**Hydro Explore Project Proposal**

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**Introduction:**

For our project, we will be utilizing the Daily Streamflow by Watershed, 15-minute Precipitation by Watershed, and Total Daily Precipitation by Watershed datasets provided by the Hubbard Brook Experimental Forest. Our client wishes to have an app that produces visualizations and analyzes trends for specific watersheds in the Hubbard Brook Experimental Forest. Our client wants the app to graph discharge, precipitation, time, and possible baseflow for a watershed. In addition, the app should also be able to perform trend and storm analysis, 30-day rolling averages, and enhanced viewing of the data to allow the user to choose specific months of the year to look at.

This data from Hubbard Brook Experimental Forest is collected in two main ways. The flow data comes from weirs placed at the bottom of the watershed so flow can be collected for the entire span of the watershed. The data we are using is also the daily flow which is measured in mm/day. The precipitation data is also measured daily but is extrapolated from water gages. They do this by using a weighted average where the gage closest to the watershed is what is treated as the precipitation measurement for that watershed. This data is also measured in millimeters per day, which means that both datasets have the same unit.

Our client wants to be able to perform change detection, especially with looking at trends of the data. She also wants to look at discharge timing, what time of the year the discharge occurs, and be able to compare that across the timescale of the data. “Is there more flow in January of 2023 compared to January of 2003” is a question that this project should be able to answer. Looking at similar timespans to see how the data has changed over time. She also wants to be able to look at snowmelt timing, when it is occurring and what the impact of an earlier snowmelt is on the flow measurements for the watershed. All these requirements rely on the ability to select a key time period and look at data for that period. For example, a graph of precipitation compared to flow that allows for zooming in on specific periods of time.

The goal for this project is to allow for specific analyses of data on given timescales and across the entire period of the dataset. This allows our client to be able to look at their data from this perspective, but also for the use outside of this specific Hubbard Brook data. Providing a tool to look at trends from both a narrow and broad perspective. This requires a broad selection of analytical tools, and the ability to select specific timespans for analysis.

**App Mockup:**

Our app will have multiple features that are essential to fulfilling our goals, and some extra features that we could include later depending on our progress. The first goal is to allow for the input of other datasets beyond the one provided to us by Hubbard Brook. This feature would give users the option to pick a watershed dataset of their choosing that they want to analyze. Second, we want a way to graph precipitation, flow, and baseflow on the same graph that also allows for zooming in on the graph. We want to allow for trend analysis including 30 day rolling averages, or a given length of time. We want to allow for the editing of data tables or the ability to download the data we are using. We want to implement these features in separate “pages” or “tabs” that the user can navigate to, which will make the app more visually appealing and allows for each page to have a separate focus. For example, a page for the trend analysis, a page for rolling averages, and a page for viewing, or inputting your own data. The main page will be the precipitation and flow graph trend analysis as this is the key focus of our app. This would make the app feel less cluttered and more visually appealing. It would also allow the user to explore the data more in a more fluid way.

**Visual App Mockup:**

**A graph on a screen

AI-generated content may be incorrect.**

This is a visualization of what our primary page for the app could look like

**Existing apps with similar functionality:**

There are a few apps we’ve seen that do work like what we are aiming for. The first one is Dr. Gannon’s water balance app, this app talks about storage, outputs, and precipitation and creates graphs for all of them. This is done by running a model behind the scenes that uses precipitation in millimeters and temperature in Celsius for each month. Another example takes in a precipitation dataset, and uses that to create graphs, but it requires flow in CFS and a very specific template for it to work. Dr. Gannon has another example which is a discharge app for Hubbard Brook this is like what our end goal is, the graph shows discharge, precipitation, and supposed to have baseflow as well. Another app we look at is called Streamflow which is used to map streamflow data, precipitation, and monthly discharge, it also has statistics for your selected data range as well as 30-day rolling averages. Including 30-day rolling averages could be beneficial, especially if we allow for a selection of the timespan you want. Another is the EcohydRology app, which is a package that is shut down, but it has code to generate baseflow lines that we could use to add baseflow to our graphs.

**Expected issues:**

Given the scale of the app, we are trying to build, we have identified some potential issues that may come up during the development phase. In the Total Daily Precipitation by Watershed dataset, we are unsure if snowfall is included in the precipitation value. We don’t know how this will affect the streamflow of the watersheds as the snow will not melt and contribute to the flow immediately. Another issue is that since we are in the early stages of designing our app, we aren’t quite sure of how we want the graphs to function. We are still trying to figure out how multiple graphs will interact with each other and how they will be displayed on the app. Similarly, we will also need to figure out how to tackle having multiple datasets being used in the app as once. We could potentially combine all the datasets into one, but having one very large dataset could lead to a higher chance of encountering issues or difficulty finding specific data. Another key issue is user input in the app. We want to make sure that nothing will break when the user goes in and changes some variables, so we will have to incorporate a good amount of redundancy into the code of our app. The final potential issue is linear models with dates. The dates in the datasets are given as year-month-day so we will have to separate them out for the user to look at individual days, weeks, or months.

**Sources:**

**Links to data:**

Daily Streamflow by Watershed: <https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-hbr.2.14>)

15-minute Precipitation by Watershed: <https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-hbr.278.5>

Total Daily Precipitation by Watershed: <https://portal.edirepository.org/nis/mapbrowse?packageid=knb-lter-hbr.14.19>

**Links to other Apps:**

Dr. Gannon’s app: <https://cuahsi.shinyapps.io/WaterBalance/>

GRWAT package in R: automatic hydrograph separation and hydrological time series analysis: <https://cran.r-project.org/web/packages/grwat/grwat.pdf>

<https://github.com/tsamsonov/grwat>

Rainfall and flow app: <https://sccwrp.shinyapps.io/rainfall_flow_analysis/>

Dr. Gannon’s app to look at discharge: <https://jpgannon.github.io/discharge_app.html>

An app that is used to show precipitation and flow as well as other useful stats: <https://owrc.github.io/shinyapps-manual/>