EcoVista: Interactive Environmental Insights Map

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1. Project Name:

(Approved By TA) EcoVista: Interactive Environmental Insights Map.

2. Abstract & Summary:

EcoVista is a web-based application that provides users with a platform for visualizing and analyzing various environmental datasets, such as drought monitoring, air pollution. EcoVista features an interactive map interface that allows users to explore environmental data by updating the map colors based on the selected environmental data. The application also provides advanced query capabilities to search for specific data for a specific city or region, and a ranking system to evaluate and compare environmental quality indicators in different locations.

3. Description:

EcoVista solves the challenge of accessing and interpreting complex environmental data. Currently, users often struggle to find integrated, user-friendly platforms to integrate various environmental datasets into a unified view. By integrating multiple datasets into a user-friendly interface, EcoVista aims to simplify the process of understanding complex environmental information, allowing users to understand the overall environmental situation of a region based on multiple environmental data. EcoVista addresses the challenges of fragmented and difficult-to-access environmental data by providing a unified platform that integrates data from multiple sources into a coherent and interactive view. It aims to help users gain insights, identify trends, and understand the environmental health of different regions.

4. Creative Components

Interactive Map Interface:

1. **Visualize environmental datasets on a dynamic map**:
    a. **Functionality:**

        The interactive map will display various environmental datasets, such as air pollution, drought conditions, and more. Users will be able to see real-time data overlaid onto a geographical map, allowing them to quickly assess environmental conditions in different regions.

b. **Technical Challenges:**

The challenge here lies in integrating and processing large volumes of data from multiple sources. Ensuring that the data is loaded efficiently in real-time while updating dynamically as users interact with the map requires a robust backend system. It also demands effective data synchronization, where new data is seamlessly integrated without causing lags or delays in rendering.

2. **Color-coded representation of different environmental conditions**:
   a. **Functionality:**

   Different environmental conditions, such as air quality levels or drought severity, will be represented on the map using color coding. For example, regions with high pollution levels could be shaded red, while regions with good air quality could be shaded green. This makes it easy for users to visually distinguish between varying environmental states.

   b. **Technical Challenges:**

   The main challenge here is determining the appropriate color gradients and ensuring that the map can handle dynamic data changes without disrupting the visual consistency. Managing multiple color-coded layers, especially when multiple datasets are being displayed simultaneously, requires optimized rendering algorithms and a well-structured user interface to prevent overlapping or cluttered visual representations.

3. **Zoom and pan capabilities for detailed regional analysis**:
   a. **Functionality:**

   Users can zoom in on specific regions to get a closer view of localized environmental data or pan across the map to explore different areas. This allows users to perform detailed analysis at both large-scale (e.g., country level) and small-scale (e.g., city level).

   b. **Technical Challenges:**

   Implementing smooth zooming and panning functionality while maintaining the integrity of the visual data is a significant challenge. The map needs to maintain performance and responsiveness even when handling large datasets. Additionally, ensuring that the data resolution adapts correctly at different zoom levels—without losing important information or overwhelming the user with too much detail—requires complex map rendering techniques.

5. Usefulness:

The web app will be highly beneficial for a range of users including researchers, policymakers, environmental activists, and the general public. By providing a visual and interactive representation of

environmental data, the app will facilitate better understanding and analysis of environmental conditions. It will support informed decision-making for environmental policies, public awareness, and individual actions to improve environmental quality.

The basic features of the application:

Data Labels:

- Separate labels for various datasets like drought and air pollution next to the map.
- Update the interactive map by selecting different labels to color-code different regions of the current dataset results

Query:

- Search for a specific city or region to view local environmental data.
- Filter options to refine data based on parameters such as date range and specific environmental indicators.

Ranking System:

- Ability to rank cities based on environmental quality indicators.
- Filter options also allow selection of data to be displayed

Data visualization

- Display data on a map based on different values and distinguish them by color. Users can get visualization results of different data sets by switching map labels

Similar Websites/Applications:

- Google Earth Engine: Provides a wealth of environmental data and analysis, but is complex and researcher-centric.
- IQAir-AirVisual: Provides real-time air quality information, but lacks integration with other environmental datasets.
- EPA AirData: Provides detailed air quality data, but lacks interactive features and integration with other datasets.

EcoVista's advantages:

EcoVista provides users with a more comprehensive view of environmental conditions by integrating multiple environmental data (such as drought levels and air pollution) into a single interactive map. It also has query and ranking functions that allow users to search for specific areas and compare cities based on overall environmental quality. EcoVista integrates different platforms to provide a holistic perspective and simplifies understanding and decision-making on environmental issues through data visualization.

6. Realness:

Drought:

- Data source: https://droughtmonitor.unl.edu/CurrentMap.aspx
- Data format: .csv file
- Data size: 100,000+ rows, 13 columns
- Data information:
  Record the percentage of soil with daily drought degree (D0, D1, D2, D3, D4) in each state of the United States in the region
  Contains date (2014-2024), state, county, percentage of drought degree in the region (D0, D1, D2, D3, D4) and other contents

CO:

- Data source: https://aqs.epa.gov/aqsweb/airdata/daily_42401_2024.zip
- Data format: .csv file
- Data size: 53,577 rows, 29 columns
- Data information: Record the Arithmetic Mean, 1st Max Value, and 1st Max Hour of CO concentration of the Site located at different County

NO2:

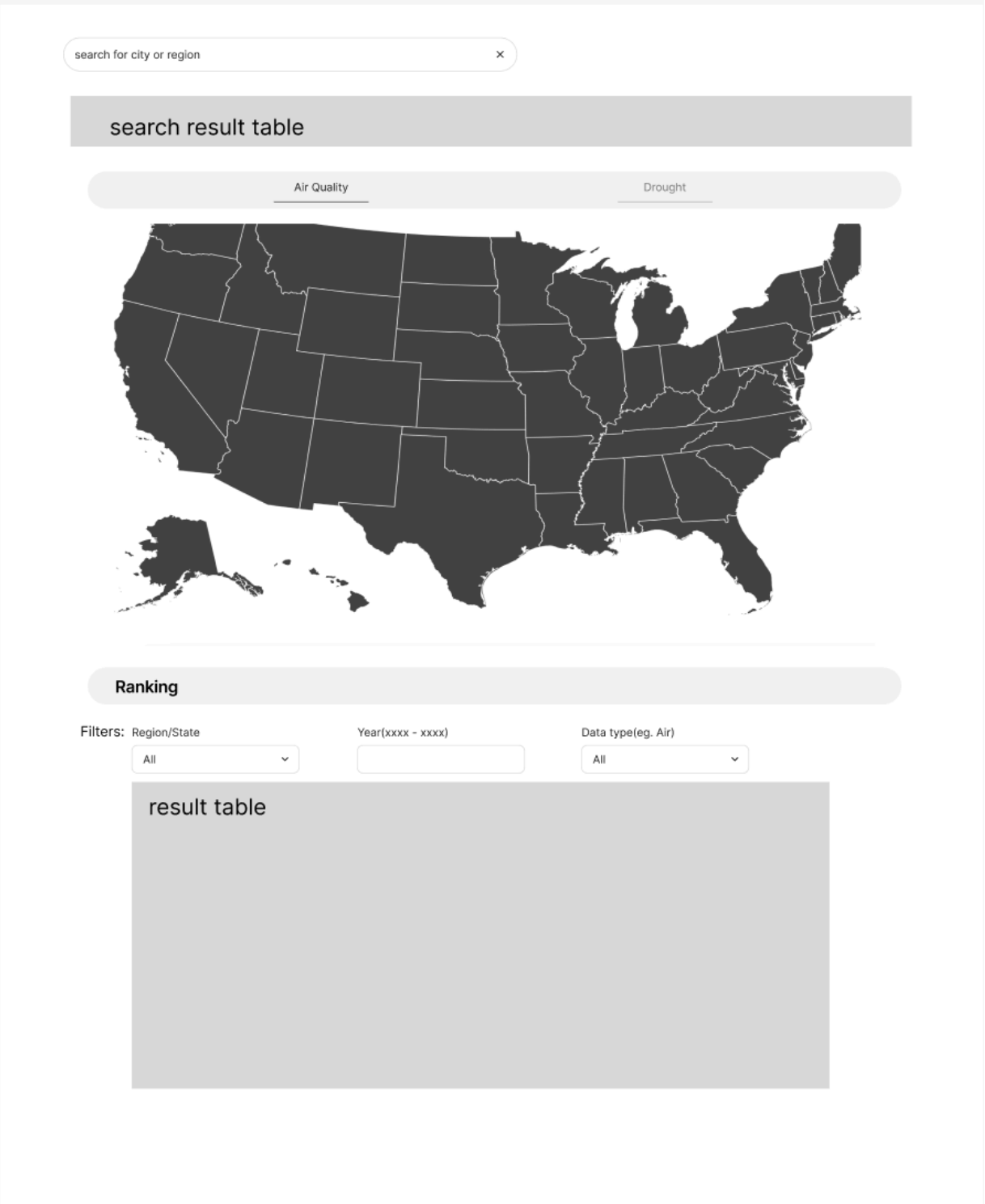
- Data source: https://aqs.epa.gov/aqsweb/airdata/daily_42602_2024.zip
- Data format: .csv file
- Data size: 52,393 rows, 29 columns
- Data information: Record the Arithmetic Mean, 1st Max Value, and 1st Max Hour of NO2 concentration of the Site located at different County

Air quality:

- Data source: https://aqs.epa.gov/aqsweb/airdata/daily_aqi_by_cbsa_2024.zip
- Data format: .csv file
- Data size: 62,964 rows, 8 columns
- Data information: Record the number of days (Days with AQI) for monitoring air quality in metro area in each state of the United States everyday, and the category and degree of air quality (Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, Hazardous)

7. Detailed description of the functionality

Low-fidelity UI mockup:



Interactive Map Interface:

- The map will serve as the primary visualization tool, displaying environmental data overlaid on geographic regions.
- Users can select different datasets from the tabs, which will dynamically update the map's color scheme according to the selected data type (e.g., air pollution levels might be shown in varying shades of gray to red).

Data Tabs:

- Each tab will correspond to a specific environmental dataset. For example, the "Weather" tab will show temperature and precipitation data, while the "Air Pollution" tab will display levels of pollutants like NO2 or PM2.5.
- Users can switch between tabs to see how different environmental factors interact.

Query Functions:

- Users will be able to enter the name of a city or select a region from a dropdown menu to view detailed environmental data for that location.
- Filters will allow users to customize the data displayed, such as selecting specific time periods or environmental parameters.

Ranking System:

- The app will calculate and display rankings based on a composite score of various environmental indicators.
- Users can view a leaderboard of cities with the best and worst environmental conditions, based on selected criteria (e.g., overall air quality, soil health).

8. Project work distribution

YiXuan Li: Interactive Map Interface and Data Visualization

- Implement the core interactive map functionality
- Visualize environmental conditions on the map using color-coded overlays.
- Develop zoom and pan features to allow users to analyze regional data in detail.
- Work closely with the backend team to fetch data dynamically based on user interactions.

Xuanming Zhang: Data Tabs and User Interface Components

- Design and implement the data tab components using a UI library
- Work on filtering options within each tab to refine data views based on parameters like date range and specific metrics.
- Collaborate with the data visualization member to ensure consistent data representation and interactivity.
- Handle UI/UX design.

ZiHan Li: Data Integration and API Development

- Integrate and manage the datasets from different sources.
- serve data to the frontend based on user queries and selections.

- Work with the ranking system developer to provide the necessary data endpoints for ranking calculations.

YaTing Pai: Ranking System and Database Management

- Design and implement a ranking system that calculates a composite score for cities based on various environmental indicators.
- Develop algorithms to rank cities according to user-selected criteria (e.g., air quality, soil health).
- Manage the database to store aggregated and processed data, as well as to support the ranking calculations and queries.