

Geospatial Workflows Pilot Project

On

Lockdown Effects on AOD over Different Cities

Using MODIS terra AOD dataset

Under the Guidance of
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Introduction

Due to exponential increase in covid-19 cases around the whole world including India, the world is experiencing lockdown; Due to lockdown various economic sectors in the country are closed down especially factories and transport systems. In India the lockdown period has started from 25 march and is still going on. As everyone is at home, there are minimal human activities which results in less air pollution in the air. Hence in this project, we have tried to analyse the air pollution levels in major cities in india by measuring the aerosol levels.

Tiny solid and liquid particles suspended in the atmosphere are called aerosols. Examples of aerosols include windblown dust, sea salts, volcanic ash, smoke from fires, and pollution from factories. These particles are important environmental elements because they can affect climate, weather, and people's health. Aerosols affect climate by scattering sunlight back into space and cooling the surface. Aerosols also help cool Earth in another way -- they act like "seeds" to help form clouds. The particles give water droplets something to cling to as the droplets form and gather in the air to make clouds. Clouds give shade to the surface by reflecting sunlight back into space. People's health is affected when they breathe in smoke or pollution particles. Such aerosols in our lungs can cause asthma or cancer or other serious health problems.[] The measurement of such particles can be done by using a parameter called Aerosol optical depth (AOD). The value of AOD can indicate the amount of pollutants in air due human activities.

The analysis is done for four major cities in India namely Delhi, Kolkata, Mumbai and Chennai for years 2017,2018,2019 and 2020. Hence, comparing the lockdown levels with other years. Finally once the analysis is done the results are published on the website made on django platform using MVC architecture.

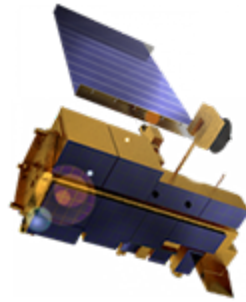
Objective

To compare the air quality of the lockdown period with previous years air quality for different cities in India and Display the results through a web page.

Dataset used

Aerosol optical thickness: It is a measure of how much light the airborne particles prevent from traveling through the atmosphere. Aerosols absorb and scatter incoming sunlight, thus reducing visibility and increasing optical thickness. An optical thickness of less than 0.1 indicates a crystal

clear sky with maximum visibility, whereas a value of 1 indicates the presence of aerosols so dense that people would have difficulty seeing the Sun, even at mid-day!



Fig(i):MODIS Sensor

Specification of MODIS Sensor	
Orbit	705 km, 10:30 a.m. descending node (Terra) or 1:30 p.m. ascending node (Aqua), sun-synchronous, near-polar, circular
Scan Rate	20.3 rpm, Cross Track
Swath	2330 km Cross Track

Table(i): Specification of MODIS Sensor

Hence, **Modis terra 550nm AOD(8 day)** data set is used for the analysis done in this project. The datasets are taken from NASA Earth Observation site.

Area Taken-

We have processed the downloaded MODIS data by taking 4 cities into the consideration that are as follows-

- Delhi
- Chennai
- Mumbai
- Kolkata

as in India these cities show major involvement in the air pollution indexing. These are the best areas where we can compare the Aerosol Optical Depth in the past 4 years.

System Requirements

Software-

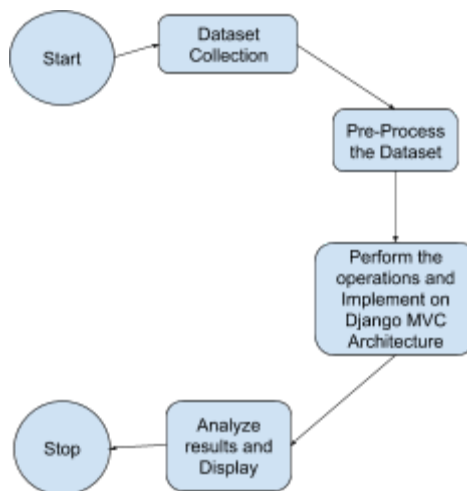
- Python 3.7 with Django Framework installed
- QGIS 3.10
- Standard Updated Web Browser (eg. Google Chrome)
- Text Editor
- Camunda Web Modeler

Hardware-

- 4GB Ram
- Minimum 2.20Ghz Processor

Methodology

We have used the raw data of the MODIS sensor and pre-processed it for the further computations. The below flow chart would explain the basic working of the project.



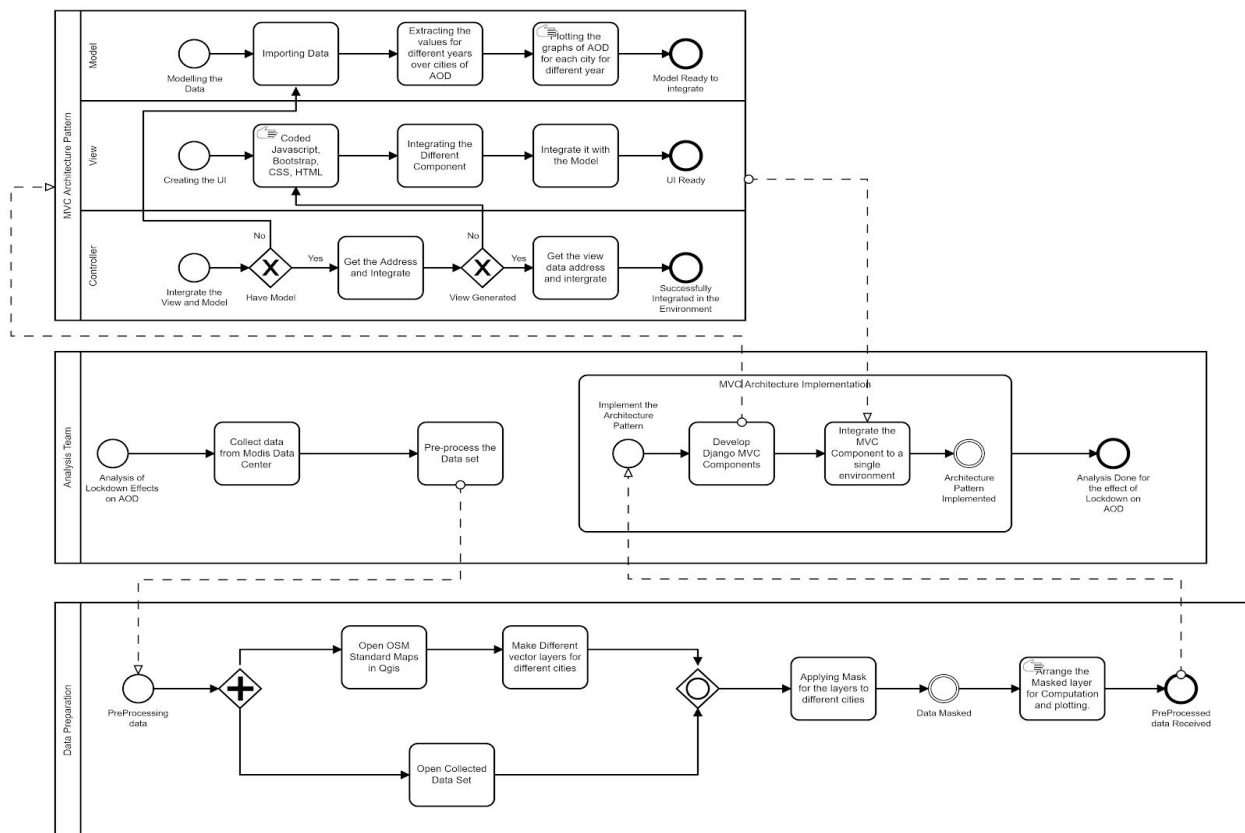
Fig(ii):FlowChart

This flowchart represents the overview of the working. As the fig explains, It has basically 4 phases. Data collection, Pre-processing, Implementation MVC, Analysis and Result.

The detailed explanation of each phase is documented in the WorkFlow section.

Workflow

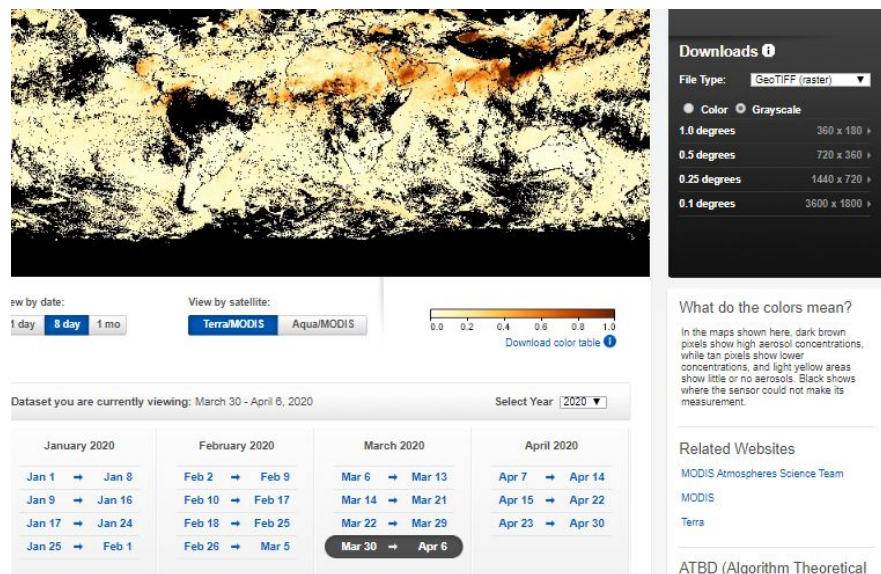
The basic workflow of each step is being reflected in the below BPMN diagram. This BPMN diagram represents the different processes in the detailed explanation for their behaviour. There are basically 3 pools that are Analysis Team, Modis Data Center, Data Processing Team. In each of the pools, there is a different task that is to be accomplished. In Modis Data Center pool, the request is sent to them to grant the access of the required data. As shown in BPMN diagram, the Data centre will validate our request and grant the access for the same. If validation is not successful then it sends an authentication message and asks to resend the request with proper validation. Similarly in other pools also, like in MVC, the Architecture pattern is made that contains Model, View, Controller. Hence, BPMN diagrams help in understanding the full architecture of the project.



Fig(iii): BPMN diagram

Data Collection-

NASA Earth Observations (NEO): NEO provides the ability for users to download CSV (comma separated values) and floating point GeoTiff files for datasets. The data values included in these files, and additionally used in the data analysis component, are only approximations based upon the scaled range of the original source data.[] As such, these values are a few levels of upgraded value of the raw data. A query is made on NEO for the dataset of the Modis Terra 550nm AOD for 8 days. After the validation of the request, they provide us the data as we need, and the data is downloaded. Prior to that the data is pre-processed for further analysis.



Fig(iv): Nasa Earth Observations (NEO)

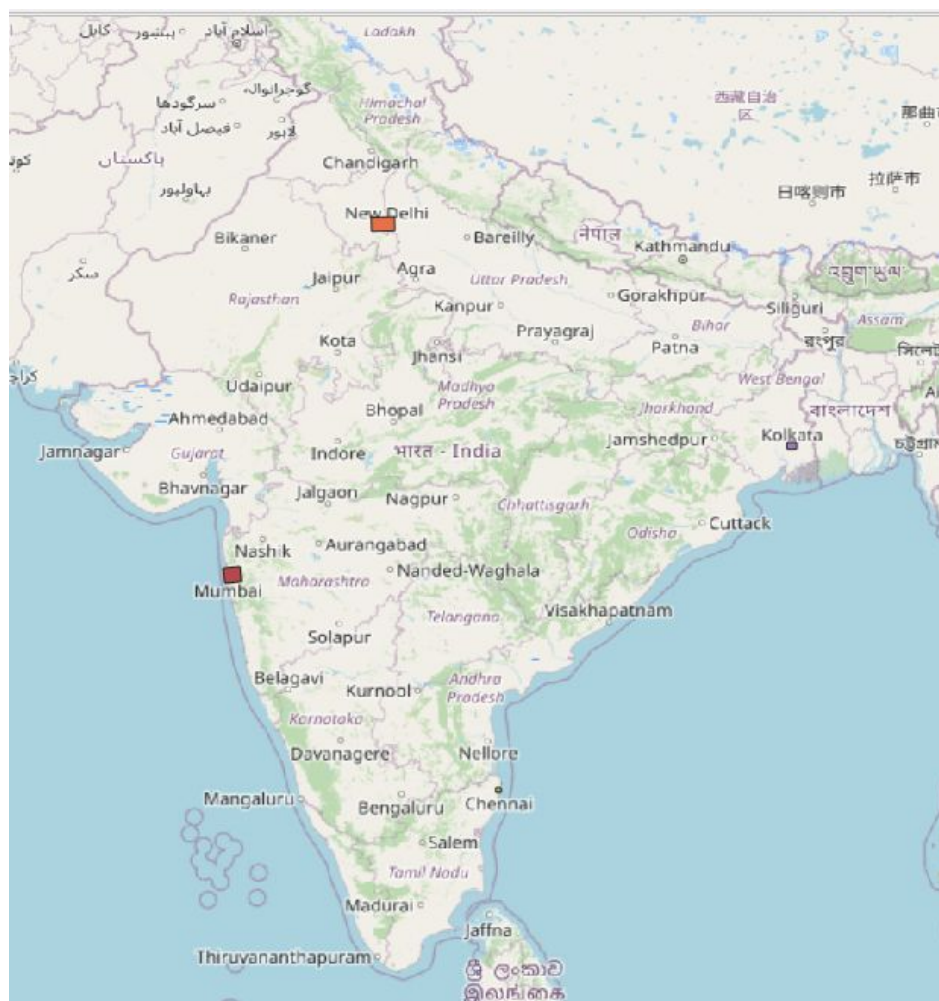
Data preparation & Analysis

Pre-processing:

Once the data is downloaded it needs to be sunsetting according to the extent chosen in the project. To subset/clip the dataset QGIS is used in a batch mode, since the same operation needs to be applied on multiple data.

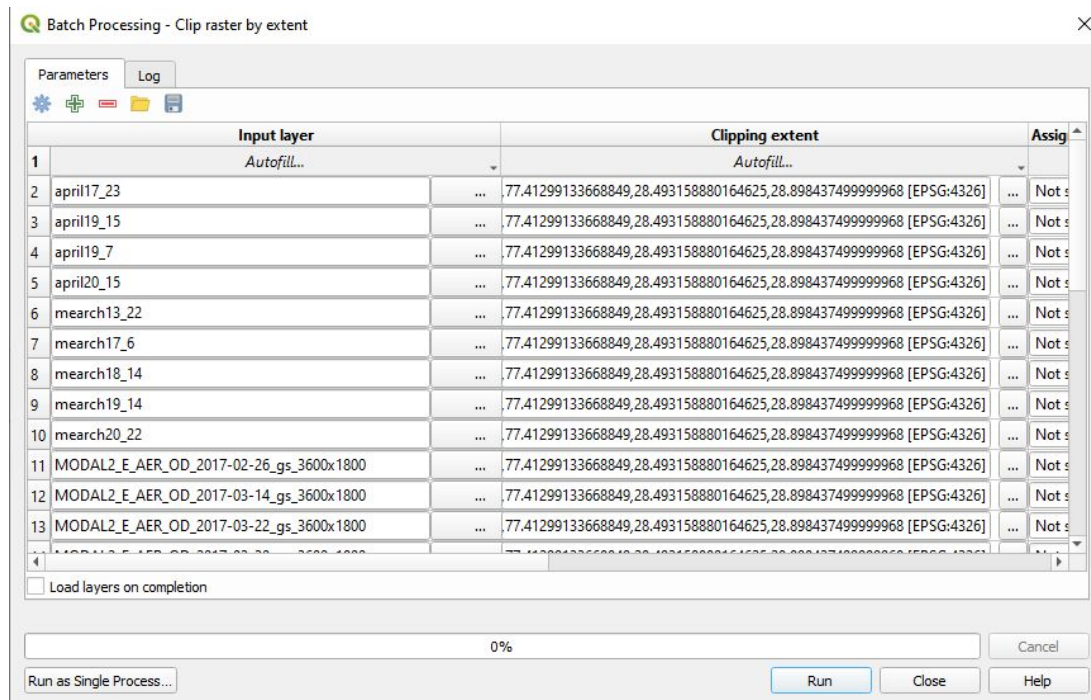
Processing in QGIS is done in following steps:

- First the various extent that needs to be clipped from the dataset is made into a vector layer with the help of OSM standard map . In this case the name of these layers would be Delhi, Mumbai, Chennai and Kolkata as shown in the fig()



<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	chennai
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	kolkata
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	delhi
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	mumbai
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	<input type="checkbox"/>	1
	<input type="checkbox"/>	255
<input type="checkbox"/>	<input type="checkbox"/>	mearch13_22
	<input type="checkbox"/>	1

Fig(v):Location of cities



Fig(vi): Batch Processing

- Once the vector layers are made in the preprocessing tool box “clip by extent “ tool is chosen in batch mode the data sets are clipped.

Further the clipped data is arranged in the folder in a chronological way, so that they are further useful for analysis.

Analysis:

After the preprocessing the data is analysed using python in the jupyter notebook.

To analyse the data first all of the tiff files are read and stored as numpy arrays. To make the reading of the data more efficient a list for a year is made and all the arrays are stored in that list. For a comparative analysis the data needs to be plotted, hence each array is averaged and plotted in the same graph. Hence generating the model for the MVC architecture deployed in django.

MVC Implementation: django

After the pre-processing of data different operations are taken place to integrate the analysis using MVC architecture pattern that helps to combine all the modules of work into a single fashion. It basically encapsulates the working directories and data into the single framework.

MVC Architecture Pattern

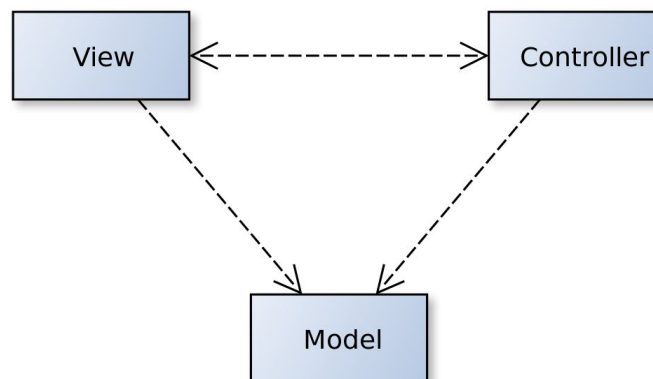
Initially, there was a time in which the codes were written in the single file. Every single piece of code increases the file size and so the **complexity to handle the modules increases**. As now in the modern era, the modules and different apps not only include some static pages but also dynamic pages. **Technologies like Machine learning, Artificial Intelligence made many apps dynamic**, the view of the interface varies from person to person upon his/her interests.

Hence to hold up to these features, MVC Architecture Pattern came into picture. It not only allows us to combine the stuff into a single capsule but also allows us to work on clouds.

MVC is the acronym for **Model View Controller**. It is basically the product development Architecture that allows dynamic user interface.

MVC architecture has 3 components-

- Model
- View
- Controller



Fig(vii): MVC Components

The difference in these components helps the developer to focus on one aspect of the web-app and therefore, better code for one functionality with better testing, debugging and scalability.

1. Model

The Model is the part of a web-app which acts as a mediator between the website interface and the database. In technical terms, it is the object which implements the logic for the application's data domain. There are times when the application may only take data in a particular dataset, and directly send it to the user Interface without any database then the dataset is called to be the model.

2. View

This component contains the UI logic in the Django architecture. View is actually the User Interface of the web-application and contains the parts like HTML, CSS and other fronted technologies. Generally, this UI creates from the Models component, i.e., the content comes from the Models component.

3. Controller

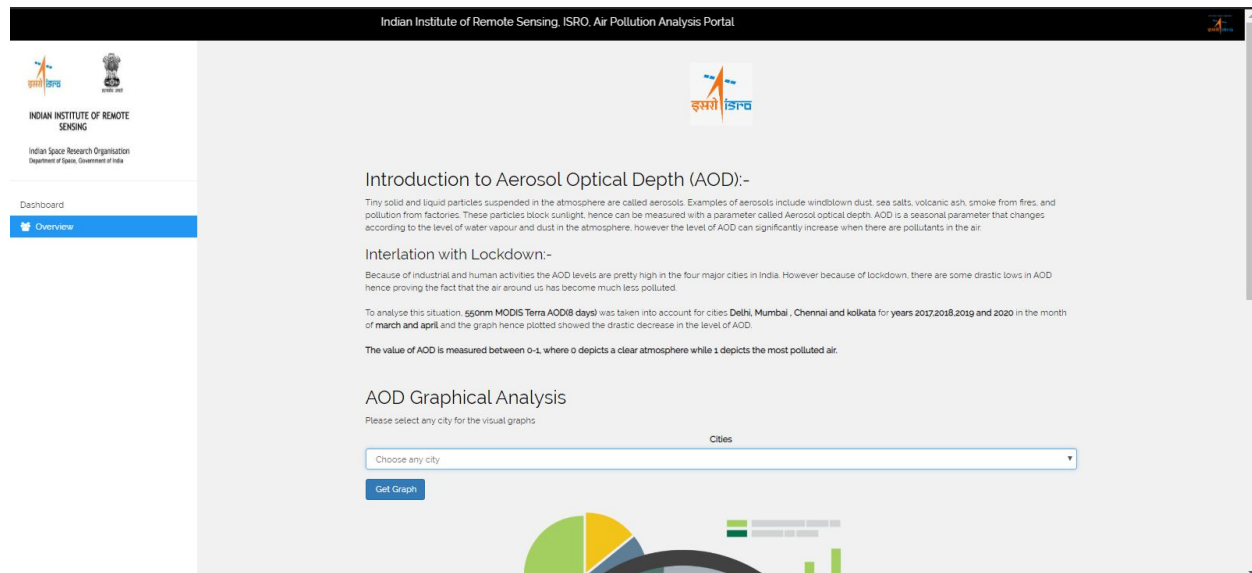
The controller as the name suggests is the main control component. What that means is, the controller handles the user interaction and selects a view according to the model. The main task of the controller is to select a view component according to the user interaction and also applying the model component.

This architecture is implemented over our project. In Model, the basic logic of data analysis and plotting is implemented. Moreover, in view, UI is made by using HTML, Bootstrap, Javascript. In the controller, urls are adjusted to integrate all the modules and encapsulate into the single frame.

Results

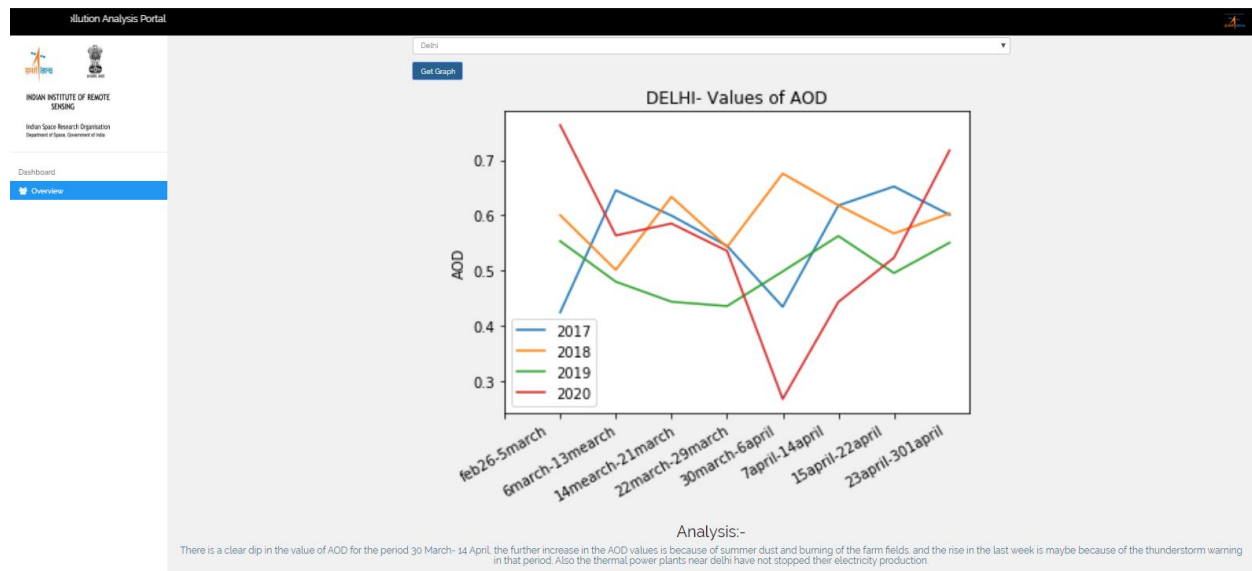
Finally a website was made depicting the comparison/analysis done for various cities. The url for the website is "https://harshal306.github.io/LockDownAOD_Analysis/index".

The layout of the website is as follows:

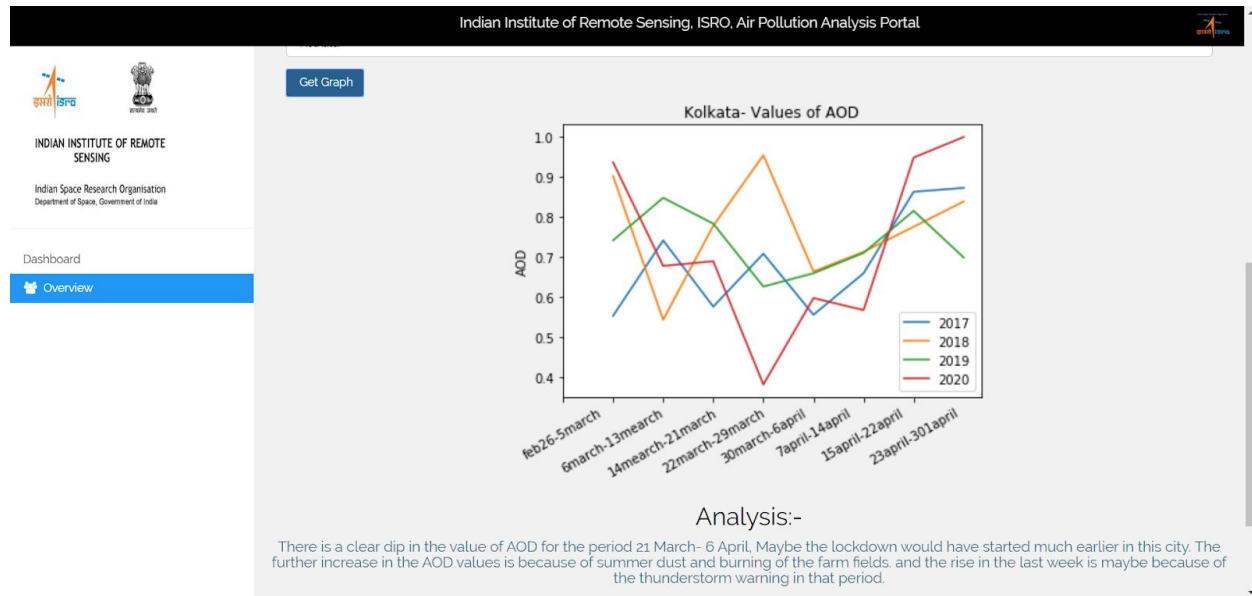


Fig(viii):Homepage

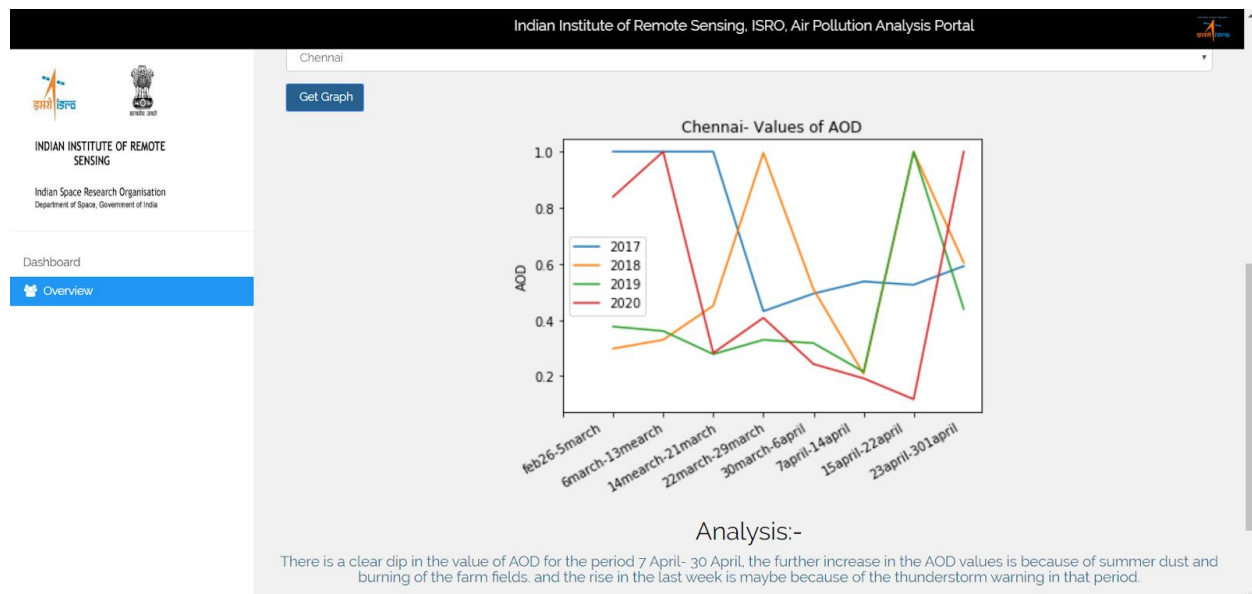
We see that we are successful in integrating all the modules using MVC architecture patterns. Below all the analysis of the Chennai, Delhi, Mumbai and Kolkata is displayed,



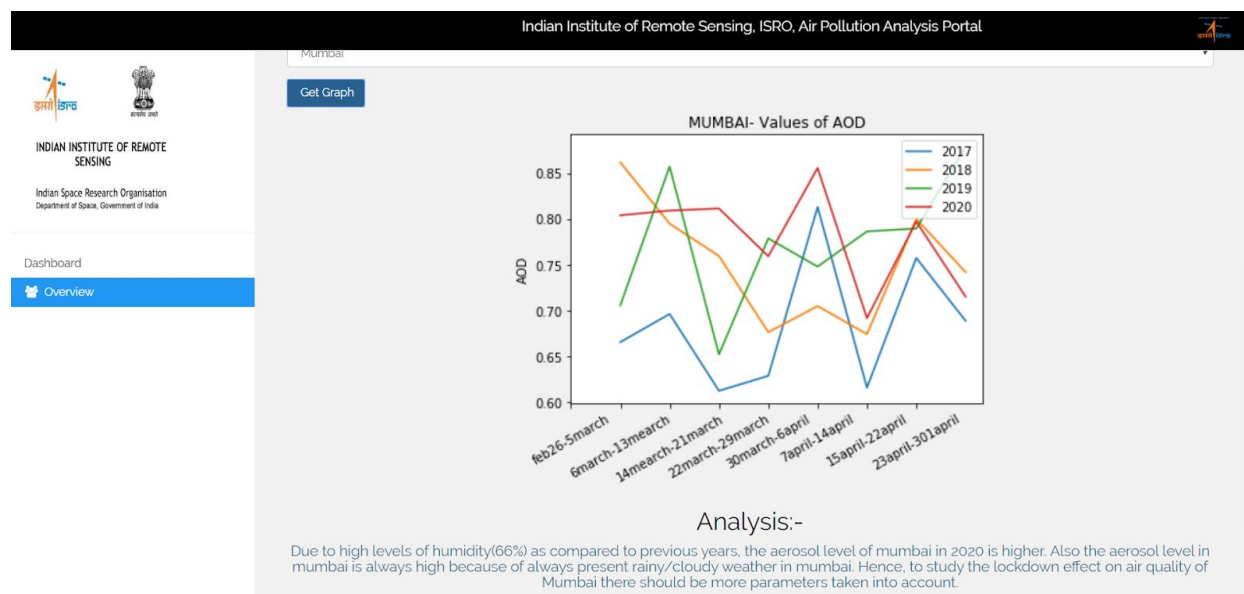
Fig(ix): Delhi Analysis



Fig(x): Kolkata Analysis



Fig(xi): Chennai Analysis



Fig(xii): Mumbai Analysis

Conclusion

The analysis of these graphs are as follow-

Delhi Region-

There is a clear dip in the value of AOD for the period **30 March- 14 April**, the further increase in the AOD values is because of summer dust and burning of the farm fields. and the rise in the last week is maybe because of the thunderstorm warning in that period. Also the thermal power plants near delhi have not stopped their electricity production.

Chennai Region-

There is a clear dip in the value of AOD for the period **7 April- 30 April**, the further increase in the AOD values is because of summer dust and burning of the farm fields. and the rise in the last week is maybe because of the thunderstorm warning in that period.

Mumbai Region-

Due to high levels of humidity(66%) as compared to previous years, the aerosol level of mumbai in 2020 is higher. Also the aerosol level in mumbai is always high because of always present

rainy/cloudy weather in mumbai. Hence, to study the lockdown effect on air quality of Mumbai there should be more parameters taken into account.

Kolkata Region-

There is a clear dip in the value of AOD for the period **21 March- 6 April**, Maybe the lockdown would have started much earlier in this city. The further increase in the AOD values is because of summer dust and burning of the farm fields. and the rise in the last week is maybe because of the thunderstorm warning in that period.

Future Scope

There are several scope starts from this project onwards such as-

1. Analysis can be further branched into more cities.
2. More Attributes can be added to UI for the analysis.
3. Use of the GIS layer can be implemented to make maps of different cities according to the intensity of AOD.
4. This result can be taken as a base value and further analysis can be done as slowly the human activities start again.