3 Design

3.1 Design Context

3.1.1 Broader Context

Describe the broader context in which your design problem is situated. What communities are you designing for? What communities are affected by your design? What societal needs does your project address?

List relevant considerations related to your project in each of the following areas:

Area	Description	Examples
Public health, safety, and welfare	How does your project affect the general well-being of various stakeholder groups? These groups may be direct users or may be indirectly affected (e.g., solution is implemented in their communities) Our project is able to forecast the flood , and report daily precipitation, both the direct and indirect user can use it to check if their area will be affected by the flood in order to avoid any loss.	Increasing/reducing exposure to pollutants and other harmful substances, increasing/reducing safety risks, increasing/reducing job opportunities The flood forecasting tool can work as an alarm for people who live in flood areas and people can have enough time to do prep before the flood. This tool can help with public safety and decrease the loss.
Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures. At the moment, we are probably focusing on flood modelling within the USA. There are a number of communities within the USA, but the central value that will be reflected by our project is safety awareness. The average citizen within the USA wants to be safe. Our flood modeling software should accurately inform users of flood hazards before they occur.	Development or operation of the solution would violate a profession's code of ethics, implementation of the solution would require an undesired change in community practices Weather alerts already exist to help protect people from natural disasters. Our model follows the same principle of safety assurance. People should get the same general message from our model as they would a flood watch or warning.
Environmental	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement. Given our tool is weather related, it is very likely to have environmental impacts. Our hope is that it is positive, bringing more	Increasing/decreasing energy usage from nonrenewable sources, increasing/decreasing usage/production of non-recyclable materials Allowing more lead time to prepare and move life and property away from worst conditions. Help better

	accurate flood forecasts to help better prepare for hazardous flood conditions. Perhaps the data could be wrong or misinterpreted, but this is the only negative environmental impact our team can foresee and is inherent to any tool of its kind.	understand how various rivers and watersheds respond to different weather conditions.
Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to consumers, or broader economic effects on communities, markets, nations, and other groups. This will impact the economy by helping protect against loss of product value that occurs from a flood.	Product needs to remain affordable for target users, product creates or diminishes opportunities for economic advancement, high development cost creates risk for organization Since our tool helps predict flooding given rainfall and soil conditions in a certain area, people can prepare for floods by purchasing precautions before a likely flood which would increase business to vendors that sell those precautions and help against loss of personal items of value.

3.1.2 User Needs

List each of your user groups. For each user group, list a needs statement in the form of:

User group needs (a way to) do something (i.e., a task to accomplish, a practice to implement, a way to be) because some insight or detail about the user group .

1. Prediction users (those who are interested in artificial intelligence predictions). These users are more interested in the technical aspects of prediction using data. Useful information shown from graphs and trends would give insights that people just interested in the prediction results would not be interested.

2. Meteorological users (people who use weather prediction for forecasting). These users would be the most common as they are interested in the actual predictions and visual aspects of the project. This group probably wants to know the odds of weather data or flooding.

3.1.3 Prior Work/Solutions

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the **advantages/shortcomings**

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available. Thus, provide a list of pros and cons of your target solution compared to all other related products/systems.

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

Precipitation and river flood forecasting is nothing new. Our team's focus for the past few weeks have been researching various methods and tools to gain insight into already available solutions. What makes our project unique is the inclusion of a machine learning model to make the prediction. Based on our research, AI based approaches to weather forecasting are quite rare. Most existing solutions use physics based approaches to extrapolate current conditions.

Pros
Machine Learning approach
Nice UI

Cons
Limited in scope

3.1.4 Technical Complexity

Provide evidence that your project is of sufficient technical complexity. Use the following metric or argue for one of your own. Justify your statements (e.g., list the components/subsystems and describe the applicable scientific, mathematical, or engineering principles)

1. The design consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles –AND–

   The project is a full stack Web-based GIS (Geographical Information System) project. The technical requirements for this project require mathematical and scientific knowledge for how to properly display a map using the right scale and measurements. This project is mainly software engineering based and therefore requires software engineering principles such as modularization, security, etc. As a team we must decide which subsystems/components to use to visualize our clients flood data. This will involve using open source GIS software along with research for how to create, store, and visualize the information on a map that is interactive for the user.

2. The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.

   Our project will use the best open source software available allowing for an interactive solution to our clients project. For visualizing watershed data, our project will be pushing the industry

standards forward by giving a map that is informative, intuitive, and customizable at no further cost to the client.

3.2 Design Exploration

3.2.1 Design Decisions

List key design decisions (at least three) that you have made or will need to make in relation to your proposed solution. These can include, but are not limited to, materials, subsystems, physical components, sensors/chips/devices, physical layout, features, etc. Siyu

1.we decide to use open sources instead of building everything from scratch since it will save us more time in order to focus on UI design and other features.

2.we decide to have waterfall planning with an agile development.

3.we decide to have both static and live data models.

4.we still need to make decisions on datasets and methods of mapping data to the map.

5.we will need to make decisions on testing.

3.2.2 Ideation

For one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). List at least five options that you considered.

We used problem ideation by identifying the functional requirements of the system then looked at similar softwares that had solutions to those problems. An example design decision would be how to display water data with some type of map. We talked about initial ideas like using a google maps API then sought out existing solutions that used it. During this time we identified different solutions that had aspects we liked and didn't like. Through this we found different solutions that we didn't know existed or were viable. For this example we found open sourced mapping software called QGIS that specialized in this problem.

3.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish to include a weighted decision matrix or other relevant tool. Describe the option you chose and why you chose it.

Our options for mapping the watershed were all mapping API's. We looked at the Google Maps API but we found that the price of using the API was far too great for us to use even if the API looked good. We eventually settled for QGIS because we can get it cheaper than Google and it carries the same functionality for our purposes.

3.3 Proposed Design

Discuss what you have done so far – what have you tried/implemented/tested?

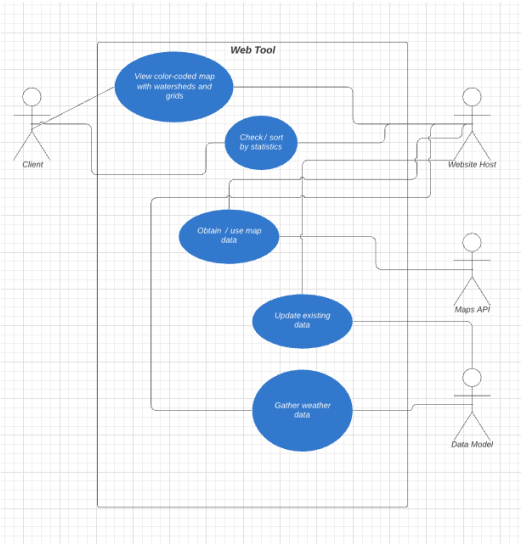
We have looked into various Maps API and existing software tools with similar uses. The main thing that we have been looking for is how to integrate all the data that we have into a UI that we can customize. The main Maps API that we are looking into is QGISI. This software allows us to utilize existing GIS data and manipulate it how we see fit. We have tried to implement a demo version of this in order to test that we can use it with other software and that we can use it for our needs. What we have found is that we can use this software along with other API's in order to fulfill the client's needs.

3.3.1 Design Visual and Description

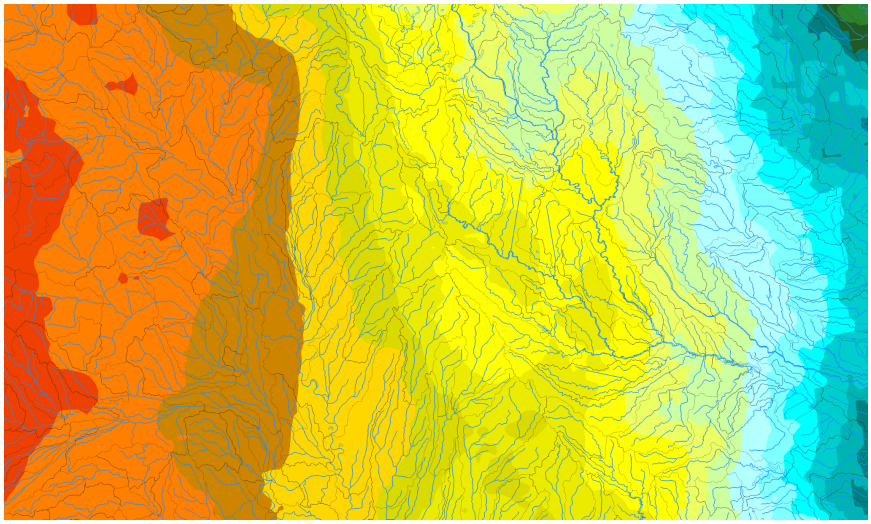
Include a visual depiction of your current design. Different visual types may be relevant to different types of projects. You may include: a block diagram of individual components or subsystems and their interconnections, a circuit diagram, a sketch of physical components and their operation, etc.

Describe your current design, referencing the visual. This design description should be in sufficient detail that another team of engineers can look through it and implement it.

Here's the use case diagram for our project. It describes a web based tool that displays a color coded gridded map with watersheds.

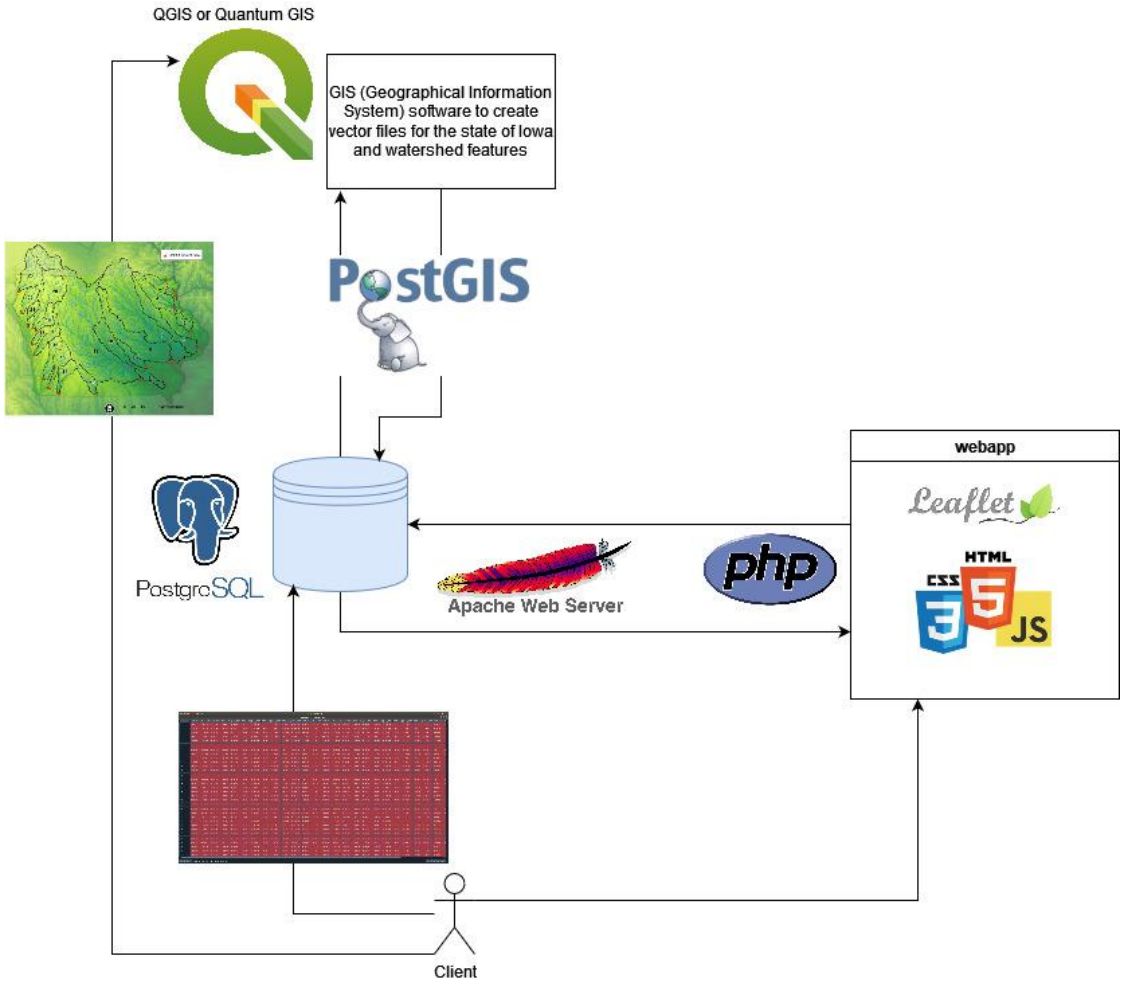


We would like to overlay different data sources such as precipitation, rivers, and watershed boundaries on a single map. This image is a demo example of gridded precipitation data with overlaid rivers. This would be shown on an interactive map with the ability to customize what is shown and navigate to various points in time.



3.3.2 Functionality

Describe how your design is intended to operate in its user and/or real-world context. This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.



Our project is intended to be a web application utilizing GIS software to create a visual representation of our clients AI for watersheds in the state of Iowa. In the diagram above it shows what technologies could be used to accomplish this with open-source software. One major challenge in our project is to be able to modify data in our sql database corresponding to our clients data.

How well does the current design satisfy functional and non-functional requirements?

This design satisfies the client's functional requirements of having an interactive map with selectable watersheds because the GIS software we use has the capability to create such maps as we have seen in examples we showed to our client.

The Display of water discharge over time and color coordinating of weather data and timeline requirements are more difficult to meet with our current design. No one in our group has experience with creating GIS maps using QGIS software or something similar.

Our design satisfies all of our non-functional requirements well because our rendering of the map using Leaflet.js on the web app has great performance and is reliable. Our design is also easy to update and maintain by the client because she can connect to our database and load her data and our software will use the already existing GIS map and simply update the weather data such as precipitation. Our design is also scalable in that it can be deployed on Iowa State's domain. Once we have shown the process to create a GIS map on QGIS and deploy it to a webapp, other software developers can use the same method to deploy their own maps embedded in web applications. Modifying the map itself and not just the data in the map may be more difficult for our client. It would involve learning how to use QGIS or whichever software used to create the map and could involve modifying the tables within the database which can potentially require recreating the table entirely.

3.3.3 Areas of Concern and Development

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

- One of our concerns has to do with how we are acquiring data. We need to be sure of where our watershed data is coming from to solidify our final design. Clarifying how the data will be obtained with our client is a high priority for resolving this concern, as we could obtain data from many sources.

- Whatever libraries / frameworks we use need to be able to display a color-coded map. Visualizing data will be a lot easier if we can use different colors to represent different things on the map. The solution to the above concern will primarily be adequate research on the libraries / frameworks we decide on.

- Another smaller concern could also be the user base we are developing for. Who is the primary audience for this design? The primary audience will have an impact on the features we include. We will need to clarify this with the client to verify who will be the primary user for the app.

- Another concern we are currently working on is figuring out what open source software to base our application on. Upon deciding that we were going to use open-source software, we started looking into what was available. We have a candidate right now, but we should definitely address this concern by doing more research on the open source software available.

- One last area of concern has to do with what kind of data we want to display. Are we only displaying flood and watershed data? Should we aim to incorporate more data into our model? How much data does the user really need? We need to clarify this with our client when we begin to actually develop the model.