

CEREO Living Atlas

Project Requirements and Specifications

Center for Environmental Research, Education, and Outreach (CEREO)



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I. Introduction

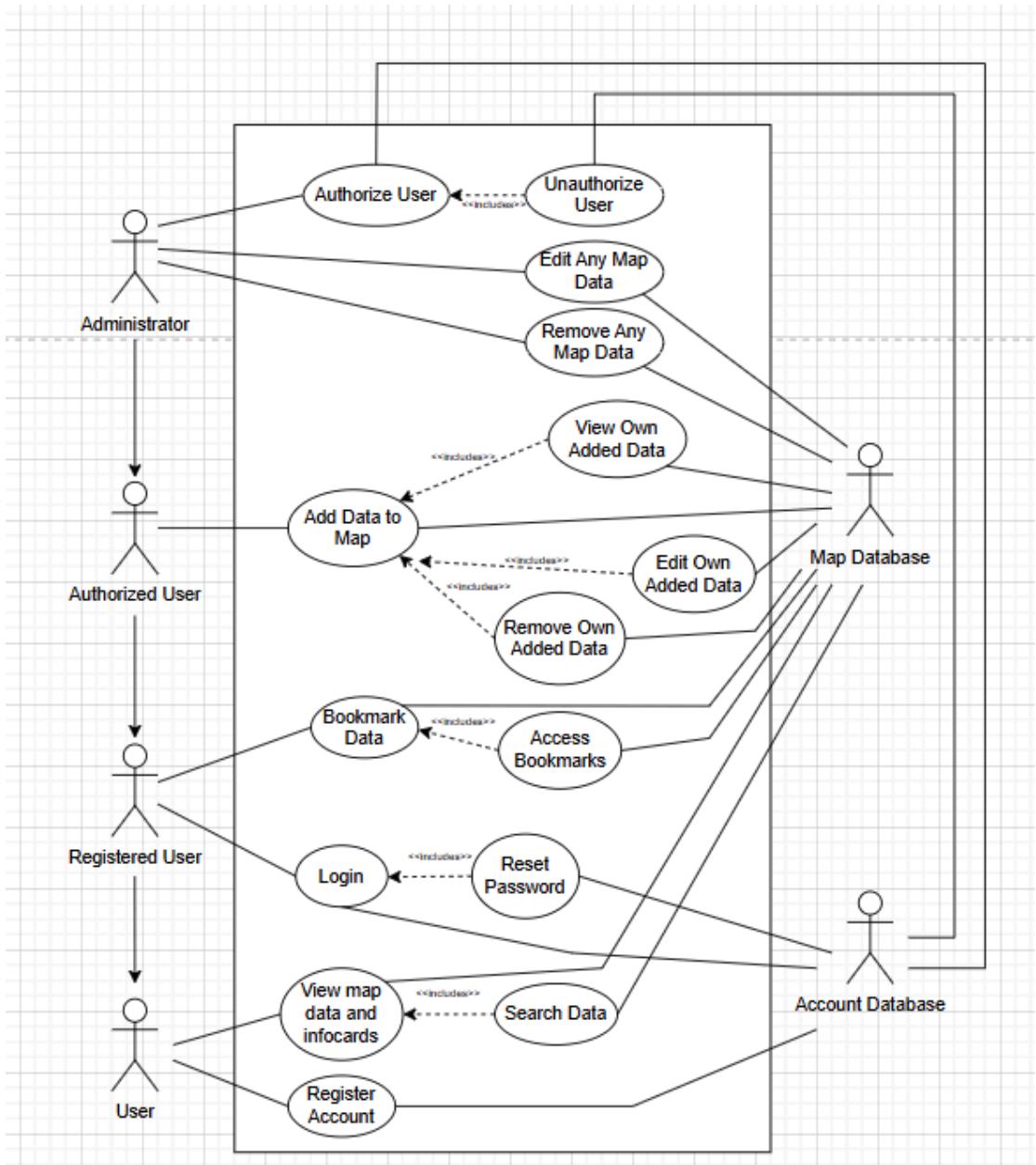
The CEREO Living Atlas is a geospatial web application designed to visualize and share environmental data, with a primary focus on water quality in the Columbia River Basin while also having the capability to extend beyond this scope. The goal of this tool is to serve as a critical resource for researchers, tribal communities, and government agencies, enabling them to contribute and access geo-tagged data stored in a database through an interactive map interface. By fostering collaboration and transparency, the Living Atlas supports informed decision-making on critical environmental issues.

Initially developed by student teams at WSU over multiple years, the application provides basic functionality but struggles with performance and scalability, particularly under high user traffic. Usability challenges and a manual data input process also limit its effectiveness for broader adoption. This project seeks to address these limitations by enhancing the system's overall performance, automating workflows, and refining the user interface for a more convenient interaction. The goal is to deliver a robust and user-friendly tool that can support a growing user base and expanded functionality.

II. System Requirements Specification

II.1. Use Cases

The use cases for the application are based on a role-based access control system. Any user has access to the map data and can use search functionality on this data. A registered user is a user who has created an account on the website, and these users can login to their account and bookmark data. An authorized user is a user with authority to add data to the map, and view, edit, or remove this data later. An administrator has authority to grant authorization to add data and can edit or remove any current data on the map. Administrative function is currently planned to be done through the backend, but administrator login may be implemented in the future.



Add Geospatial Data To Map

Actors	Authorized user
Preconditions	<ul style="list-style-type: none"> - Be logged in to an authorized user account - On main map page
Postconditions	<ul style="list-style-type: none"> - Geospatial data and attached information card is added to database and is publicly displayed on map
Path	<ol style="list-style-type: none"> 1. Authorized user clicks Add Data option from homepage

	<ol style="list-style-type: none"> 2. User enters geospatial information such as geospatial data types or map coordinates to establish location for data to be stored on map 3. User enters relevant information such as study results to attach to these coordinates as a card 4. Optionally upload photo to display on card 5. User submits data addition 6. Data is displayed on map at given coordinates and new card is added
Related Requirements	II.2.1 User Management: Role-Based Access Control II.2.2 Data Management: Geospatial Data Uploading & Editing II.2.3 Map & Visualization Features: Interactive Mapping Interface II.2.3 Map & Visualization Features: Picture Data Upload & Display

View Added Geospatial Data

Actors	Authorized user
Preconditions	<ul style="list-style-type: none"> - Be logged in to an authorized user account - On main map page
Postconditions	<ul style="list-style-type: none"> - Information cards corresponding to the geospatial data that was previously added by the logged in user are displayed
Path	<ol style="list-style-type: none"> 1. Authorized user clicks View Added Data option from homepage 2. Information cards added by the user are displayed
Related Requirements	II.2.1 User Management: Role-Based Access Control II.2.3 Map & Visualization Features: Interactive Mapping Interface

Edit Added Geospatial Data

Actors	Authorized user
Preconditions	<ul style="list-style-type: none"> - Be logged in to an authorized user account - On main map page
Postconditions	<ul style="list-style-type: none"> - Edit the text and/or photo on an information card previously added by the logged in user

Path	<ol style="list-style-type: none"> 1. Authorized user clicks View Added Data option from homepage 2. Information cards added by the user are displayed 3. Click Edit option on card to be edited 4. User enters updated information for card 5. Optionally user uploads new photo for card 6. User submits edit 7. Information and photo is publically updated in real time on the card
Related Requirements	II.2.1 User Management: Role-Based Access Control II.2.2 Data Management: Geospatial Data Uploading & Editing II.2.3 Map & Visualization Features: Interactive Mapping Interface II.2.3 Map & Visualization Features: Picture Data Upload & Display

Remove Geospatial Data From Map

Actors	Authorized user
Preconditions	<ul style="list-style-type: none"> - Be logged in to an authorized user account - On main map page
Postconditions	<ul style="list-style-type: none"> - Geospatial data and attached information card previously added by the logged in user is removed from the map
Path	<ol style="list-style-type: none"> 1. Authorized user clicks View Added Data option from homepage 2. Information cards added by the user are displayed 3. Click Delete option on card to be deleted 4. User confirms deletion 5. Geospatial data on map is removed from map and the attached card is removed
Related Requirements	II.2.1 User Management: Role-Based Access Control II.2.3 Map & Visualization Features: Interactive Mapping Interface

Bookmark Data

Actors	Registered user of any authorization
Preconditions	<ul style="list-style-type: none"> - Be logged in to an account - On main map page
Postconditions	<ul style="list-style-type: none"> - Information card is saved in user's bookmarks

Path	<ol style="list-style-type: none"> 1. User clicks bookmark on card to be bookmarked 2. Card is saved in user bookmarks
Related Requirements	II.2.2 Data Management: Data Filtering & Search

Access All Bookmarked Data

Actors	Registered user of any authorization
Preconditions	<ul style="list-style-type: none"> - Be logged in to an account - On main map page
Postconditions	<ul style="list-style-type: none"> - Information cards previously bookmarked by the logged in user are displayed
Path	<ol style="list-style-type: none"> 1. User clicks View Bookmarks option from homepage 2. Information cards bookmarked by the user are displayed
Related Requirements	II.2.2 Data Management: Data Filtering & Search

Search (updated)

Actors	Any user
Preconditions	<ul style="list-style-type: none"> - On main map page
Postconditions	<ul style="list-style-type: none"> - Display information cards based on date, location, and other sort and filter options
Path	<ol style="list-style-type: none"> 1. Optionally click sort option to sort list of cards 2. Optionally click filter option to filter list of cards 3. Display cards best matching the search criteria
Alternate Path	<ol style="list-style-type: none"> 1. User clicks search bar 2. Type keywords to be matched with cards in database 3. Display cards relating to keywords 4. Optionally click sort option to sort list of cards 5. Optionally click filter option to filter list of cards 6. Display cards best matching the search criteria
Related Requirements	II.2.2 Data Management: Data Filtering & Search

Reset Password

Actors	Registered user of any authorization
Preconditions	<ul style="list-style-type: none"> - On login page

Postconditions	- The user's password is updated
Path	<ol style="list-style-type: none"> 1. User clicks Forgot Password option 2. A one-time verification link is sent to the email attached to the user's account 3. Click link in email account 4. Enter new password 5. User submits password 6. Login password is updated to new password
Related Requirements	II.2.1 User Management: User Registration & Authentication

II.2. Functional Requirements

The CEREO Living Atlas is a web-based application developed to assist researchers, tribal communities, and government agencies in visualizing and sharing critical environmental data. To ensure the system remains accessible, efficient, and scalable, a structured set of functional requirements has been established.

These functional requirements define the system's essential capabilities, outlining what the application must achieve to effectively meet user needs. They are categorized into three primary modules: **user management, data management, and mapping visualization**.

Each requirement is aligned with stakeholder needs and assigned a priority level based on its significance:

- **Priority Level 0:** Essential, non-negotiable functionality.
- **Priority Level 1:** Important but not critical features.
- **Priority Level 2:** Optional enhancements or future upgrades.

II.2.1 User Management

- **User Registration & Authentication:**
 - The system must allow users to create accounts and log in securely.
 - Users should be able to reset passwords via email authentication.
 - Emails must be reliably forwarded from the application's Gmail account to WSU emails.
 - Source: CEREO's need for controlled data access and email functionality improvements.
 - **Priority:** Level 0 (Essential)
- **Role-Based Access Control:**
 - The system must differentiate user roles (e.g., researchers, administrators, public users).
 - Certain data upload and modification features must be restricted to authorized users.
 - There is currently **no admin login**, but this may be required in the future.
 - Source: Stakeholder request for future expansion options.
 - **Priority:** Level 1 (Desirable)

II.2.2 Data Management

- **Geospatial Data Upload & Editing:**
 - Users must be able to upload geospatial files (e.g., shapefiles, GeoJSON) instead of hardcoding data.
 - The system should support additional **data types**, such as watershed boundaries.
 - Polygons representing geospatial data should be customizable, such as color coding to represent different environmental factors.
 - Source: Client request for flexible spatial data storage and visualization.
 - **Priority:** Level 0 (Essential)
- **Data Filtering & Search:**
 - Users should be able to filter datasets based on **date, location, and environmental metrics**.
 - A search function must allow users to locate specific data points easily.
 - Users should be able to bookmark data to make the data easily accessible at a later time.
 - Source: Stakeholder need for enhanced data navigation.
 - **Priority:** Level 1 (Desirable)

II.2.3 Map and Visualization Features

- **Interactive Mapping Interface:**
 - The map must dynamically display geospatial data and be **updated in real-time**.
 - Users should be able to toggle different map layers (e.g., satellite, terrain).
 - The map must include a legend of symbol meanings, categories, and active layers.
 - Source: Usability improvement request from researchers and policy analysts.
 - **Priority:** Level 0 (Essential)
- **Picture Data Upload & Display:**
 - Users must be able to **upload images** associated with geospatial data points.
 - Ensure smoother handling of image uploads to avoid failures.
 - Source: Client feedback on frontend usability.
 - **Priority:** Level 0 (Essential)
- **Performance Optimization:**
 - The website should be able to work **faster** and handle **a larger user base**.
 - Reduce delays in loading data points on the map.
 - Source: Client's primary goal for enhancement.
 - **Priority:** Level 0 (Essential)

II.3. Non-Functional Requirements

Non-functional requirements are aspects such as performance, security, reliability, and scalability. While the functional requirements define what the system must do, non-functional requirements determine how efficiently and effectively it operates under different working conditions.

To support its expanding user base and large datasets, the CEREO Living Atlas must ensure data integrity, high availability, and an intuitive user experience. Meeting long-term stakeholder expectations requires a strong focus on efficiency, security compliance, and system extensibility.

These requirements are categorized into key areas, including performance, security, cross-platform compatibility, reliability, and future scalability. Each is assessed and prioritized based on its influence on system usability and long-term sustainability.

II.3.1. Performance & Scalability:

- The system shall support **500+ concurrent users** without performance degradation.
- The backend should be optimized to handle **large datasets** efficiently.
- Source: Client's requirement for scalability.
- **Priority:** Level 0 (Essential)

II.3.2. Security & Authentication:

- Email forwarding issues must be resolved to allow **WSU emails** to receive system messages.
- Future improvements should consider adding **email-based user verification**.
- Source: Client's security concerns.
- **Priority:** Level 1 (Desirable)

II.3.3. Cross-Platform Compatibility:

- The web application shall function on **modern browsers** (Chrome, Firefox, Edge).
- The system should support **mobile access** with a responsive design.
- Source: User accessibility requirements.
- **Priority:** Level 1 (Desirable)

II.3.4. Reliability & Uptime:

- The system shall maintain a **99.5% uptime** with failover mechanisms.
- Regular **database backups** must be implemented to prevent data loss.
- Source: Client expectation for high-availability services.
- **Priority:** Level 0 (Essential)

II.3.5 Extensibility & Future Integrations:

- The system should be modular to allow **future integrations** (e.g., external GIS platforms).
- API endpoints should be designed for **third-party compatibility**.
- Source: Long-term system evolution considerations.
- **Priority:** Level 2 (Stretch Goal)

II.3.6 Improved Application Accessibility

- Develop a standalone **WinForms application** that wraps the CEREO web application.
- Users can launch the app via a **desktop shortcut** instead of running npm start in a terminal.

- The application can be **easily installed** by downloading and extracting a ZIP file from GitHub, providing a more intuitive setup for non-technical users.
- **Priority:** Level 1 (Desirable)

III. System Evolution

The development of the CEREO Living Atlas relies on several key assumptions, including the expectation that the current application holder will continue hosting the web application on their server. It is also assumed that the team's understanding of client needs is aligned with project objectives and that the planned improvements are correctly oriented to address the identified challenges. Additionally, the necessary permissions are expected to be granted for testing and development on the existing application.

Several risks could impact the project's success. As part of the development process, we will be enhancing user role management functionalities, including permission controls and access restrictions. Modifying these core features may inadvertently introduce security gaps, disrupt existing workflows, or create unintended access issues. Additionally, testing functionalities, such as adding a new polygon point to the map, may inadvertently alter or disrupt CEREO's existing data. Furthermore, the introduction of new features or enhancements to existing ones may introduce unforeseen bugs due to compatibility issues or conflicts with current system components, potentially causing temporary disruptions in system functionality.

Certain client requirements remain unclear, including the specific functionality of image attachments and the intended use of new polygon features, such as shape options and flexibility. Understanding how polygons support environmental research is necessary for precise implementation. Additionally, the goal of seamless student and faculty contributions needs clarification—whether it pertains to user-friendliness, system scalability, or enhanced access controls. These aspects will be addressed in future client meetings.

IV. Glossary

Authentication & Authorization:

Authentication verifies a user's identity, while authorization controls their access and permissions.

API (Application Programming Interface):

A set of protocols enabling software applications to communicate and integrate with external services.

Concurrent Users:

The number of users accessing the system simultaneously without performance issues.

Data Filtering & Search:

A feature that allows users to refine and retrieve geospatial data based on specific criteria.

Data Integrity:

Ensures stored data remains accurate, consistent, and reliable over time.

Geospatial Mapping Interface:

An interactive system that displays and analyzes location-based data on a map.

Role-Based Access Control (RBAC):

A security model that restricts system access based on user roles and permissions.

Scalability:

The system's ability to handle growing user activity and data without performance loss.

Third-Party Compatibility:

Enables integration with external applications and datasets via APIs or standard formats.

V. References

- [1] Lethbridge, Timothy Christian., Laganière, Robert. Object-oriented Software Engineering: Practical Software Development Using UML and Java. United Kingdom: McGraw-Hill Education, 2005.