Name: Jegadit Sakthi Saravanan

Client name: Prof. Akintomide Afolayan Akinsanola, PhD (Assistant Professor, Department of Earth and Environmental Sciences, University of Illinois Chicago)

Project title: Interactive Visualization of Global Heatwaves and Drought Patterns

Brief project description:
Extreme climate events, such as heatwaves and droughts, have significant impacts on ecosystems, agriculture, and human health. Prof. Akinsanola has provided historical heatwave data, as well as global drought data spanning 1900s to the 21st century, from the CRU TS v4.09 dataset. This project aims to create an interactive visualization platform that enables exploration of data for both scenarios. Users will view a heatwave map over a particular region or globally, where clicking on a country dynamically generates a spiral visualization showing temperature trends in that region across decades. Additionally, a global drought map will display anomaly intensity and standard deviation, allowing users to explore patterns of drought severity worldwide. The interface will combine country-level choropleth maps with linked temporal visualizations to enable intuitive, multi-dimensional exploration of climate extremes. This platform will help researchers, educators, and policy analysts better understand spatial and temporal climate patterns, uncover anomalies, and generate hypotheses for climate-related research.

Project significance:
Understanding climate extremes is critical for climate science, disaster preparedness, and policy planning. Current tools for exploring historical heatwave and drought data are limited, often requiring extensive preprocessing, statistical expertise, and non-interactive plotting. By leveraging advanced interactive visualizations, this project provides domain experts with intuitive, exploratory tools to investigate complex spatiotemporal patterns. Linked visualizations such as country-level heatwave maps and spiral temperature plots allow users to detect trends, anomalies, and region-specific behaviors that are difficult to observe using standard plotting tools. The global drought visualization highlights intensity and variation, providing context for regional heatwave events. This project demonstrates a practical application of visual data science techniques to large, multidimensional climate datasets, bridging the gap between raw data and actionable insights while offering a reusable framework for future climate studies.

Requirements Analysis

I. **Humans**

The primary user is Prof. Akintomide Afolayan Akinsanola, a climate scientist specializing in heatwaves and droughts. Users are expected to include environmental researchers, policy analysts, and graduate students exploring climate patterns. Users will interact with the system weekly to explore both African and global climate

datasets. The system must support domain experts with minimal training, enabling intuitive exploration of large spatiotemporal datasets.

II. Tasks

1. Visualize African heatwave severity at a country-level granularity.
2. Allow users to click on a country to display a spiral chart of temperature trends over decades.
3. Show global drought intensity and standard deviation using color-coded maps.
4. Enable filtering by year or decade to focus on specific time periods.
5. Identify regions or countries with the most extreme heatwave events.
6. Detect trends in temperature anomalies over time within selected countries.
7. Highlight correlations between drought intensity and regional heatwave severity.
8. Enable comparison of temperature trends across multiple countries simultaneously.
9. Display tooltip metadata for selected countries (e.g., average temp, max deviation).
10. Support exporting visualizations for reports or presentations.

III. Data

- **African heatwaves:** Provided by Prof. Akinsanola, spanning 1950–present, stored as CRU TS v4.09 Data Variables (e.g., temperature, precipitation).
- **Global drought:** CRU TS v4.09 datasets include multiple variables (e.g., cld, dtr, frs, pet, pre, tmn, tmp, tmx, vap, wet). These will be visualized in terms of anomaly intensity and standard deviation.
- **Data abstraction:** Both datasets will be processed into country-level aggregates for map visualizations; temporal data will be structured for spiral visualizations.

IV. Flow

1. Load global and African datasets into the visualization interface.
2. Display Africa heatwave map; color-coded by severity.
3. Click a country to generate a linked spiral temperature chart for that country.
4. Display global drought map with intensity and standard deviation metrics.
5. Users filter or select time ranges; visualizations update interactively.
6. Allow side-by-side comparisons of multiple countries or drought regions.

V. Nonfunctional requirements

- Interactive rendering for hundreds of countries/data points with no perceptible lag.
- Intuitive interface usable by climate scientists with minimal training.
- Responsive web design supporting D3.js visualizations.

- Tooltips and interactivity to highlight specific regions or anomalies.

VI. Probes

- Current visualization methods are static and do not support interactive exploration of trends.
- Existing tools cannot easily link spatial heatwave maps to temporal spiral charts for region-specific insights.
- Open research opportunity: comparative analysis of heatwave and drought patterns over decades to understand regional climate vulnerability.

Work Plan

Oct 10 – Oct 17: Completed Requirements Analysis

- Consolidate datasets and confirm preprocessing requirements.
- Define interactive elements (map click, spiral chart, filtering).

Oct 17 – Oct 24: Prototype

- Basic African heatwave map with interactive country selection.
- Spiral chart visualization for a selected country.

Oct 24 – Oct 31: Alpha version

- Link map and spiral chart interactivity.
- Implement global drought map with intensity and standard deviation metrics.
- Enable year/decade filtering.

Nov 7 – Nov 14: Beta version

- Enhanced tooltips and interactivity.
- Side-by-side country comparisons.
- Minor UI/UX polishing and bug fixes.

Nov 21 – Nov 28: Final Deliverable

- Full system integration.
- Documentation and presentation preparation.
- Final testing and deployment-ready visualization.

Bios/CVs

Jegadit Sakthi Saravanan

- CS Graduate Student at UIC
- Skills: D3.js, JavaScript, Python, data visualization, climate data processing

Prof. Akintomide Afolayan Akinsanola (Client / Domain Expert)

- PhD, Earth & Environmental Sciences, UIC
- Expertise: Climate extremes, heatwaves, droughts, environmental data analysis