Requirement Analysis and Specification Document

GeoAir

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Contents

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1. Introduction

1.1 Context and Motivations

Air quality monitoring has become increasingly vital for understanding pollution levels and their impact on public health, as citizens grow more concerned about the air they breathe and demand transparent, real-time access to environmental data. This project aims to develop a client-server application that visualizes and analyses air quality data from "Dati Lombardia," enabling the assessment of pollution trends across different administrative levels within the region. By transforming complex environmental data into accessible information, the application addresses both institutional needs and public interest, fostering greater awareness and informed decision-making.

The measure of this system's success will ultimately be determined by how effectively it fulfills its core purpose: empowering users with meaningful air quality insights that support informed decision-making and contribute to improved environmental and public health outcomes in the Lombardy region.

1.2 Solution Overview:

The proposed solution is a client-server application composed of three main components:

- A database (e.g., PostgreSQL/PostGIS) to ingest and store air quality data from "Dati Lombardia".
- A web server (backend) (e.g., Flask) that exposes a REST API for querying the database and retrieving data, performing data cleaning and filtering process, and returning data in JSON format.
- An interactive dashboard (frontend) (built using Jupyter Notebooks) that interacts with the web server to process, analyze, and visualize air quality data through maps, charts, and statistical analysis, allowing users—including both decision-makers and citizens—to generate custom views.

The users can interact with the platform through the dashboard and queries the database to receive maps, data (tables) and graphs.

1.3 Further consideration

The project aims to develop an interactive client-server web application that enables users to access, visualize, and manage air quality data within the Lombardy region. The platform supports historical and real-time data on pollutants offering a user-friendly dashboard with maps and graphs for exploring pollution trends. Users can register, query the data, which relies on a structured backend database and a REST API for efficient data handling.

However, the platform is currently limited to the Lombardy region and does not cover other geographic areas or broader environmental indicators. (While real-time data ingestion is a possible feature, it is not guaranteed in the initial version) The accuracy of insights is dependent on the quality of external data sources like Dati Lombardia. Advanced features such as mobile compatibility, predictive modeling, or health impact assessments fall outside the current scope, and further development would be required to adapt the system for large-scale or production-level deployment.

1.4 Acronyms, Abbreviations

Term / Acronym	Definition
PMx	Particulate Matter
NOx	Nitrogen Oxides
SO2	Sulfur Dioxide
CO	Carbon Monoxide
O3	Ozone
API	Application Programming Interface
UI	User Interface
RU	Registered user
UU	Unregistered user

1. Requirements

2.1 Actors

The primary actors for this system are:

- Registered users, such as environmental agencies and public health organizations, who register on the website and can interact with the dashboard to query and visualize air quality data to understand pollution trends and exposure risks.
- Unregistered users, that are not registered users, who can view where each sensor is located and what they are measuring.

2.2 Domain Assumptions

The API providing the air pollution (PMx, NOx, SO2, CO, O3) data is available 24/7 and the "Dati Lombardia" dataset contains accurate and relevant air quality data.

The suggested software tools (PostgreSQL/PostGIS, Flask, Jupyter Notebooks, etc.) are suitable for the project requirements.

The users have a basic understanding of air quality monitoring and analysis concepts.

2.3 Use Case Diagram and Description

Use cases (Appendix image 1) include:

- Unregistered user: Everyone that can open the web-app can view the already created map.
- Registered user: if a user is already registered, can log in with his credential and access map and the graphs.
- Visualize stations: Registered users and unregistered users can view where the stations are located inside the region by a map and by an histogram that shows the number of sensors.
- Visualize Map: Registered users can view a map that shows the average value by province of a certain pollutant, by a time period.
- Visualize Trend: Registered users can view the evolution of each pollutant by time period, and the interpolation of each pollutant filtered by province, time period with a moving average

- Download Graphs: Registered users can export the selected data by a defined plot like histogram or a linear plot to better visualize the pollution trends over time.
- Download Custom Map: Registered users can export maps, generated by the selected data, to better visualize the data with the spatial view.

1.4 Type of Requirements

2.4.1 Functional Requirements

RF 1: Data

The web app should allow registered users to visualize air quality data.

RF 2: Data visualization

The web app should present data in different formats:

- **RF 2.1**: maps
- **RF 2.2**: graphs

RF 3: Data manipulation

The app should allow registered users to filter data by different properties:

- **RF 3.1**: by pollutant type or group
- **RF 3.2**: by time period
- **RF 3.3**: by province

RF 4: Export data

The web app should allow registered users to:

- **RF 4.1:** export graphs as images
- **RF 4.2:** export maps as shapefile

RF 5: Login/Logout

The app should allow users to:

- **RF 5.1**: sign in new users with email and password
- **RF 5.2**: log in if already registered
- **RF 5.3**: log out

RF 6: Great user interface: The web app should provide an easy-to-use and clear user-interface.

2.4.2 Non-functional Requirements

RNF 1: The system should provide a quick response time.

RNF 2: The UI should be intuitive and accessible to both professionals and general public users.

RNF 3: Maps should be intuitive and provide a clear visualization of the data.

RNF 4: Graphs should help to understand the evolution of the pollutant in certain time periods and see any possible correlation between pollutants caused by any events.

2.4.3 Technical Requirements ("Pseudo Requirements")

RT 1: The dashboard should be developed using Python.

RT 2: The web server should expose a REST API accessible via HTTP.

RT 3: Data exchange between the web server and the dashboard should be in JSON format.

RT 4: The database should be implemented using PostgreSQL and PostGIS.

RT 5: The web server should be implemented using Flask (Python).

RT 6: The project source code must be stored in a GitHub repository.

3. User Stories

Registered user Stories:

- As a RU, I can query air quality data by provinces, so I can analyze pollution trends.
- As a RU, I can filter data by pollutant, so I can focus on substances of concern.
- As a RU, I can specify a time period, so I can view historical patterns.
- As a RU, I can compare data across provinces, so I can identify pollution hotspots.
- As a RU, I can export visualizations, so I can include them in reports.

Unregistered user Stories:

- As a UU, I can filter by pollutant group, so I can check the closest pollutant stations.
- As a UU, I can see how many sensors are located in a certain province.

4. Appendix

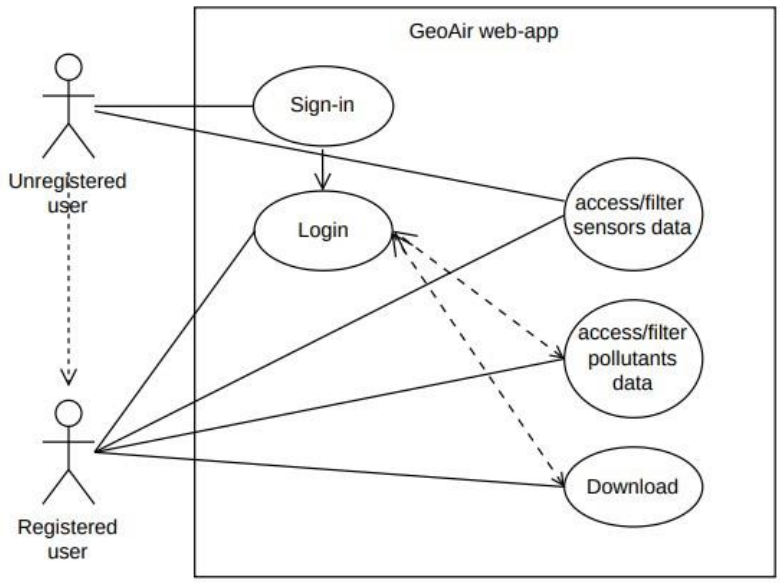

Figure 1.Use-case Diagram representing two possible use of the software

5. Bibliography

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