

Software Engineering for
Geoinformatics 2025

PolluTrack

Requirement Analysis and Specification

Document (RASD)

Air Pollution Data Display and Custom Graph Generation

By

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1. Introduction

1.1 Purpose

This document outlines the software requirements for a web-based application aimed at analysing and visualizing air pollution data in the Lombardy region. The application provides interactive features to view, analyse, and export pollution data in a user-friendly manner.

1.2 Scope

The software system allows users to explore air pollution levels without needing to register or log in for citizens but requires government/private sector users to register/login for advanced feature access. It includes an interactive dashboard, pollutant information, and data export functionalities. Users can view pollution levels across time and regions within Lombardy.

1.3 Definitions, Acronyms, and Abbreviations

- RASD: Requirement Analysis and Specification Document
 - CSV: Comma Separated Values
 - PM₁₀/PM_{2.5}: Particulate Matter
 - NO₂, CO, NOx, O₃: Pollutants
-

2. Overall Description

2.1 Product Perspective

The web application is a standalone system accessible publicly via a browser. It features client-side interactivity combined with backend data processing capabilities. The system is visual in nature, emphasizing clarity and user experience.

2.2 Product Functions

- Display pollution levels across Lombardy
- Provide pollutant information
- Interactive dashboards with map and time series
- Data export in CSV

2.3 User Classes and Characteristics

| USER | Access |
|----------------|---------------------------------------------------------------------------------------------------|
| Government | View/export data, Access and export detailed graphs, Need to Register/Login |
| Private Sector | View and analyze data, export data for business or environmental purposes, Need to Register/Login |
| Citizen | View latest public data only, explore local pollutant status |

2.4 Operating Environment

- Compatible with modern web browsers (Chrome, Firefox, Edge)
- Responsive design for desktops and tablets

2.5 Constraints

- Must handle pollution data from 01-Jan-2022 to 01-Jan-2025.
- Frontend must load efficiently under normal broadband conditions

2.6 Assumptions and Dependencies

- Pollution data is pre-collected and formatted in a consistent structure
- Users access the system over a stable internet connection

2.7 Stakeholder

Stakeholder Goals/Concerns

- Government User: Monitor pollution trends, formulate environmental policies and access advanced analysis tools
 - Private Sector User: Analyze pollution data for environmental or business purposes, support strategic decision
 - Citizens: Stay informed about local pollution, protect personal health, increase environmental
-

3. System Features and Requirements

3.1 Landing Page

- Users can access the Landing/Home Page of application via a public URL.
- Login or registration is required for government/private sector, not required for citizens.
- The app name (PolluTrack) is displayed clearly in the header.
- A short description explains the app's purpose: "Analyze and visualize air pollution data across the Lombardy region."

3.2 Pollutant Overview Section

- A dedicated section lists monitored pollutants (e.g., CO, NO₂, NO_x, O₃, PM_{2.5}, PM₁₀).
- Each pollutant includes a brief description and its environmental/health impact.

3.3 View Pollution Data Interface

- A clear button labeled "View Pollution Data" redirects users to the user selection page.
- Positioned prominently on the landing page for accessibility.

3.4 User Authentication System

- Register/Login/logout support.
- User types: Government, Private Sector.
- Role-based access:
- Government: Full access including export pollution data and graph visualization & export.
- Private Sector: Export Pollution data for analysis access.
- Citizen: Read-only access to public data.

| Feature / Permission | Government | Private Sector | Citizen |
|---------------------------------------|------------|----------------|----------------------|
| Access real-time air quality data | ✓ | ✓ | ✓ |
| Interactive map-based visualization | ✓ | ✓ | ✓ |
| Authentication required | ✓ | ✓ | ✗ (public dashboard) |
| Access historical data | ✓ | ✓ | ✗ |
| Download data (CSV) | ✓ | ✓ | ✗ (view only) |
| View pollution trend graphs and stats | ✓ | ✗ | ✗ |
| Generate & export graphs | ✓ | ✗ | ✗ |

3.5 Interactive Pollution Dashboard

- An interactive map of Lombardy with hover and click actions.
- Hovering on cities or sub-regions shows pollution summaries.
- Clicking opens detailed latest data for each pollutant at a location.
- Available for all type of users.

3.6 Export Data Feature

- Users can select a custom date range between 01-Jan-2022 and 01-Jan-2025.
- Option to download data as CSV.
- Optional enhancement: dropdown to choose format.
- Available to government/private sector users.

3.7 Graph Feature

- Users can select a custom date range between 01-Jan-2022 and 01-Jan-2025.
- User sees graph for each pollutant for the given date range.
- Available to government users only.

4. External Interface Requirements

4.1 User Interfaces

- Responsive web design
- Navigation page with links to all major sections
- Login/logout/Register forms
- Map with zoom, hover, and click interactions
- Data export form with date picker, graph view & export form.

4.2 Hardware Interfaces

- None (cloud-hosted web app)

4.3 Software Interfaces

- Frontend interfaces for visualisation
- Backend services for data retrieval
- Libraries for data processing, interactive maps and graphs (e.g., Folium, plotly.js)

4.4 Communication Interfaces

- HTTPS for all communication
- REST APIs (internal)

5. Non-Functional Requirements

5.1 Performance Requirements

- App should load within 3 seconds on average broadband
- Map interactions must respond within 500ms

5.2 Security Requirements

- Public read-only access; user accounts for private/government sector
- Secure APIs with CORS policies and rate limiting

5.3 Maintainability

- Modular design using components
- Clear documentation for future updates

5.4 Portability

- Platform-independent, works on any modern web browser

6. Scenarios

6.1 Scenario 1: A government official wants to check the air quality over a period of time.

- Goes to the export section
- Selects date range from 01-Jan-2022 to 31-Dec-2022
- Downloads CSV file with daily data for each pollutant
- Goes to Graph section
- View graph with Pollutant Data for date range from 01-Jan-2022 to 31-Dec-2022
- Option to Download Graph with Pollutant Data (optional to user).

6.2 Scenario 2: An environmental researcher from a university/company needs historical data for analysis.

- Goes to the export section
- Selects date range from 01-Jan-2022 to 31-Dec-2022
- Downloads CSV file with daily data for each pollutant

6.3 Scenario 3: A citizen wants to understand which pollutant is dominant in their city.

- Reads the pollutant overview section
- Clicks their city/station on the map to view latest data

6.4 User Stories

The following user stories express the core needs and goals of various system users in simple narrative format:

Government user

As a government user, I want to generate and download custom graphs so that I can share data insights with decision makers

Private sector user

As a private sector user, I want to download pollutant data in CSV format so that I can perform business-related environmental assessments.

Citizen user

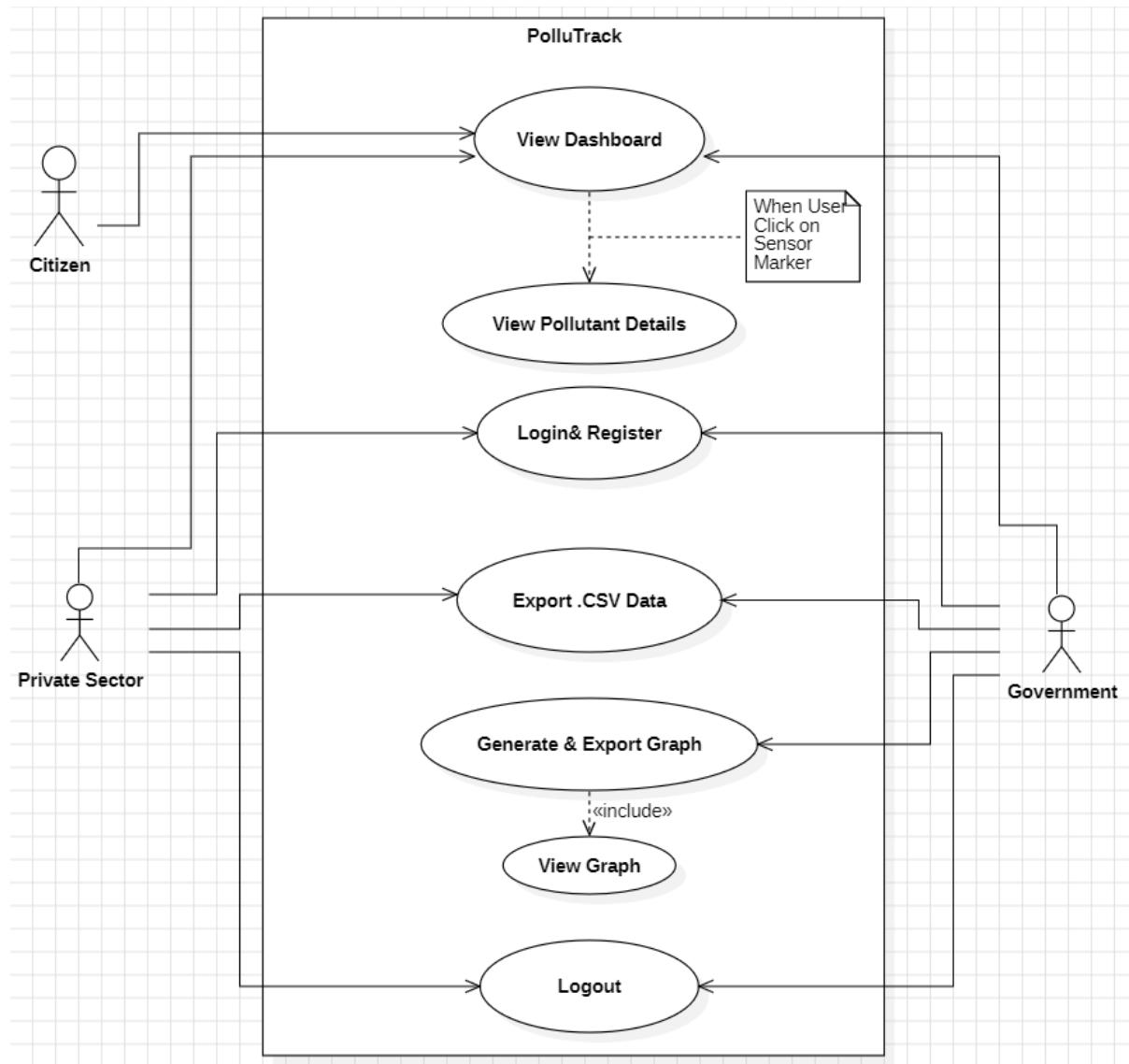
As a citizen, I want to see real-time pollution levels in my city so that I can take necessary health precautions.

7. Use Cases

7.0 Use Case Diagram

The diagram below illustrates the main interactions between system actors (Citizen, Private Sector, Government) and the key use cases of the "Air Pollution Data Display, Data Export and Custom Graph Generation "system.

It visually complements the textual use case descriptions presented in the subsequent subsections See the Use Case Diagram below:



7.1 Use Case 1: View Pollutant Information

- Actor: User
 1. Precondition: User is on the Homepage/front page
- Flow:
 1. User scrolls to pollutant section
 2. Reads short descriptions
- Postcondition: User understands pollutant types

7.2 Use Case 2: User Login/Register

Actor: Government/Private

Precondition: Login page accessible

Flow:

- Enters email and password for Login
- Enters Name, government (government user) or company/university email (private user), password and confirm password for Registration
- System verifies and assigns role
- Redirects to respective dashboard

Postcondition: Logged in and access granted based on role

7.3 Use Case 3: View Dashboard

- Actor: User
- Precondition: Website is accessible
- Flow:
 1. User clicks "View Pollution Data"
 2. User clicks 'Normal Citizen'
 3. Dashboard loads with interactive map
 4. User explores regions
- Postcondition: Pollutant details shown for selected region displayed by marker

7.4 Use Case 4: Export Data

- Actor: User
- Precondition: Data export interface is available
- Flow:
 1. User clicks "View Pollution Data"
 2. User clicks 'Government/Private Sector'
 3. User needs to Login or Register
 4. Dashboard loads with interactive map
 5. User explores regions, selects sensor/s
 6. User selects a date range
 7. Chooses export option
- Postcondition: CSV File downloaded with pollution data

7.5 Use Case 5: Export Graph

- Actor: User
- Precondition: Graph download interface is available
- Flow:
 1. User clicks "View Pollution Data"
 2. User clicks 'Government Sector'
 3. User needs to Login or Register
 4. Dashboard loads with interactive map
 5. User explores regions
 6. User selects a date range
 7. Chooses 'Show KPI Graph'
 8. Clicks 'download plot as a png' on graph object
- Postcondition: Graph downloaded with pollutant data for selected date range

7.6 Use Case 6: Logout

- Actor: Government/Private Sector
- Precondition: Logout Button is available
- Flow:
 1. User clicks "Logout"
 2. User is redirected to Homepage/front page

8. Functional Requirements

- **FR1:** The system shall provide a landing page with app name and description.
- **FR2:** The system shall display a list of pollutants with descriptions.
- **FR3:** The system shall display ‘View Pollution Data’ button.
- **FR4:** The system shall be accessible without login for Citizen.
- **FR5:** The system shall be accessible with login (for new users- login after registration) for Government/Private Sector user.
- **FR6:** The system shall allow navigation to the interactive dashboard.
- **FR7:** The system shall render an interactive map of Lombardy.
- **FR8:** The system shall allow hover and click actions on markers in a region.
- **FR9:** The system shall display latest pollutant data.
- **FR10:** The system shall support CSV data export for selected date ranges for Government/Private Sector User.
- **FR11:** The system shall support graph display & export for selected date ranges for Government Users only.
- **FR12:** The system shall support logout for government/private sector users.

APPENDICES

Data Sources

- Pollution data provided by ARPA Lombardia or equivalent sources

Future Enhancements

- Add user registration for saving queries
- Integrate pollution forecast models
- Enable visualization comparisons between years