

Senior Design Project Report

Data Science for Climate Change Management with Focus on Drought and Wildfire in California



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1. Introduction:

1.1. Background:

Wildfires have impacted thousands of Californians throughout the past decades. Fires have become more vicious and difficult to put out due to climate change. The evacuation also has issues - an investigation found that only 22% of high-risk communities have evacuation plans. Economically, California spends an estimated \$2.5 billion a year on CAL Fire firefighting, and farmworkers in Northern California in 2020 were estimated to have lost an average of \$5,500 in wages due to fires.

1.2. Design Principles:

The main deliverable for this project is the web application. The goal for the web application is to be an all-in-one dashboard that provides useful information pertaining to Wildfire and the cause and effect of it. It needs to operate efficiently and display information in an effective way while being intuitive and user-friendly. The application is still in their development phase so the design needs to be simple for future maintenance and expansions.

1.3. Design Benefits:

By having a system architecture that is very simple and contains computer-intensive ArcGis maps in a separate page from the main page, it allows for several maps to load much faster. By having all the maps organized in one page, it will allow for future maps to be easily integrated. The maps can also easily be updated through ArcGis online, with the changes immediately showing on the dashboard.

There are some maps that were designed using ArcGis Pro, the desktop application of ArcGis. This was done in order to work with several datasets that were not allowed on ArcGis Online. The benefit of this is that we were able to expand our resources to display more accurate meteorological maps. Using the desktop application, we were able to publish our maps onto ArcGis online and integrate it onto our dashboard. For future map edits for those made with ArcGis Pro, it can easily be done by re-publishing onto ArcGis Online. This way all of the maps can be edited in just a few simple steps, allowing our dashboard to be accurate and up to date.

1.4. Achievements:

This academic year we were able to finish a dashboard with several wildfire-related visualizations to analyze the cause and effect of wildfires. There is a map that contains information about wildfires in the past 20 years. This map includes the location and size of a wildfire, as well as the date it began. There are also several meteorological maps, including: wind, vegetation, and soil moisture. These maps, similar to the wildfire map, contain information, such as time, and location. Each map visualizes different features that may affect wildfires, but combined users can look at the before, and after of wildfires, as well as during. This allows for the analysis of wildfire cause and effects. There was also a research page created, that includes a storyboard used to look at the cause and effect of the Woolsey fire. It has several screenshots of the maps, with some text explaining what is shown on the map.

2. Related Technologies:

2.1. Existing Solutions:

As of now, that we know of, there are no dashboards with only wildfire-related maps. There are maps created by NASA to show where a wildfire may occur, and there are vegetation maps created by them. CalFire also has a map with a predictive model that can predict places in California that will be prone to high-severity wildfires. CalFire also has a map that displays current active fires. However, there are no dashboards that include historical maps to show the cause and effect of wildfires. This project was also new, and we were the first to work on it, so we did not have anything to work off of and improve.

2.2. Reused Products:

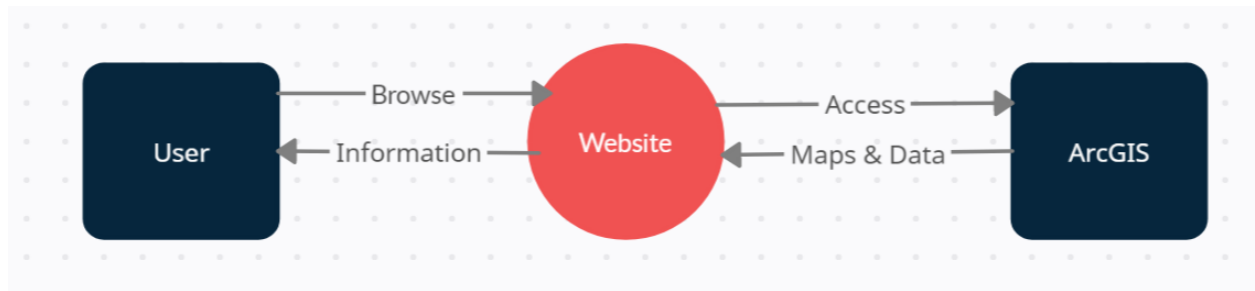
Most maps were created by downloading datasets, and creating new maps. There were no products we reused.

3. System architecture:

3.1. Overview:

The architecture for the website dashboard system (Wildfire Watcher) can be broken down into three main factors: the User, the Website, and ArcGIS.

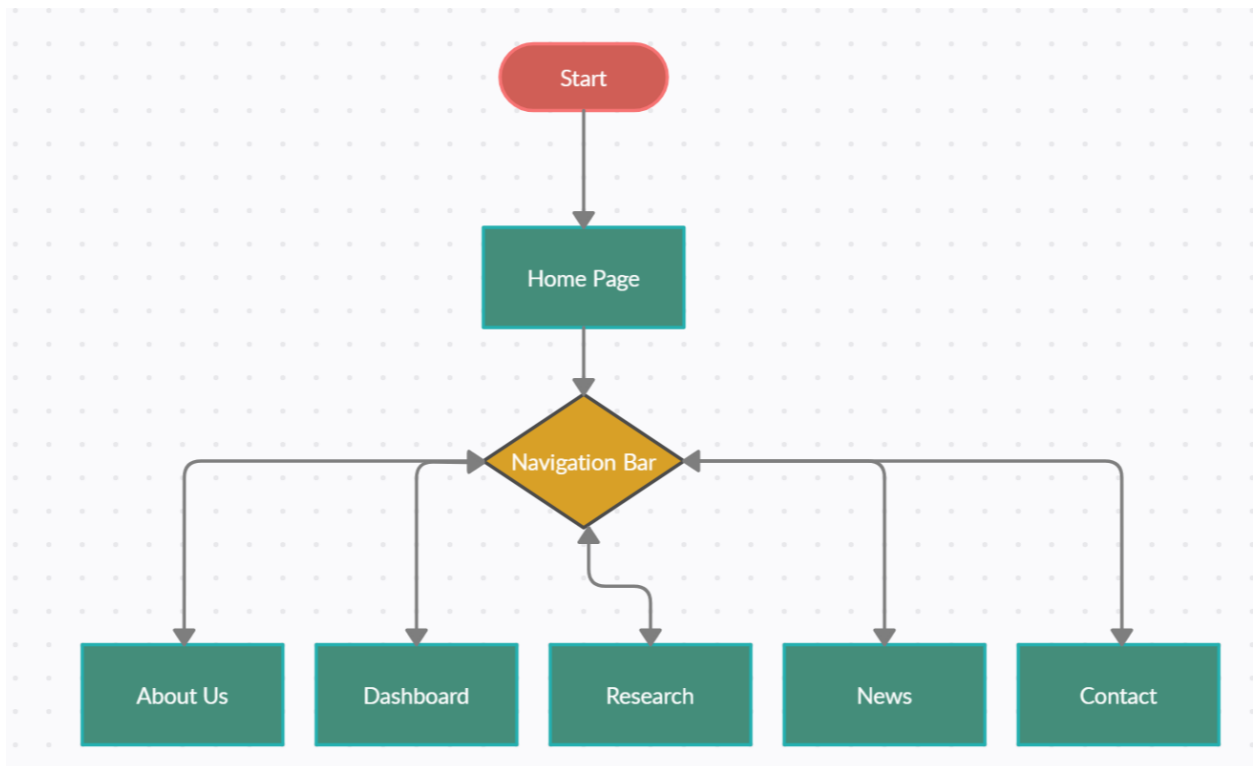
Here is a diagram (DFD level 0) that shows how this architecture works at a high level:



- **The User:** this is a factor in the architecture because considerations need to be made on how the website will be used. The user is in charge of making the requests on the Website to obtain information that is derived from ArcGIS.
- **The Website (Wildfire Watcher Dashboard):** this is the main goal/component of the project. The website provides functionalities that the User can utilize to search maps or research from ArcGIS. The website has functionality that provides information from ArcGIS to visualize the research that the team conducted.
- **ArcGIS:** through the use of ArcGIS, the website can display the maps pertaining to the following categories: wildfire, precipitation, temperature, wind speed, soil moisture, and vegetation.

3.2. Data Flow:

Here is an overview of the Website as a system:



There are seven major pages in this system. Here is a brief overview of them:

3.2.1. Home Page: The home page is the starting point for users. It will display in a bootstrap GUI an overall overview of what our project is about, relevant information, and including components from the navigation bar.

3.2.2. Navigation Bar: The navigation bar appears at the top of every page for easy navigation to other pages.

3.2.3. About Us: The about us section has some information about wildfires.

3.2.4. Dashboard: The dashboard displays a map of wildfires in California for the past 2 decades. It also has a button to more maps, such as vegetation, wind, soil moisture, etc.

3.2.5. Research: The research page contains a storyboard/research of the Woolsey fire that has images of the before, during, and after the fire. Images are of the wildfire map, vegetation map, soil moisture map, temperature map, etc.

3.2.6. News: The news page contains several current articles relating to wildfires.

3.2.6. Contact: The contact information has a form to contact our team, whether it be for questions or suggestions.

3.3. Implementation:

There were multiple steps to implement our dashboard.

3.3.1. Wildfire and Meteorological Data

First, we had to learn more about wildfires and what causes wildfires to become vicious. After figuring out what we wanted to map we began to search for datasets. The wildfire map's data came from CalFire, which we downloaded and mapped on ArcGis Pro. We also had to search for the temperature data to map. Some data was readily available on ArcGis Online, such as soil moisture. Other data, like the wind map, was not readily available and also had to be downloaded and then created on ArcGis Pro.

3.3.2. ArcGis Maps

When creating ArcGis maps there were a lot of methods used. Some maps were created using ArcGis Online that were immediately published. However, there were some more intensive maps that required ArcGis Pro. ArcGis Pro allowed us to map larger, graphic-intensive datasets. After mapping on ArcGis Pro we published our maps to ArcGis Online, and then made them public to display on our dashboard.

3.3.3. User Experience Design

When creating our dashboard we had to keep in mind the user's experience. The website had to have a navigation bar to allow users to easily navigate between pages. The text also had to be easily readable, as we had research to show. The maps had to be neatly organized. Initially, we created a quick prototype that we followed to ensure the final result was user-friendly.

3.3.4. Dashboard

The dashboard contains all of our maps that we created either on ArcGis Online or ArcGis Pro. There were two students who were tasked to update the dashboard regularly as there were more maps to display.

4. Conclusions:

4.1. Results:

At the end of the project we were able to create a dashboard that can help people understand/analyze the cause and effect of wildfires. We were able to find some correlations between wildfires, vegetation and meteorological data. This is shown under our research page where we go in detail explaining the maps.

We created the maps on the dashboard by downloading several datasets, and mapping them using ArcGis. These maps combined can show the cause and effect of wildfires. There is also a news page to keep users informed about current wildfires through various recent articles.

4.2. Future:

There are a lot of dashboard improvements that can be made in the future. We would have liked to include more maps, however, some data is not easily available, which was a hindrance. The visualization of the maps can also be improved, as the time slider can block the information that the map visualizes for users who have smaller laptop screens. Predictive models would be nice to have in the future, possibly a map that displays areas where high-severity wildfires may occur.

5. References:

- [Cal Fire Current Incidents](#)
- <https://n2yxp.csb.app/>
- <https://idahofirewise.org/fire-ecology-and-management/wildfire-ignition-behavior-and-effects/>
- <https://earthobservatory.nasa.gov/images/148789/climate-change-pushes-fires-to-higher-ground>
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- <https://www.w3schools.com/>
- <https://learn.arcgis.com/en/arcgis-book/>