CEREO Living Atlas

Project Description and Clarification

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

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I. Introduction

The CEREO Living Atlas is a geospatial web application developed to visualize and share environmental data, with a primary focus on water quality in the Columbia River Basin but with the capabilities to span much more than its overall focus. This tool's goal is to serve as a critical resource for researchers, tribal communities, and government agencies, allowing them to contribute and access geo-tagged data stored in a database through an interactive map interface. By fostering this aspect of collaboration and transparency, the Living Atlas supports and allows informed decision-making on critical environmental issues.

Initially developed by student teams here at WSU over the course of 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 for more users. This project seeks to address these limitations by enhancing the systems 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 the expanded functionality.

II. Background and Related Work

The CEREO Living Atlas is a geospatial web application that is designed with the purpose to simplify the visualization and sharing of environmental data, with a focus on monitoring water quality within the watersheds of the Columbia River Basin. Supported by the Center for Environmental Research, Education, and Outreach (CEREO) at Washington State University, the application is an example of the center's commitment to fostering collaboration on environmental challenges. By bringing together researchers, tribal communities, and government agencies, CEREO aims to promote cooperative solutions, with the Living Atlas serving as a tool to allow them to advance these objectives. Over the last several years, student teams have contributed to the development and refinement of the platform, enabling users to engage with and contribute geo-tagged environmental data through an interactive map interface. However, despite its promise, the Living Atlas currently faces challenges related to scalability, performance, and usability, which limit its ability to manage larger datasets and expand its over all reach to a broader audience.

Domain and Context

In the realm of environmental research and policy, tools for visualizing data play a crucial role in supporting evidence-based decision-making. Geographic Information Systems (GIS) are a key part of this effort, offering a method that enable the analysis and sharing of environmental information. The Living Atlas addresses the specific needs of the Columbia River Basin by providing a tool that supports dynamic, user-contributed data. This is especially valuable for monitoring water quality, a key issue for many different stakeholders, including scientists, environmental organizations, local governments, and tribal groups.

State of the Art and Related Work

Several platforms illustrate the state of the art in geospatial tools and serve as useful benchmarks and comparisons for the Living Atlas. For instance, the HIFLD Open Data Platform offers an extensive repository of geospatial datasets, including environmental and infrastructure data. While comprehensive in terms of data availability, HIFLD does not support

user-contributed data, which limits its utility for collaborative research. Similarly, the Washington State Department of Ecology's GeoPortal provides access to environmental datasets but is focused on static data with minimal interactivity.

From a user experience perspective, tools like Zillow highlight effective practices in map-based navigation and filtering. Zillow's intuitive interface makes data exploration nearly seamless, providing the inspiration for enhancing usability in the Living Atlas. On the technical side, open-source mapping frameworks such as Leaflet.js and Mapbox demonstrate proven methods for building interactive geospatial features, offering a solid foundation for improvements.

Despite these advances, no existing tool fully meets the unique demands of the CEREO Living Atlas. Its focus on fostering collaboration and enabling user-contributed data tailored to a specific geographic region sets it apart. By drawing onto lessons from these platforms while incorporating targeted enhancements that the client seeks, this project aims to establish the Living Atlas as a leader in environmental GIS tools.

New Technical Knowledge and Skills

To realize these enhancements, the project team must acquire expertise in several key areas:

- **Frontend Development**: Mastering modern frameworks like React to design an intuitive and responsive user interface.
- **Backend Optimization**: Enhancing server-side performance using FastAPI or similar frameworks to handle increased data loads efficiently.
- **Database Management:** Implementing scalable solutions, such as PostgreSQL with PostGIS, to store and query large geospatial datasets.
- **Geospatial Data Integration:** Leveraging libraries like GeoJSON and tools like Mapbox to provide advanced mapping functionalities, such as filtering by data attributes or dynamic updates.
- **Workflow Automation:** Streamlining data input and user account management through automated processes to reduce administrative overhead.

Project Contribution

This project represents an opportunity to address the gaps in current geospatial tools by creating a scalable, user-friendly application that caters to the specific needs of environmental researchers and other potential stakeholders. By improving upon the system performance, automating the workflows, and enhancing usability, the Living Atlas will not only advance the field of GIS-based environmental tools but also contribute to the broader goals of environmental research and decision-making.

III. Project Overview

Although the Living Atlas has already been developed by previous student teams and can currently be used as functional software, these teams fell short of their planned goals and failed to finish the project as it was originally envisioned. Our objective as a team is to recognize which planned features have remained unimplemented and continue development so that the software will be greatly improved in functionality, user-friendliness, and security.

The Living Atlas application is currently lacking in features for its user base. The current version of the program requires data attached to map pins to be manually added from the backend. A new update will be added to allow authorized users to enter this data directly from the website in order to streamline data entry. It is also important that new types of spatial data will be supported by the application. This includes allowing users to mark polygonal sections of the map as a pin rather than being limited to a single set of geographic coordinates per pin. The map will also be viewable to any user visiting the website, even if they are not logged in.

There are also some quality of life features that will be implemented to improve the overall usability and appeal of the Living Atlas application. The search function for map data will be updated with sort and filter options to make the website more navigable and specific pins easier to locate. Users will also be able to favorite or bookmark pins so that they are saved to the user's account and easier to find later. When a user adds data to the map, they will also have the option to upload a custom image to the attached card. This image would take the place of the default CEREO logo currently displayed on all cards. Accessibility features such as alt text or keyboard navigation will be added to allow the application to be used by everyone. The application's user interface will also be significantly updated. Inspiration will be taken from other websites based on geo-tags such as Zillow on how to design an interface to be appealing to its average user. The interface on the website's admin pages are very basic, so these pages will be updated to be in a similar design style to the rest of the website.

The application in its current state is not designed to handle a large influx of web traffic. Performance under high stress will be tested to ensure a user will not experience slow load times or slow reaction times to input. This type of testing can be done using tools such as Lighthouse, WebPageTest, or Google PageTest. The frontend is being hosted on a free hosting plan, so an upgrade to a paid plan may be necessary for acceptable performance. The Google Cloud service used for data storage was out of service for the previous team, so finding a new database hosting plan also may be necessary. This hosting plan will have the capability to hold enough data so that new pins can continue to be added to the map for the foreseeable future. The application will also be designed to work on all devices, so compatibility must be tested across all browsers and operating systems, including mobile devices.

The application is in need of basic account security. User passwords will be encrypted within the database as a defense against cyberattacks. A form of multi-factor authentication will be added to the login system for added security. Implementing one-time verification codes may be the best way to accomplish this as they can easily be accessed by the user through email or SMS.

Throughout further development of the Living Atlas, code will be written in a modular fashion so as to make certain functionalities reusable for similar projects. Documentation will also accompany any new functionality so that future maintenance and updates will be made easier. The website will also be migrated to a custom domain for ease of access.

With these changes, we believe the Living Atlas can be a more reliable resource in overcoming environmental issues in our local communities and beyond.

IV. Client and Stakeholder Identification and Preferences

The primary stakeholder is the **Center for Environmental Research, Education and Outreach** (CEREO) at Washington State University. CEREO is dedicated to addressing environmental challenges through research and educational support, aiming to develop meaningful solutions for critical environmental issues. Currently, CEREO relies on the Living

Atlas as a key research tool. They desire an application that is more functional and user-friendly, enabling broader adoption and improved collaboration among users.

Other stakeholders include **researchers**, **tribal communities**, and **government agencies**. Both current and future researchers working with CEREO could benefit from a more efficient and robust application to enhance their research and collaboration. Tribal communities living in the Columbia River Basin, deeply connected to the region's environment, could gain from an improved application that strengthens CEREO's capability to monitor the local ecosystem, identify environmental concerns and address critical issues. Government agencies that fund CEREO's program would have greater confidence that their investments are delivering measurable results and being utilized effectively.

V. Glossary

Geospatial Web Application

A web-based software tool that allows users to visualize, analyze, and interact with geographic data.

GIS (Geographic Information System)

A system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.

Geo-Tagged Data

Data that includes geographical information such as latitude and longitude coordinates, often used in mapping applications.

Scalability

The ability of a system, application, or process to handle increasing amounts of work efficiently.

Frontend Development

The process of designing and implementing the user interface and experience of a web application, typically using technologies like HTML, CSS, JavaScript, and modern frameworks such as React.

Backend Optimization

Improving the performance and efficiency of the server-side components of an application, such as databases, APIs, and server processes.

FastAPI

A modern, high-performance web framework for building APIs with Python, known for its speed and ease of use.

PostgreSQL

An advanced, open-source relational database management system that supports extensibility and SQL compliance.

PostGIS

A spatial database extender for PostgreSQL that provides geographic object storage and analysis capabilities.

GeoJSON

A lightweight data format used for encoding geographic data structures such as points, lines, and polygons.

Mapbox

A mapping and location data platform that provides APIs and tools for creating custom interactive maps.

Workflow Automation

The process of automating repetitive tasks and processes to improve efficiency and reduce manual workload.

User Interface (UI)

The graphical and interactive components of a software application that users interact with, such as buttons, forms, and menus.

User Experience (UX)

The overall experience a user has while interacting with a system, application, or product, including ease of use and satisfaction.

Multi-Factor Authentication (MFA)

A security measure requiring users to provide multiple forms of verification before gaining access to a system.

Encryption

A method of converting data into a secure format that can only be accessed or decrypted by authorized parties.

Cyberattack

A malicious attempt to disrupt, damage, or gain unauthorized access to computer systems, networks, or data.

Accessibility Features

Functionalities designed to improve usability for individuals with disabilities, such as keyboard navigation and alt text for images.

Geospatial Data Integration

The process of combining and analyzing different types of geographic data from multiple sources.

Environmental Research

The study of natural and human-made environments to understand and mitigate environmental issues.

Columbia River Basin

A large river basin in the Pacific Northwest, covering multiple U.S. states and parts of Canada, with significant ecological and hydrological importance.

VI. References

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