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A Study on Air Quality Index

Harshita Raj[1*], Suhasini Vijaykumar[2]

[1,2]**Bharati Vidyapeeth Institute of Management and Information Technology, Kharghar**

Corresponding author: harshitarajj@gmail.com

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Abstract- Urban air pollution rate has grown to alarming state across the India. Most of the cities are facing issue of poor air quality which fails to meet standards of air for good health. An **air quality index**(AQI) is a numeric representation used by government agencies to tell the people that how polluted the air they are breathing or how polluted it is forecast to become. As the AQI increases, an large percentage of the population is likely to experience increasingly severe adverse health effects.
Number of various methods and algorithms are used by various agencies across the world to compute the AQI requires and the air pollutant concentration over a specified averaging period, the algorithms used are bsed on EPA's (Environmental Protection Agency) method for relating hourly data to the AQI or using technologies like the big data analytics used to process terabytes of data every hour-along with a dispersion model powered by machine learning techniques to get validated, reliable information. World Air Quality Index Project is another social enterprise project started in 2007 providing AQI info for more than 80 countries, covering more than 10,000 stations in 1000 major cities via those two websites: acqin.org and waqi.info which involved in understanding, accessing and verifying those new technologies, which can replace the more traditional setups at a affordable cost. This paper aims to study the various methods used for the calculation and the forecast of the various air pollutants which can help the officials to take necessary actions against the increase of the air pollutants.

Keywords: Air Quality, Real Time AQI

I. INTRODUCTION

Environmental Protection Agency (EPA) has developed the table named Air Quality Index (AQI) to provide accurate, up-to-date and easily understandable information about daily levels of air pollution.
Fresh air saves life but once its get polluted then it can cause long-term as well as short-term health effects. It is found that babies and elders are more affected by the polluted air.

Breathing polluted air puts you at a higher risk for Asthma and Cancer including other respiratory diseases. The severity of the air pollution can be seen as, exposure to air pollution during pregnancy can increase the risk of premature birth, stillbirth and low birth weight. That's why it's a necessity for people to be aware of the quality of the air they are breathing. So it is an important responsibility and accountability of the government of any country to ensure this.

In numbers, AQI is diagrammatic between a scale of '**0**' to '**500**', in which **0** representing **fresh air** and **500** representing **hazardous air**(Values can vary from country to country). The measurement scale is based on a prefixed colour system for a definite value on scale. In India the national AQI was launched in New Delhi on 17th September, 2014 under the Swachh Bharat Abhiyan. The proposed index has 6 categories with elegant colour scheme as follows:

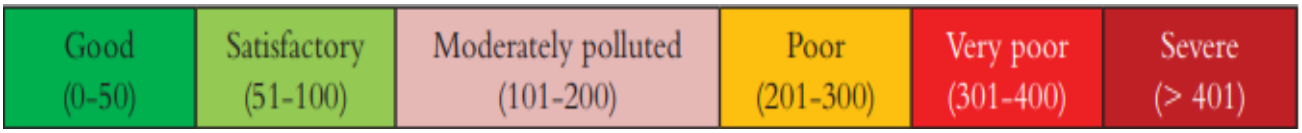

Fig 1: (taken from https://en.wikipedia.org/wiki/Air_quality_index)

Table 1(AQI Values with associated impacts)

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 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 people on prolonged exposure, and discomfort to people with heart disease.
Very poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401–500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

II. LITERATURE REVIEW

The process for AQI calculation is different in different countries which implies that the result of AQI varies from country to country.As we can observe this from following figures in which the AQI of same place (Bandra, Mumbai) is calculated at the same day and time (16-02-2019, 6:00 pm) on three different websites which are:

1. National Air Quality Index (Central Pollution Control Board, Ministry of Environment, Forests and Climate Change)
2. aqicn.org / waqi.inf (The world Air Quality Index Project which is a non-profit project started in 2007 , founded by the team located in Beijing,China.)
3. SAFAR-India (**S**ystem of **A**ir Quality and Weather **F**orecasting **A**nd **R**esearch, Ministry of Earth Science, Govt. Of India. Indian Institute of Tropical Meterology, Pune)

These three websites are giving the different AQI for same place at the same time which is quite confusing. One is showing the AQI as **123 as** in Fig.(2) which is **moderate**, another is showing it as **145 as** in Fig.(3) which is **unhealthy** and the last one is showing the **overall AQI** as **153** in the Fig.(4) .

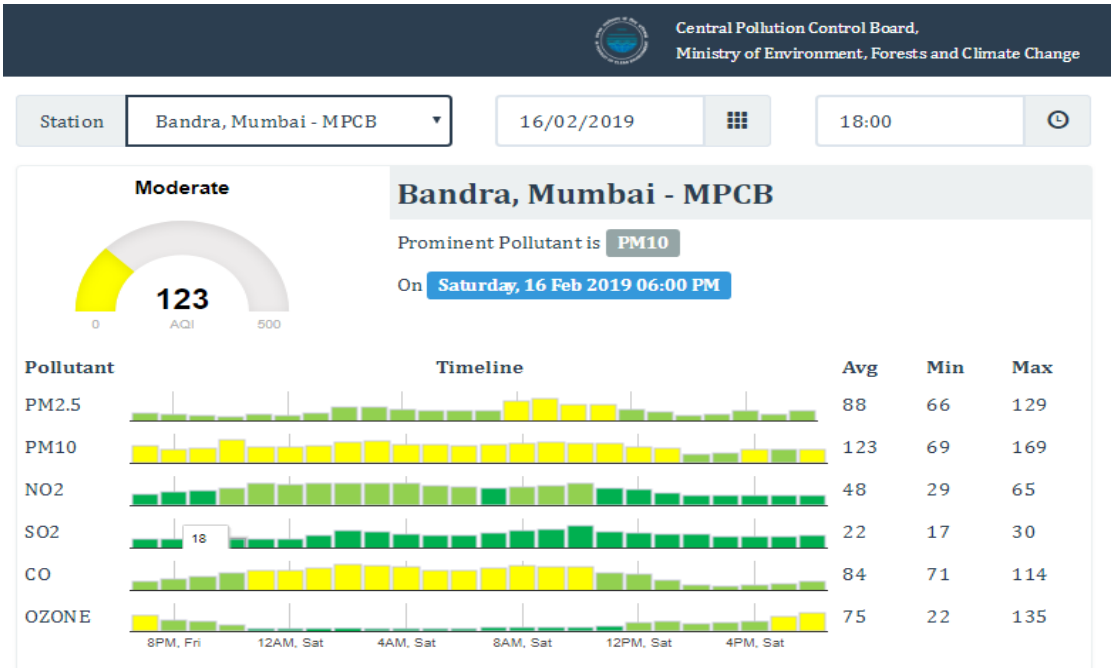

Fig 2: Real Time AQI of Bandra(Mumbai) on Saturday, 16 Feb 2019
Source: National Air Quality Index

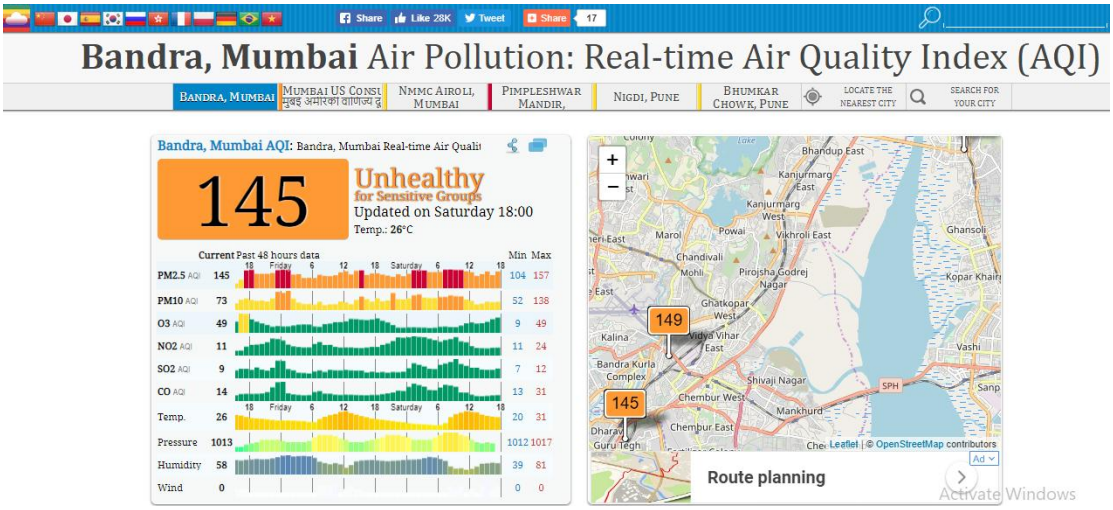

Fig 3:Real Time AQI of Bandra(Mumbai) on Saturday, 16 Feb 2019
Source: aqicn.org, International

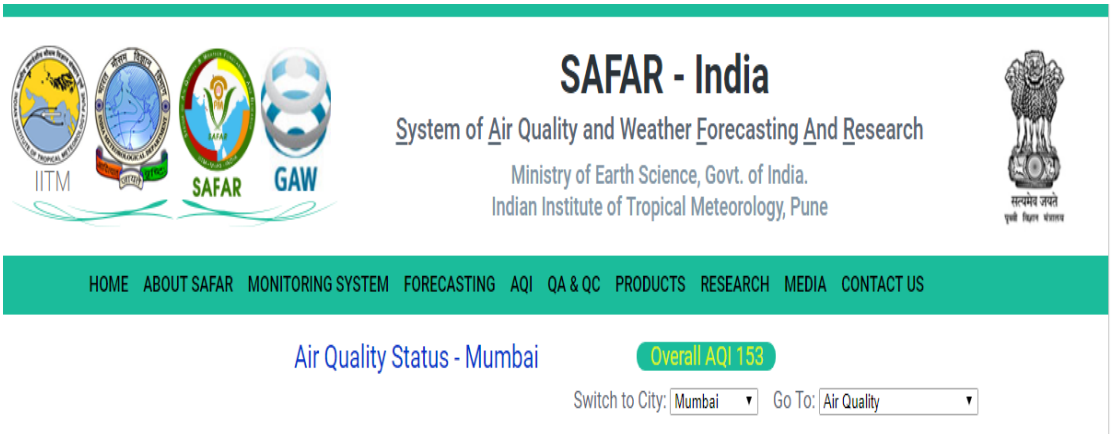

Fig 4:Real Time AQI of Mumbai on Saturday, 16 Feb 2019
Source: SAFAR-India

III. METHODOLOGY

The difference in values of calculated AQI doesn't implies that one of them is falsifying their data. It is just because of different considerations and assumptions which they are making while creating their own API. For example China initially only considered PM2.5 but not the PM10 whereas United State has considered both the values.
In **Canada** , **United Kingdom** and **Hong Kong** the measurement scale provides a number from **1 to 10+** with **1** representing **low risk** and **10+** representing **very high risk** to indicate the level of health risk associated with local air quality whereas in **India**, **South Korea** and **United States** provides the measurement scale numbered from **0** to **500** with the increasing levels of Health Concern.

In India, the AQI is calculated around **5** main pollutants which are:
1. PM10 (Particulate Matter with a diameter less than 10 micrometers)
2. PM2.5 (Particulate Matter with a diameter less than 2.5 micrometers)
3. O3 (Ozone)
4. CO (Carbon Monoxide)
5. NO3 (Nitrogen Dioxide)

In the calculation of AQI, majorly two steps are involved as shown in Fig(3):
1. Calculate individual index for each and every pollutants which is generally known as **sub-index**.

2. Then apply **aggregate function** on previously calculated sub-indexes to finally get **overall AQI**.
Sometimes from the calculated sub-indexes, the index which has the worst value according to the predetermined standards will decide the value of overall AQI or the highest value among the different sub-indexes become the overall AQI.
There are several stations which are established to give the concentration of all the pollutant at that moment in time and the corresponding average over a period of time. For **Carbon Monoxide and Ozone**, the time over which the average is taken foe further calculation is **8 hours**, whereas for the remaining 3, it is **24 hours**. The unit in which the measurement of the concentration of the pollutant is taken is **microgram** and in the case of Carbon Monoxide it is **miligram per cubic meter**.

3.1.1 Sub-Indices

Relationship between the pollutant concentration Y(n) and their corresponding index Index(n) represents the Sub-Index function.So as the concentration of the particular pollutant changes,relative environmental consequences also get reflected as shown in Fig(3).It can be in the form of segmented linear, linear and non-linear.The individual sub-index for the given pollutant is calculated as:

$$\mathbf{I_p = [(I_{HI} - I_{LO})/(BP_{HI} - BP_{LO}) * (C_p - BP_{LO})] + I_{LO}}$$

Where,
$\mathbf{I_p}$ = Index for pollutant p.
$\mathbf{I_{HI}}$ = AQI value corresponding to $BP_{HI.}$
$\mathbf{I_{LO}}$ =AQL value corresponding to $BP_{LO.}$
$\mathbf{BP_{HI}}$ = Breakpoint that is greater than or equal to $C_{p.}$
$\mathbf{BP_{LO}}$ =Breakpoint that is less than or equal to $C_{p.}$
$\mathbf{C_p}$ = Rounded concentration of pollutant p.
The highest index (highest value of I_p) represents the AQI of the location.

3.2.1 Aggregation

After the calculation sub-indices, the next step is to combine them in a simple or weighted additive form like as shown in Fig(3):

$$I = \Sigma W_n I_n \text{ (For n = 1 to i)}$$

Where,
W_n = weightage of the pollutant.
I_n = sub-index for pollutant n.
i = total number of pollutant variables.

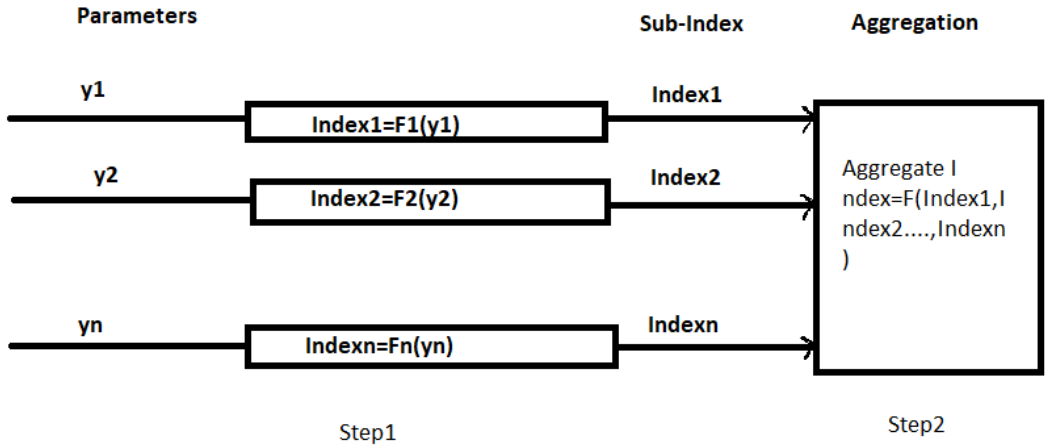

Fig 3: pictorial representation of AQI calculation

IV.IMPLEMENTATION

The **Pollution Detection Application** will help the user in knowing that the city in which they live is facing poor air quality and they have to take cautions.
There are 3-4 mobile apps available in the market to check the city's air quality, some of them are:

- Air Quality | Air Visual
- Air Quality Index Breezometer
- Air matter for ios devices
- SAFAR-Air app launched by government for the citizens in Delhi and Pune

The proposed application is able to produce the result of pollution level based on air quality index of the current location as well as the required location. It shows the pollution level as the air is in good quality or is in dangerous state or is in moderate state and so on. It also gives a short notification associated with the above information like which group of people are in danger primarily.

I have used 3 APIs :

1. aqicn.org
2. AirNow API
3. AirVisual API

The first one is a world wide used api for air quality forecasting.

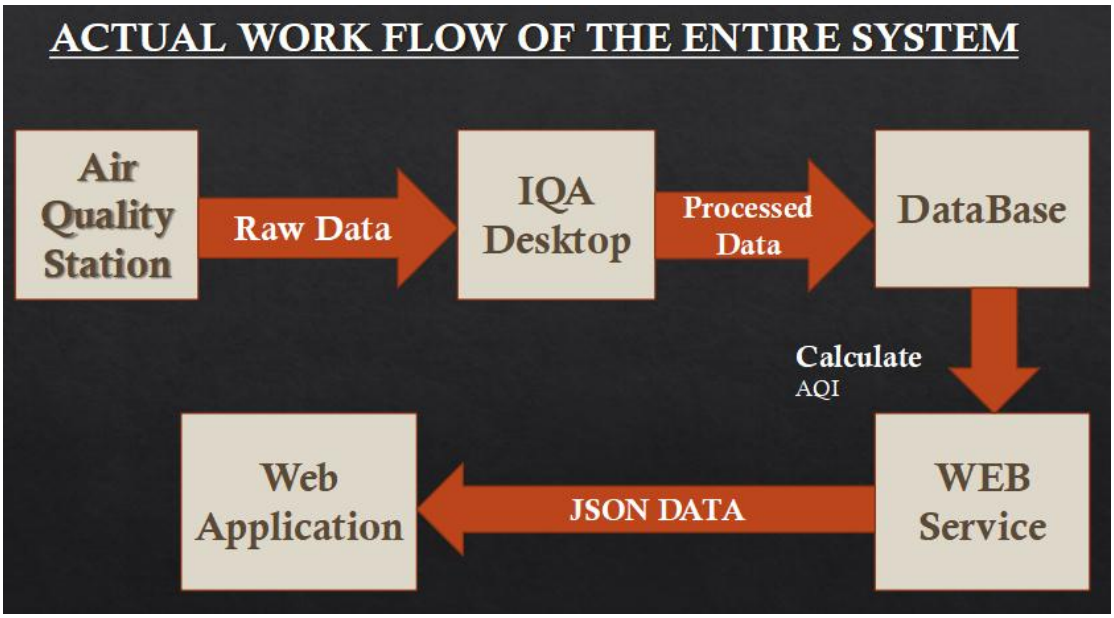

Fig 4: Actual work flow of the entire system

V. CONCLUSION

We understand the basic meaning of Air Quality Index and the general approach used in the calculation of AQI.

- The AQI is an effective way to communicate the status of the polluted air to the general public in the simple color-coded form.
- It is an unitless index which indicates the air quality and its health effects.
- The AQI of the same place at the same time may vary from website to website which doesn't implies any false impression and misleading data.
- It is of utmost importance to prepare indices according to the predefined standard of each pollutant.

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Authors Profile

Harshita Raj pursued Bachelor of Computer Applicatio from Patna University,Bihar, India in 2016. She is currently pursuing Master of Computer Application from Bharati Vidyapeeth's institute of management and information technology(BVIMIT) ,Navi Mumbai,affiliated to University of Mumbai,India.

Suhasini Vijaykumar is a professor of Bharati Vidyapeeth's Institute of Management and Information Technology, affiliated to University of Mumbai.

