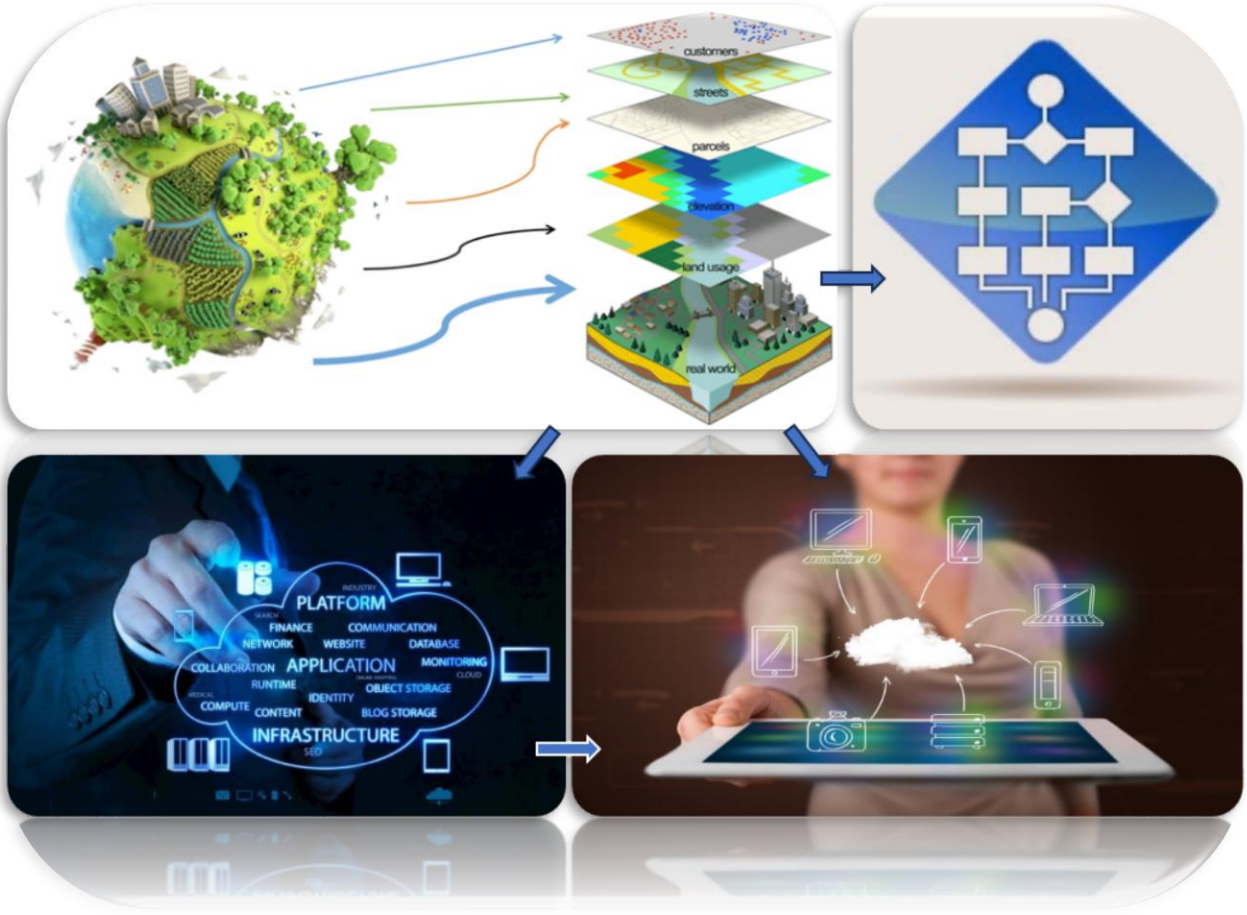
Integrated Geospatial Workflow Project Report - Weather & Air Pollution Web App



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1. INTRODUCTION

The weather and air quality play a significant role in personal well-being and safety. Factors such as extreme heat, high humidity, and air pollution can have detrimental effects on our health, leading to respiratory issues, allergies, and exacerbating existing medical conditions. It is crucial to understand and monitor the quality of the air we breathe. To assess air quality, the Air Quality Index (AQI) is used which relies on measurements of various pollutants, including particulate matter (PM2.5 and PM10), ozone (O3), nitrogen dioxide (NO2), Sulphur dioxide (SO2), and carbon monoxide (CO). These measurements provide valuable insights into the composition and concentration of pollutants in the atmosphere, helping us evaluate the potential health risks associated with the air we breathe. There are six AQI categories, namely Good, Satisfactory, moderately polluted, Poor, Very Poor, and Severe. Each of these categories is decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints). AQ sub-index and health breakpoints are evolved for eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term (up-to 24 hours) National Ambient Air Quality Standards are prescribed.

AQI Category	AQI	Concentration range*							
		PM_{10}	$PM_{2.5}$	NO_2	O_3	CO	SO_2	NH_3	Pb
Good	0 - 50	0 - 50	0 - 30	0 - 40	0 - 50	0 - 1.0	0 - 40	0 - 200	0 - 0.5
Satisfactory	51 - 100	51 - 100	31 - 60	41 - 80	51 - 100	1.1 - 2.0	41 - 80	201 - 400	0.5 - 1.0
Moderately polluted	101 - 200	101 - 250	61 - 90	81 - 180	101 - 168	2.1 - 10	81 - 380	401 - 800	1.1 - 2.0
Poor	201 - 300	251 - 350	91 - 120	181 - 280	169 - 208	10 - 17	381 - 800	801 - 1200	2.1 - 3.0
Very poor	301 – 400	351 - 430	121 - 250	281 - 400	209 - 748*	17 - 34	801 - 1600	1200 -1800	3.1 - 3.5
Severe	401 - 500	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

* CO in mg/m^3 and other pollutants in $\mu g/m^3$; 2h-hourly average values for PM_{10}, $PM_{2.5}$, NO_2, SO_2, NH_3, and Pb, and 8-hourly values for CO and O_3.

Figure 1: Air Quality Standards

On the other hand, Weather consists of the current atmospheric conditions, such as temperature, humidity, precipitation, wind speed, and overall atmospheric state. It affects our daily lives and influences our activities, from planning outdoor events to making travel arrangements. By understanding the current weather conditions, we can make informed decisions and take appropriate measures to ensure our safety and well-being. Both the weather and air quality are interconnected and impact our health and safety. Monitoring and staying informed about these factors enable us to proactively protect ourselves, make informed choices, and adapt our plans accordingly. By prioritizing our understanding of the weather and air quality, we can lead healthier lives and create safer environments for ourselves and those around us. We recognize the significance of staying well-informed about the surrounding environment, whether you are organizing outdoor activities,

concerned about health implications, or simply curious about atmospheric dynamics. Our Weather and Air Quality Index webpage is the ultimate resource for comprehensive and up-to-date information on weather conditions such as temperature, humidity, precipitation, wind speed and air quality in your vicinity. With this information at hand, users can make informed decisions and take necessary precautions or prepare for extreme weather events. The interface of our web page is user-friendly, ensuring that users can easily navigate and access the desired information.

Key Features of Weather and Air Pollution Web Page

1. Historical Weather Trends: Investigate long-term weather patterns and trends with the use of historical information. Create a visual representation of typical temperatures, precipitation amounts, wind patterns, and more. Become more knowledgeable about climate changes and how they may affect your plans.
2. Data Analysis: The information shown here is the most recent scenario data for the time period to be displayed for the supplied coordinate.
3. Interactive Data Visualizations: Our online application visualizes weather data analysis using attractive, interactive maps. Use tools like zooming and weather parameter overlays to delve further into the data. Discover insightful information and identify correlations with ease.
4. Comparative Analysis: Analyze weather patterns in various areas or throughout various time periods. Analyze temperature variances, precipitation totals, or other meteorological variables between cities. Recognize climatic patterns and regional variations with ease.
5. Personalized weather analytics: Tailor the analysis of the weather data to your own requirements. Keep tabs on and evaluate your own weather-related data, such as outdoor activities or gardening tasks. personalized observations and suggestions based on past weather information are provided.
6. Reliable and up-to date information: Integrating with reliable third-party weather data APIs allows us to provide reliable and current information with ease. Take use of thorough weather databases, predictions, and analysis of past data. You can feel at ease assured that you have access to precise weather data.

2. OBJECTIVE

1. The web-app will enable the user to know the real time weather parameters and Air Pollution parameters of any location, provided input.

3. DATA AND TOOLS USED

3.1 Data Used

The 'Open Weather Map' data source served as the source of the necessary information. It contains information for various time periods relating different meteorological or weather factors. The volume of this data is enormous, and handling it is difficult. An Application Programming Interface (API) can be used to simplify this

procedure. It serves as a layer of intermediate processing for data transit across systems. The usage of API makes it simple to retrieve data using the request method directly from the source without keeping it locally or utilizing a cloud service. This makes it simple to query the retrieved data using any query language or programming language and show it on an output form.

We used two APIs for carrying out this project; one was fetching the 'Current Weather' data (https://api.openweathermap.org/data/2.5/weather?lat={lat}&lon={lon}&appid={API key}) from the Open Weather Map portal, and the other was fetching the 'Air Pollution' data (http://api.openweathermap.org/data/2.5/air_pollution?lat={lat}&lon={lon}&appid={API key}). The necessary ones were retrieved from the data in the Current Weather API, which offers information on a variety of weather and meteorological factors, including temperature, humidity, windspeed, how it feels etc. Like this, the Air Pollution API retrieves such as carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO2), ozone (O3), Sulphur dioxide (SO2), ammonia (NH3), and particulates (PM2.5 and PM10), in addition to the basic Air Quality Index, from which the most frequently addressed and measured pollutants were queried and displayed.

3.2 Tools Used

1. **Hypertext Markup Language (HTML):** Web pages and web apps are most widely made using HTML, considered the industry standard markup language. It dictates the elements and their placement on the page, providing the web page's structure and content. To mark up every aspect of a web page, HTML employs a set of tags. These tags are positioned inside the HTML content and are surrounded by angle brackets (‘< >’). Every tag has a specific function and provides instructions to the web browser on how to understand and display the material. Web pages' structure and content are rendered by HTML, thereby lays the foundation upon which web browsers build their pages. It is a key language for creating websites and since it is frequently used with JavaScript for interaction and CSS for style to produce dynamic and interesting web experiences. Structure and Semantics: HTML offers web content an organized and semantic markup. It lets you specify the app's logical organization, including its headers, paragraphs, lists, and sections. Cross-Browser Compatibility: As HTML is supported by all popular web browsers, your web app will function reliably across a variety of platforms and gadgets. By employing a standardized method, it reduces compatibility concerns that could occur when using browser-specific technologies to create web pages.
    1.1. **Accessibility:** HTML yields accessibility features and suggestions. providing it achievable to develop online applications that are usable by a variety of users, including people with impairments. You may increase the usability of the app for users of assistive technology by utilizing semantic tags, alt attributes for pictures, and appropriate document structure.
    1.2. **Wide Adoption and Community Support:** HTML has a sizable and vibrant development community and has been around for a while. This indicates that you have access to a multitude of tools, guides, and documentation to help you create your web application. On top of HTML, several frameworks and libraries are constructed, adding extra capabilities, and streamlining the development process. Flexibility & Extensibility: A variety of frameworks, libraries, and tools may be used to customize and

expand HTML. Building online applications using a component-based approach is made easier and more scalable by well-known frameworks like React, Angular, and Vue.js.

2. **Cascading Style Sheets (CSS):**

   To manage the visual display and styling of web pages, it is used with HTML. Through the aid of CSS, can separate style concerns from HTML, alter the visual perceive, uphold consistency, develop responsive layouts, prioritize certain components, foster accessibility, and simplify maintenance. Developers get the tools they need by CSS to create web pages that are both aesthetically pleasing and easy to navigate while also achieving their design objectives. Having key features distinction of Interests, Flexible Styling, Continuity of Design, Responsive designs, Targeting Strictly, Improvements to Accessibility, Simple Maintenance.

3. **JavaScript**:

   JavaScript provides a wide range of features that may be used to build dynamic and interactive web sites. It is feasible to do client-side data processing, manage form validation, obtain data from APIs, and more by mixing JavaScript with HTML and CSS. Web applications that employ JavaScript are more interactive and useful because they can respond to user input and alter their content dynamically.

   Leaflet.js:

   Interactive maps are created for websites using the widely used JavaScript library Leaflet. It provides a straightforward and flexible method of including maps in web applications. Create interactive, user-interactive maps using Leaflet's assistance. markers, polygons, lines, and other objects might be used to indicate locations, routes, borders, and other geographic information on the map. Leaflet provides a seamless map viewing experience on both desktop and mobile devices since it is mobile-friendly. Leaflet provides a broad range of options when it comes to changing the appearance of maps.

4. **Visual Studio**

   The integrated development environment (IDE) created by Microsoft has the acronym Visual Studio. It offers an extensive collection of tools and capabilities for developing several kinds of applications, including web applications, desktop applications, mobile apps, and cloud-based solutions.

5. **Camunda**

   The workflow and business process automation platform Camunda is open-source. For modelling, carrying out, and monitoring business processes, it offers a full range of tools and capabilities. In order to automate and improve their business operations, organizations of all sizes and in a variety of sectors frequently utilize Camunda. Organizations can accomplish more insight and control over their processes as well as simplify operations, increase efficiency, and decrease mistake rates. Camunda offers a potent platform for projects related to digital transformation and process automation because to its open-source nature, extensibility, and active community.

4. METHODOLOGY

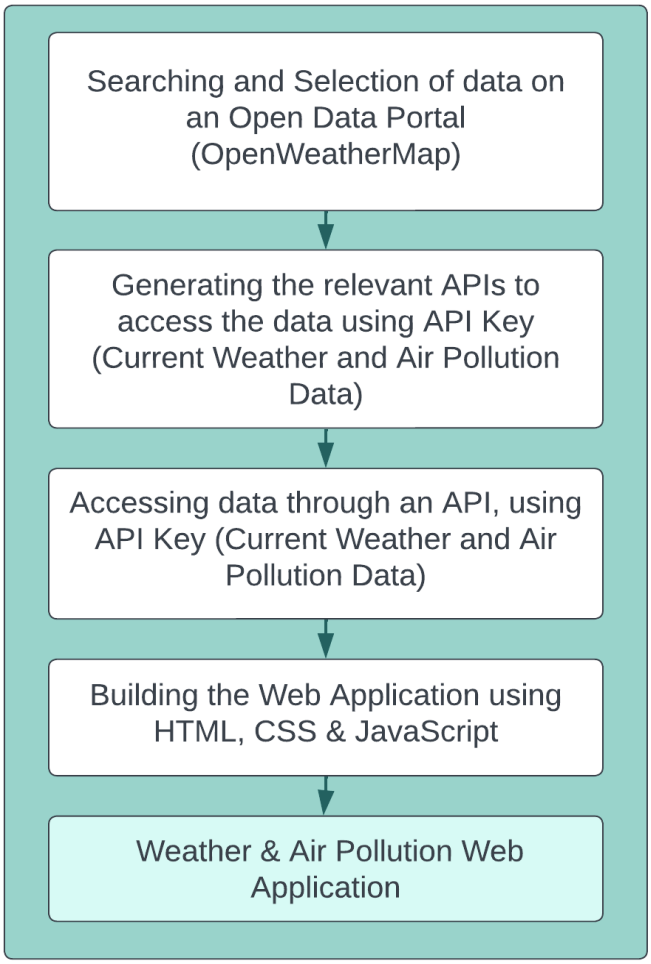

Figure 2: Methodology Flowchart

- Displaying the area's weather and air quality using open weather data services.
- Generating Application Programming Interfaces (APIs) for the web browser can employ to call the necessary data set in order to convey data.
- Current weather data is fetched by API from the sources; including satellites, radar, local and worldwide weather models, and it includes information on the minimum and most extensive temperatures, humidity, wind speed, mean sea level, and how it feels.
- For anyplace on the globe, the Air Pollution API exposes current, predicted, and historical air pollution statistics. The API also delivers information on polluting gases, such as carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), ozone (O_3), Sulphur dioxide (SO_2), ammonia (NH_3), and particulates ($PM_{2.5}$ and PM_{10}), in addition to the basic Air Quality Index. Four days of hourly granularity are available for air pollution forecasting.

- Open Street Map is used to show user-inputted coordinates so that the region may be correctly pinned on the web browser-generated data utilizing HTML, CSS, JavaScript.
- The five levels of the Air Quality Index (AQI) are good, fair, moderate, poor & very poor and each parameter has a significant impact on each level.

5. IMPORTANT PROCESS DIAGRAMS

- **Data flow diagram**

The flow of data is depicted in this as the website is public, users can request individual datasets from the open weather data services. The needed data is sent to the website via an API call that is produced for that data service, and when the call is made and the information button is clicked, the data is presented in accordance with the data requested.

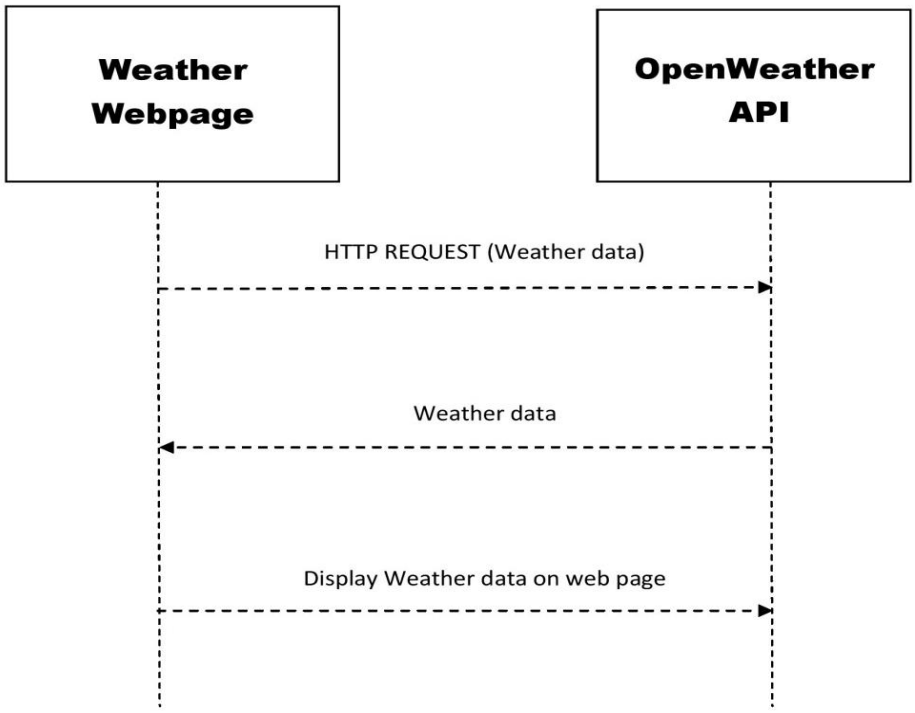

Figure 3: Data Flow Diagram

- **Class diagram:**

The basic idea behind this rendering is to show how the two characteristics may be used to define each element of the web application. The user's input, which entails longitude and latitude, is the first component. The second element is weather information retrieved from the open weather database, which includes metrics for temperature, humidity, windspeed, and air quality.

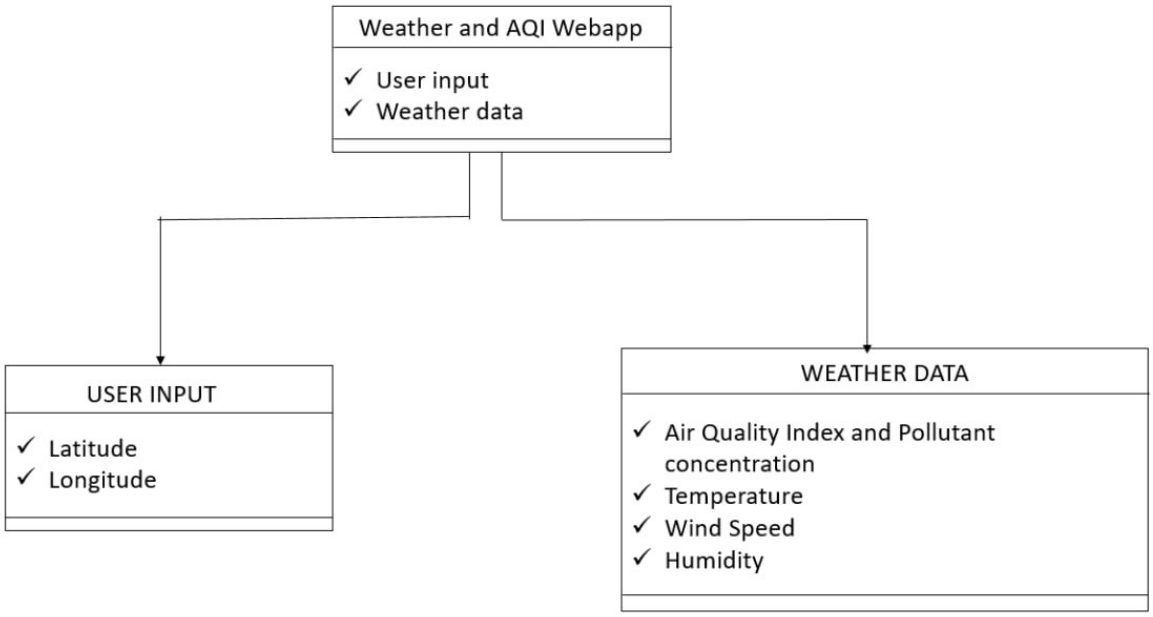

Figure 4: Class Diagram

- **BPMN diagram:**

In this BPMN diagram, the process via which the user will experience the entire web application is depicted. After providing their input, users have the option of viewing the weather report for that location or checking the air quality in the same location.as the API request is sent to an external website providing by open weather service. As soon as the request is approved, the information will be made available on the website and pinned to the right location on the map.

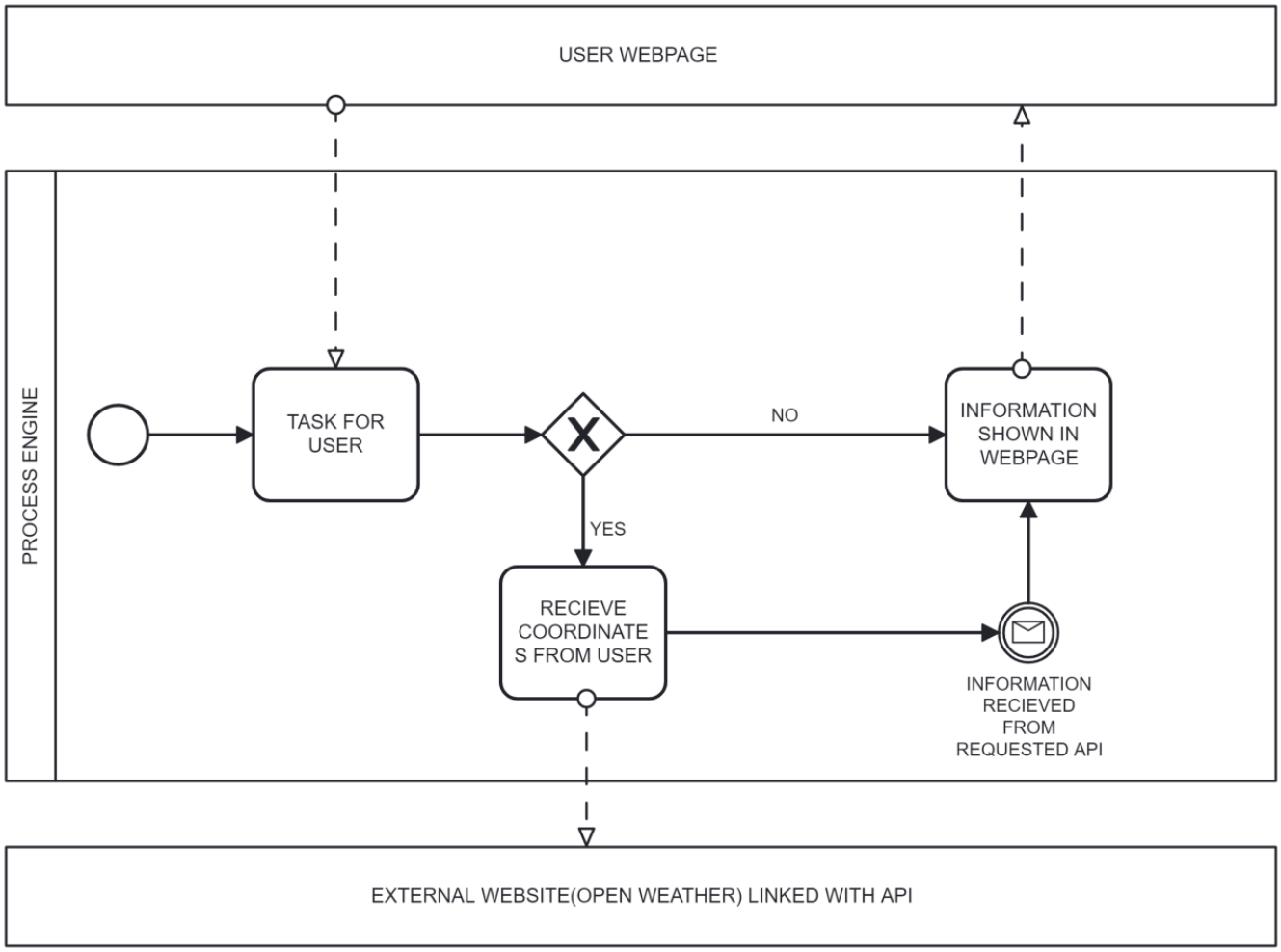

Figure 5: BPMN Diagram

6. OUTPUT – WEATHER & AIR POLLUTION WebApp

The resulting web app was accessed for the city of Dehradun located at latitude 30.316495 and longitude 78.032192. The current weather data was accessed via an API, Open Weather Map provides up-to-date weather data, usually updates with every 10-minutes. The response time when requesting current weather data using the Open Weather Map API is affected by factors including network latency, server load, and the amount of data being requested. To provide a seamless user experience, Open Weather Map delivers effective and quick API requests. Air pollutant concentration and air quality index information can also be seen via another API.

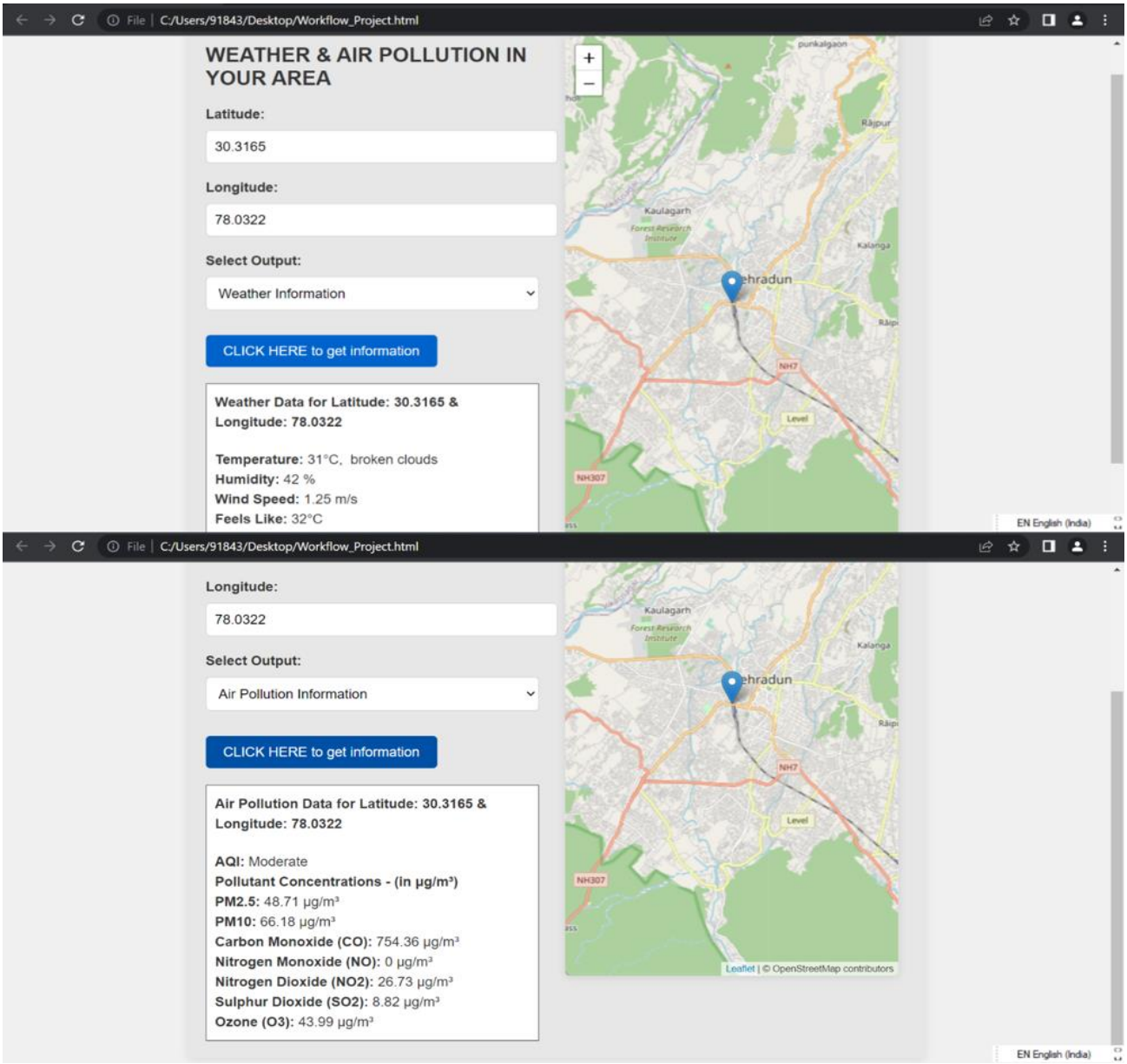

Figure 6: Dehradun Weather and Air Pollution Information

The results are displayed for the city of Bhopal at latitude 23.259933and longitude 77.412613. The output displays the two information for any location provided - Bhopal in this case, Weather Data such as Temperature, Humidity, Wind Speed, and Feels Like. Other information, Air Pollution, displays the AQI and concentrations of major pollutants in the city. The data update frequency depends on the area and the accessibility of data sources. Update intervals might be longer in some remote or infrequently monitored sites.

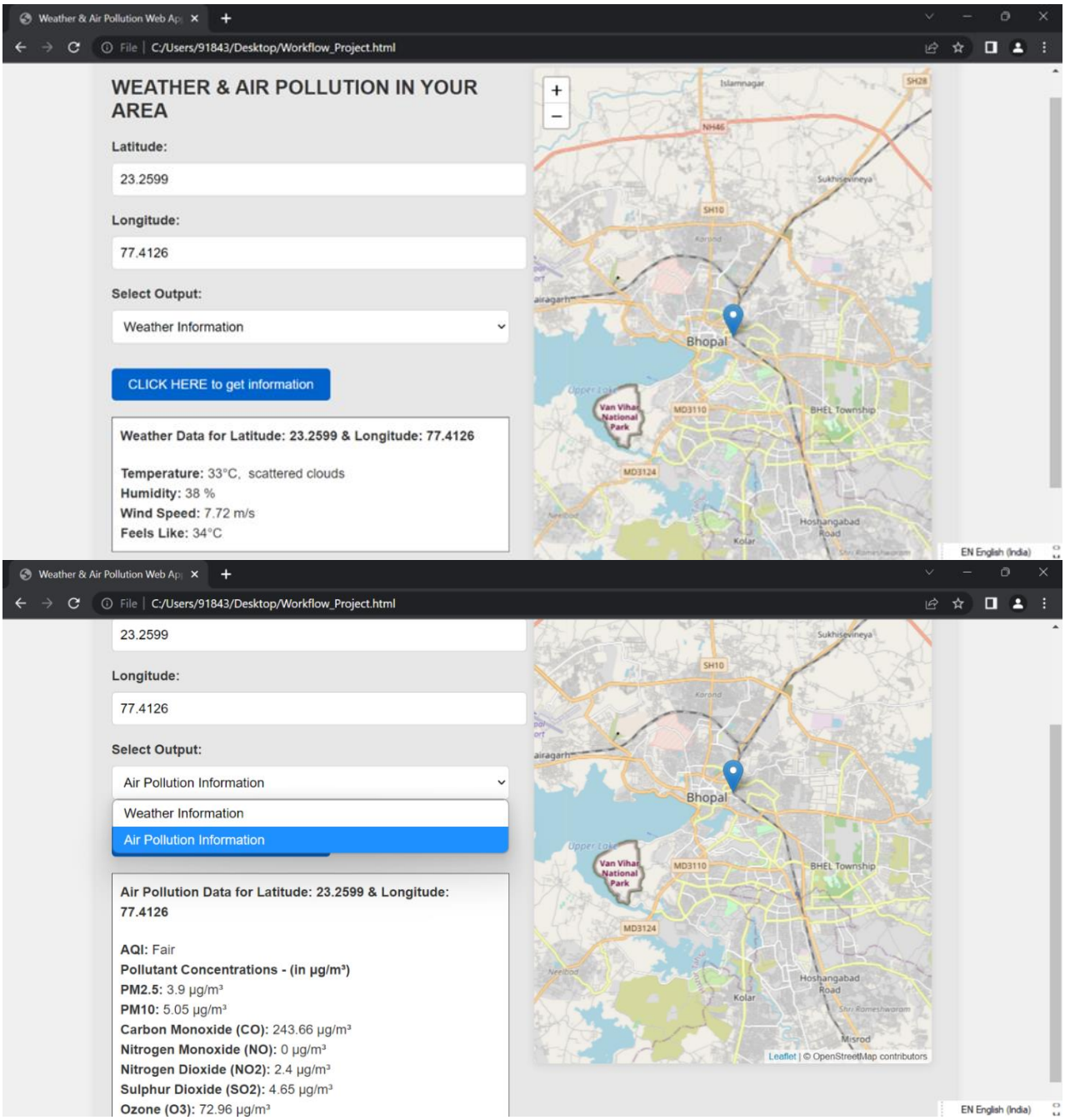

Figure 7: Bhopal Weather and Air Pollution information

The GitHub link to access the Web Application and all the code files is: Geospatial_Workflow_Project-WEATHER_&_AIR_POLLUTION_WEB_APP