Isn't That Spatial: Connecting Geography with River Systems and Climate Through Historical and Real-Time Stream Gage Data

--Joseph J. Kerski

One of the richest sources of scientific data available on the Internet is the USGS data on the occurrence, quantity, quality, distribution, and movement of surface and underground water. Data are collected for an amazing 1.5 million sites on water resources in all 50 States, in the District of Columbia, and in Puerto Rico. Much of this data was converted to real-time availability during the 1990s. Real-time data are recorded at 15 to 60 minute intervals, stored on-site, and then transmitted to USGS offices every 1 to 4 hours, depending on the data relay technique used, but may be more frequent during critical events. Data from real-time sites are relayed to USGS offices via satellite, telephone, and/or radio and are available for viewing within minutes of arrival.

Joseph Kerski at a stream gage in San Antonio, Texas, station 08178000, available at: http://waterdata.usgs.gov/tx/nwis/uv?dd_cd=03&format=gif&period=31&site_no=08178000

How could one use this in the primary, secondary, or university classroom? Let's say your area received a snowfall or a heavy rainfall the previous weekend. The most detailed data, a continuous, minute-by-minute graph, is stored and displayed for up to the past 31 days, available for viewing, printing, and downloading. For longer than 31 days, the data are still available, but they may just have hourly or daily data points. One could easily illustrate with the resulting graph, below, how precipitation, or the lack thereof, is related to the dynamics of rivers. For example, here in Colorado, we had a spring snowfall during this week in April, reflected in the higher flows during the most recent week.

For a subset of gaging stations, one can examine not only the level and volume of flow of rivers, but also water temperature, conductivity, dissolved oxygen, and pH. Conductance (electrical conductivity) measures the amount of dissolved ions (ionic salts) in the water. In the units given, the specific conductance is approximately equal to 2 times the concentration of dissolved salts in parts per million (ppm). A conductance of 500 equals 250 parts per million of dissolved salts; 1000 ppm is considered the maximum desirable ionic salt content for drinking water. You and your students using these data can see how water quality changes during the course of the runoff from a rain or snowstorm.

The data can be obtained from the USGS home page, (www.usgs.gov), by selecting the state of interest on the U.S. map, and selecting "Real-time Water Data." Colored dots represent gaging stations, giving a good impression of which areas are above or below normal. One can either point the cursor at the dots until the desired station is obtained, or click on Statewide Streamflow Table. The second choice below this is the Statewide Precipitation Table, which provides a precipitation record, for use in comparing river flow with timing of precipitation.

One can also generate a custom summary table for one or more stations. Because one can download the data and obtain the latitude-longitude for each gaging station, this information can be input into a GIS to analyze gaging stations across space. Perhaps you can even take a field trip with your students to visit one of these gaging stations. Many of the gaging stations appear as point symbols on USGS topographic maps. At the gaging station, you could take your own flow and water quality measurements there and compare them to those from the USGS.

Questions for students using these data include the following:

How does the volume and water quality of selected rivers across the country compare?

Where is your selected gaging station located relative to your school campus or to your home? What were the highest, and lowest, water flows during this period of time? How do they compare to the normal average flow for this time of year? When is this stream highest during the year? Why? How high did your river rise above or fall below its lowest level this week? How many cubic feet of water does your bathtub at home hold? For the lowest (and highest) flows of the river last week, how long would it take the river at this point to fill your bathtub? Or, how many bathtubs could the river fill every minute or every second?

The flow (volume) of a river is equal to its width x depth x speed of flow (feet x feet x feet/second = cubic feet per second). If the channel of a river where these measurements were made were 50 feet wide and 1 foot deep, how fast would it be flowing at its greatest and its lowest flow rates that week? After calculating those speeds in feet per minute, convert them to miles per hour or kilometers per hour. Can you walk, run, or bicycle as fast as the river flows?

If "Streamflow Table" is selected instead of the map, a list of all the stream gages in that state will appear, grouped by drainage basins. Scroll down to the desired station. The graphs also give minimum, mean, and maximum average flows for the years since the station has been online. You could examine such major flood events as the 1993 Mississippi River flood, or the 1997 flood of the Red River of the North, easily detected in this list of annual mean streamflow in the Red River at Grand Forks, North Dakota:

1990	851
1991	1,233
1992	1,742
1993	5,758
1994	5,508
1995	6,068
1996	6,617
1997	10,280
1998	6,568
1999	8,437
2000	5,447
2001	7,631
2002	5,452
2003	2,238

Compare the precipitation graph to the stream flow graphs. How does the day and time when the most precipitation fell compare to the day and time when the river rose most? What factors could cause these two not to be the same? Would it make a difference if the precipitation fell as snow, or rain?

Why does the temperature graph vary so much? What time of day does the water temperature reach its maximum or minimum? You could go to a National Weather Service website and find and compare the air temperature on these same days to the water temperatures.

What did the conductivity do when the stream level started to rise? Why is the pattern so complicated? What do you think the conductivity of snow or rain is? What kinds of things can happen to snow or rain, between the time they fall and the time that the water might drain off into the river?

What is dissolved oxygen? Why is it important to aquatic life? How is affected by plants living in the river? By animals? Why is it different during the day versus the night? Which day shows a dissolved oxygen pattern different than the rest? How does dissolved oxygen vary by the season of the year? Why?

What is pH? What time of day is it highest or lowest? What do you think goes on in the water that might affect the pH during the course of each day? What is "neutral" pH? What range of pH is acceptable for fish to live in? What factors can cause pH to become higher, or lower? Is the river you are studying in a safe range?

What kinds of human structures and activities affect the water in the river? What kinds of natural or human causes affect the river's level, temperature, or chemical composition? Are these "good" effects or "bad" effects? How do we decide which is which?

If you were a rain drop or a snowflake falling somewhere in your state, what kinds of things could happen to you between the time you fell and the time you were carried into this or another river? What kind of path would you follow? What kinds of natural or man-made places or obstacles, would have you have to pass through? Would this be fun, or not? One could write a story about what happens to a raindrop along the path of its journey.

Where does the water in the selected river run, after it flows through your community? How does it reach the ocean? What implications does this have for how we all need to work together when it comes to water quality and availability?

These are only some of the data and some of the topics one can investigate using the wealth of water data from the USGS. I look forward to hearing your ideas!