

Group 3: Land Use and Algal Blooms in the Savannah River Watershed

The Savannah River Watershed flows through the length of western South Carolina and eastern Georgia down into the Atlantic Ocean. The Savannah River provides drinking water to over 1 million people and is the backbone behind the majority of agriculture within this region. The Savannah River Watershed is closely monitored by a number of federal and state agencies including SCDHEC, the US Army Corps of Engineers, and even industries, specifically the transportation industry.

The Savannah River watershed is not just any river—it's the lifeblood of communities in South Carolina. The presence of an algal bloom affects local residents who rely on this water source for their daily needs, whether for drinking, fishing, or recreation. The threat of exposure to harmful algal toxins looms large, impacting the health and routines of the people.

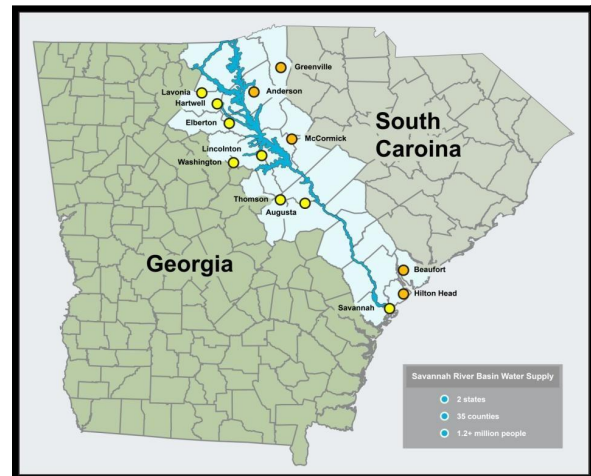


Figure S3.1. A map of the Savannah River Watershed that runs through South Carolina and Georgia.

In July 2020, a fish kill incident, reported by The Augusta Chronicle, was attributed to harmful bacteria, shedding light on the river's vulnerability and the complexities of water management. Simultaneously, blue-green algae has become a recurring concern during peak summer. These algae blooms not only impact the river's aesthetics but also raise health and ecological issues. The stakeholders are concerned about how this will develop in the future and how the future generations might be affected.

Definitions of Algal Bloom Toxins to Help Decipher the Data Below:

Cyanobacteria

Cyanobacteria is also known as blue-green algae and can be found in all types of waters such as freshwater lakes or saltwater environments. When excess cyanobacteria grow they form a harmful algal bloom. Human consumption of cyanobacteria can result in health effects that range from mild to severe. Mild symptoms that can be experienced are skin rashes, fever-like symptoms, respiratory- and gastrointestinal distress. Severe symptoms are for example liver- and kidney damage which can overtime cause serious illness or even death.

Microcystin

Microcystin is a toxin produced by cyanobacterias. Hence, similarly to cyanobacteria it can be found in both fresh- and marine water environments. Being exposed to microcystin may be through ingestion, inhalation, skin- or eye contact. Consequences of being exposed to microcystin may be abdominal pain, nausea, vomiting, headache, diarrhea, sore throat among others.

Objective: In many cases, the frequency of algal blooms are related to the surrounding land use. Land use is defined as the classification or purpose of specific land. Types of land use include pasture, forest, agricultural, or urban.



Figure S3.2. An example ArcGIS map of land use in South Carolina to demonstrate how to use ArcGIS.

For this activity, we want you to categorize the sites by land use based on your observations. You will need to find the land use of each site by going to this site: [Land Use/Algal Bloom Website](#)

Once on the site, select the add data button (circled in yellow on the right). Scroll down until you see the overlay titled: Sentinel-2 10m land use/land cover time series of the world.

From there, scroll to each site listed in your data sheet. Zoom in until the scale bar at the bottom left is at 0.4mi. Next, center your site in the middle of your screen and estimate the amount of the surrounding area

that is occupied by the built area. You will categorize this as none, low, medium, high amount of built area. Record your categorization in your data table in column B.

Access This Year's Savannah River Watershed Data: [here](#) (note there are multiple tabs with data)

Once you have completed your observations on land area, you can compare if the level of algae present is different between these land use groups. You can do this by using a t-test to compare the Microcystins_{ug}_L (column L in your data set) between the different built area groups. If you want, you may run an analysis of variance across these land use types. After running your t-tests, create a plot comparing the level of algae between levels of built area. Instructions on running a t-test, and creating a graph in google sheets is located below.

Running a Statistical Test:

A t-test is a statistical test that allows you to determine if the means of two sets of data are different. In a t-test, one output is a p-value, and this value will help determine if the means are statistically different.

When running a t-test, there are certain assumptions that need to be made about your data. One assumption is that your data is normally distributed. Normally distributed data is where your data occurs evenly around the mean, with data points near the mean occurring more frequently than data far from the mean. There are several tests you can run to determine if your data is normal, but **for this activity, we will assume our data is normally distributed and proceed with a t-test.**

To run a t-test in google sheets you will use the function T.TEST. To compare means you will need two lists of data. These are often columns in a dataset and can be selected by entering the range of cells. A range includes the following the first datapoint in the column, a colon, and the last datapoint in the column (ex. A1:A30).

To run a t-test, you will enter the following equation into an empty cell in your document:

`=T.TEST(Range 1, Range 2, 2, 2)`

The end of that equation has two “2’s” separated by a comma, shown in red. These tell Google Sheets what function to use, and you should just leave them alone. From your t-test you will get an output called a p-value. Based on the results of your t-test, you can make conclusions about your data. If $p < 0.05$, the means between groups are different. If $p > 0.05$, means between groups are the same.

Instructions for Graphing:

To create a graph of algal bloom data, the first step should be to assess which data points go along the x versus the y-axis. Most data provided contains some form of information relative to time like a date or a year. This information should be placed along the x-axis, with anything like pH or color (measured numerically) on the y axis. For example, if you wanted to see how the pH changed over time, you could place the time on the x-axis with the pH on the y-axis.

Other information to keep in mind when graphing is including information like a title, legend if appropriate, axis title, titles for the axes, as well as an appropriate trendline. Google Sheets will likely populate most of this information, but you should review the details before proceeding. For example, it will auto-populate as a line graph, but typically a scatter plot with a trendline is more appropriate for scientific data, especially if we want to derive an equation.

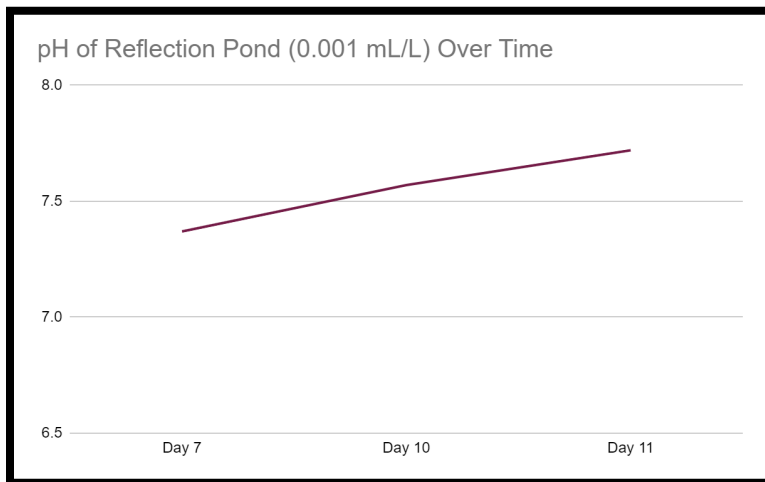


Figure S3.3. Example of a graph generated in Google Sheets.

In Google Sheets, a graph can be created by selecting two columns of data, clicking insert, and then chart. From here, you can change the graph type to a scatter plot within 'Chart Editor'.

References

Papp, J. (2020, July 4). *Bacteria revealed as cause of fish kill in savannah river*. The Augusta Chronicle.

<https://eu.augustachronicle.com/story/news/2020/07/04/bacteria-revealed-as-cause-of-fish-kill-in-savannah-river/114843906/>

United States of Army Corps of Engineers. (2023) *Savannah River, Georgia & South Carolina*. U.S. Army Engineer Institute for Water Resources (IWR).

<https://www.iwr.usace.army.mil/sustainablerivers/sites/savannah/>