471-474, 2017.

[8] Y. Anand Babu, S. S. G. Sowjanya, M. Musalaiah, A. Lokesh Kumar, and G. V. M. Vikas, "Lustrum Ambient Air Quality Comparison Study in Emerging Cities of Andhra Pradesh", International Journal of Advances in Mechanical and Civil Engineering, Vol. 4, Issue-2, April 2017.

[9] Central Pollution Control Board, Government of India, Ministry of Environment, Forest and Climate Change "National Air Quality Index", 2015. [Online], Available: https://www.cpcb.nic.in/ .

[10] Air Now, "Air Quality Index Basics", June 2019. [Online], Available: https://www.airnow.gov/ .