Water Quality Graphing Activity
with Student Worksheet

Date: June 27, 2010

Might be used in courses such as: Environmental Biology, Chemistry, General Biology

Approximate time to complete activity: 2 hours to work through first specific example, 2-4 additional hours if students graph additional relationships.

Source of idea or activity: Uses the USGS National Water Quality Assessment Data Warehouse (http://water.usgs.gov/nawqa/data)

Materials/resources needed: Computer with access to the internet. Teacher Guide and Student Worksheet for Water Quality Graphing Activity.

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What level of learning does this activity aim to stimulate?

Necessary background knowledge: Basic familiarity with the water cycle, nitrogen cycle, and phosphorous cycle will be helpful. Understanding of the sources and implications of nitrogen and phosphorous in aquatic systems.

Detailed description of activity: The student worksheet guides students step-by-step through the online USGS National Water Quality Assessment (NAWQA) Data graphing application online. The first activity uses the Iowa River in Eastern Iowa as the study site. Students follow the steps to generate a graph of streamflow, nitrate and nitrite levels, and orthophosphates in water samples over the course of one water year. Once the graph is generated, the worksheet guides students through interpretation of the graphical information by asking questions that require them to not only read the information on the graph, but also draw some conclusions about observed patterns.

Suggested extensions: Upon completion of the first activity, students or instructors can choose to investigate other study sites throughout the country and/or other parameters of water quality. The NAWQA Data site provides a wide array of information is worth exploring for additional classroom applications as well.

The Student Worksheet includes the following:

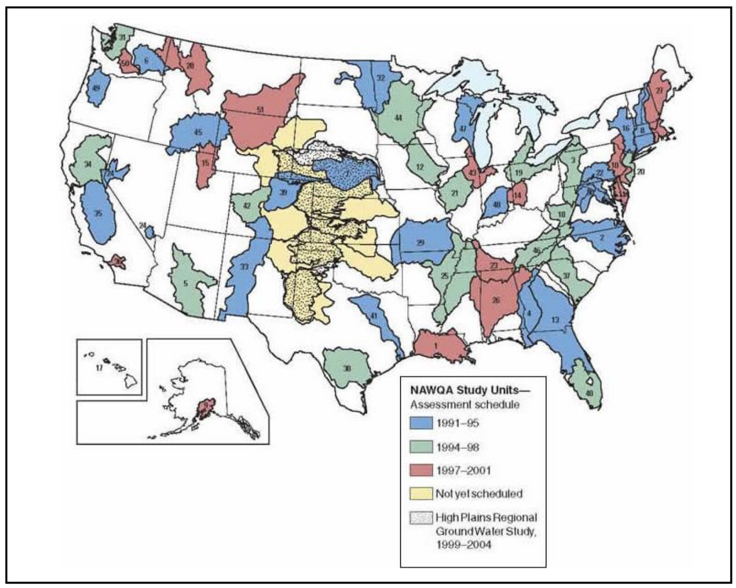
Overview of Water Quality Monitoring - Graphing Activity
Student Worksheet

This activity uses data from the U.S. Geological Survey's National Water-Quality Assessment Program to graph changes in discharge and water quality parameters over the course of a water year. The main objectives are to practice reading information that is presented in graphical form and to use critical thinking skills to interpret the observed relationships.

The first activity will use data from the Iowa River within the Eastern Iowa study unit. This activity will provide familiarity with use of the data base and interpretation of graphical data.

Upon completion of the first activity, you may choose to investigate other water quality parameters or different stream gage locations, as guided by your instructor

NAWQA BACKGROUND



The National Water-Quality Assessment program was started in 1991 by the U.S. Geological Survey (USGS). From 1991 – 2001, the program collected chemical, biological, and physical water quality data from 51 study units across the United States. The goal was to gather long-term data about streams, rivers, ground water, and aquatic systems to help agencies (national to local) make decisions regarding water-quality management and policy.

Ultimately, the study was designed to address three major questions: (1) What is the condition of our Nation's streams, rivers, and ground water? (2) How are these conditions changing over time? (3) How do natural features and human activities affect these conditions, and where are those effects most pronounced?

From 2001 to 2012, monitoring continued on 42 of the original study units on a rotational basis. Trends are assessed every 10 years.

The data warehouse currently contains and links the following data from the USGS National Water Information System:

- Chemical concentrations in water, bed sediment, and aquatic organism tissues for about 2,400 chemical constituents
- Site, basin, well and network characteristics with many descriptive variables
- Daily stream flow information for fixed sampling sites
- Ground water levels for sampled wells

- 7,700 surface water sites (including 3,400 reach segments for biological studies) and 9,400 wells
- 61,000 nutrient samples and 40,000 pesticide samples as well as 11,000 VOC samples
- 2,700 samples of bed sediment and aquatic organism tissues
- Biological community data for 22,500 fish, algae and invertebrate samples

Go to image source for the full-sized map and access to NAWQA's reports.
http://water.usgs.gov/nawqa/studies/study_units_listing.html

Activity 1: Iowa River at Marengo, Iowa

Background

The Eastern Iowa Basins study unit covers about 19,500 mi^2 in eastern Iowa and southern Minnesota. In addition to the Iowa River, the study unit also includes the Skunk, Cedar, and Wapsipinicon River Basins. The Iowa River originates in north-central Iowa and flows approximately 300 miles in a southeasterly direction to the Mississippi River.

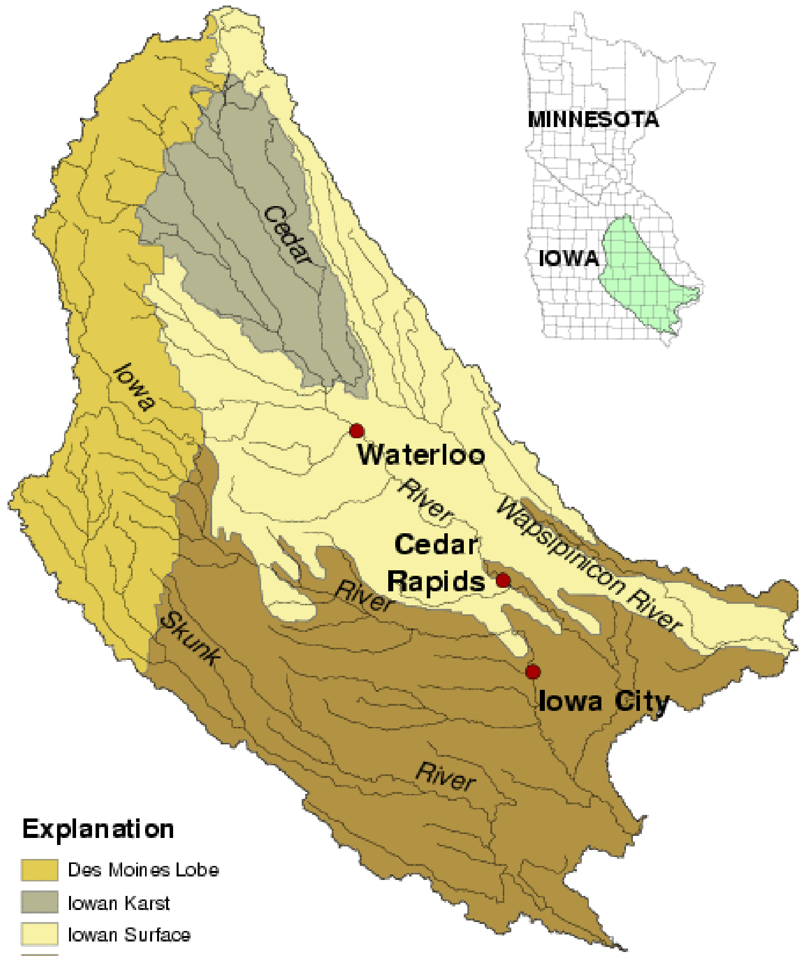


Figure 1.—The Eastern Iowa Basins study unit (Iowa landforms from Prior, 1991)

Source: http://ia.water.usgs.gov/nawqa/images/figure1.gif

Average annual precipitation in the basin is 30-36 inches, with the greatest rainfall falling during the spring and summer months. The area also receives snowfall, starting as early as September and occasionally falling as late as May. Approximately 25% of the annual precipitation runs off into the streams, with the remainder either evaporating or infiltrating into the soil. Approximately 6% of the population uses surface water within the basin for their public water supply.

The major land use in the basin is production of row crops (corn) and cover crops (alfalfa), with some of the land immediately adjacent to the streams being forested. These and other human activities can have a significant effect on the quality of both surface water and groundwater supplies. Municipal sewage effluent and runoff from agricultural and urban fertilizers contribute to eutrophication of surface waters. Similarly, pesticides can also runoff or infiltrate to contaminate public water supplies. Finally, sedimentation from soil erosion leads to increased turbidity and decreased habitat and aesthetic quality of the streams.

The Marengo, IA gage is located 139.1 miles above the mouth of the Iowa River, upstream from the dam and reservoir at Coralville, IA. Flood stage at Marengo is 14 feet, and discharge rates at flood stage are approximately 6,000 cfs. In June 2008, rivers in Eastern Iowa reached record heights in a flood that has been described as "epic." On June 12, 2008, the Marengo gage reached a height of 21.38 feet and discharge was recorded as 51,000 cfs.

The following map shows a portion of the Iowa River basin from the Marengo, IA gage (red marker) to the Coralville Lake area above Iowa City.

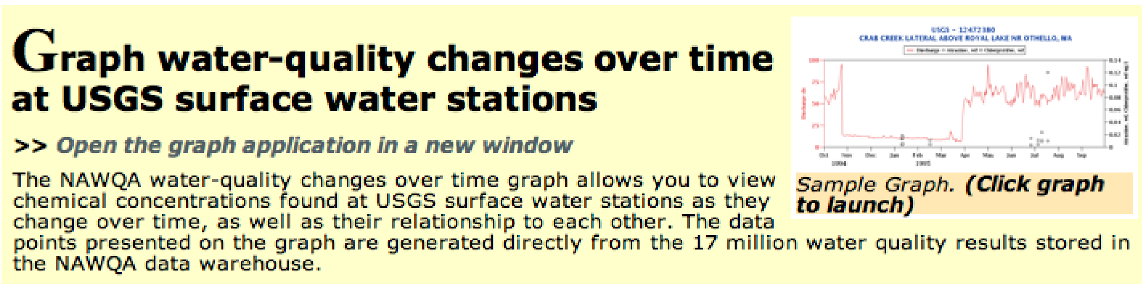
For additional information about the Eastern Iowa Basin, refer to the 1996-1998 USGS Summary Report at http://pubs.water.usgs.gov/circ1210/

Generating the Graph

1. Access the NAWQA Data homepage at http://water.usgs.gov/nawqa/data

2. Click on the link "Graph of water-quality changes over time." There you will see some information about how the program works.

3. When you are ready to begin, click the image of the graph or the link "Open the graph application in a new window."

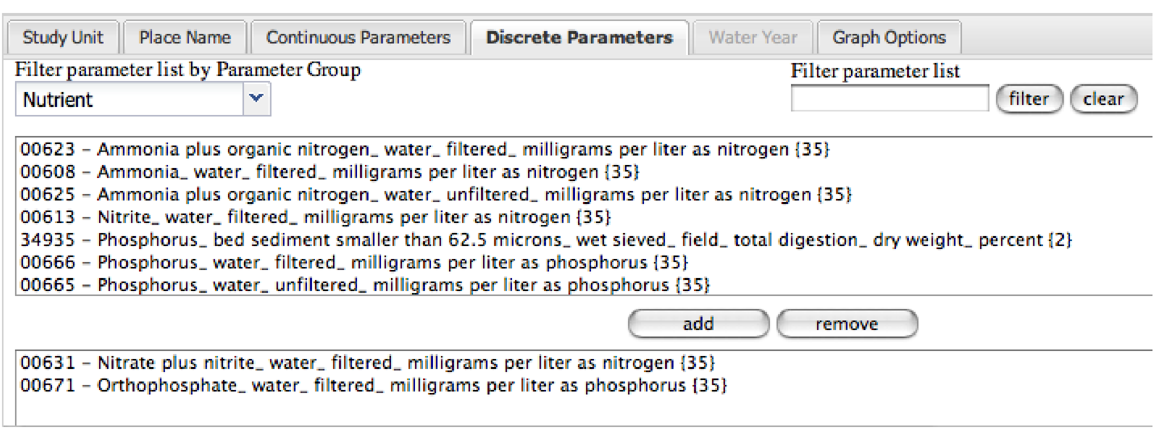


4. Once the graphing page opens, select "Eastern Iowa Basins" as your study unit and click "OK". (See Figure above)

5. Next, you will choose a specific location. For this activity, we will use data from the Marengo, IA river gage. Select "Iowa River at Marengo" on the Place Name tab and click "OK".

6. Select "Discharge" as the continuous parameter and click "OK".

7. Under the Discrete Parameters tab, you can narrow down the choices by choosing "Nutrient" under the "Filter parameter list by" drop down menu. From this list, choose "00631 Nitrate and Nitrate" and "00671 Orthophosphate". You can either select them one at a time, clicking "Add" after highlighting your choice. Or, use the control key to select both. Just be sure to click "Add" before moving on! When both choices show up in the lower box (see Figure below), click "OK".



8. Finally, you will select the "Water Year." Choose 1998 and click "Graph". It may take several seconds, but eventually, the graph will appear, ready for analysis.

Interpretation

Use the graph you generated to answer the questions below.

1. Which parameter is plotted on the x-axis?

2. When does the 1998 water year start and end?

3. Which parameters are plotted on the y-axis? What are the units and ranges for each?

4. Briefly summarize how discharge changes during the water year.

5. What is the highest rate of discharge seen during this water year and when did this occur?

6. Was there any other time during the year when the discharge seemed to peak? If so, when and what was the highest rate recorded during this time?

7. What was the highest concentration of nitrates and nitrites recorded during this water year and when did this occur?

8. What was the lowest concentration of nitrates and nitrites and when did it occur?

9. Briefly describe any patterns or trends that you see in the levels of nitrates and nitrites recorded during this water year.

10. What was the highest concentration of orthophosphates recorded during this water year and when did this occur?

11. What was the lowest concentration of orthophosphates and when?

12. Briefly describe any patterns or trends that you see in the levels of orthophosphate as recorded during this water year.

Critical Thinking Questions

Based on what you've learned about climate and land use in this region, answer the following questions.

1. What factors might cause changes in discharge at different times of year at this site?

2. What factors might cause changes in levels of nitrates and nitrites at this site?

3. What factors might cause changes in levels of orthophosphate at this site?

4. Is there any relationship between rates of discharge and levels of nutrients at this site?

Further Investigations

Now that you have examined the 1998 water year, graph the trends for water years 1997 and 1996 to see how they compare.

1. From the “Water Year” tab, choose 1997 and click “Graph”.

2. How does 1997 compare to 1998 in terms of discharge? (In addition to the general pattern, you might wish to compare maximum discharge rates, timing of peaks, etc.)

3. How does 1997 compare to 1998 in terms of nitrates and nitrites?

4. How does 1997 compare to 1998 in terms of orthophosphates?

5. Is there any relationship between rates of discharge and levels of nutrients during this water year?

6. Finally, examine the graph for water year 1996. How does 1996 compare to the other two years in terms of discharge, nitrates and nitrites, and orthophosphate? (Note that there is no data for nutrient levels from October 1995 through March 1996).

7. Is there any relationship between rates of discharge and levels of nutrients during this water year?

Activity 2: Your Own Investigation

Now that you know how to use this site and interpret the graphs that are generated, you can design your own water quality study. Perhaps you would like to choose a different study unit or specific site. Maybe you would like to investigate other parameters, such as dissolved oxygen levels, chloride concentrations, suspended sediment, or bacterial levels. The possibilities are endless!

1. Briefly describe your study. What questions are you trying to answer? If possible, state a hypothesis that you plan to test.

2. List the specifics here.

   a. Study Unit:

   b. Specific Site:

   c. Continuous parameter(s):

   d. Discrete parameter(s):

   e. Water year:

3. Analyze your graph(s). What conclusions can you draw? Did the results support your hypothesis?

Resources

Kalkoff, S.J. 1994. Fact Sheet 94-031 NATIONAL WATER-QUALITY ASSESSMENT PROGRAM--Eastern Iowa Basins
http://ia.water.usgs.gov/nawqa/factsheets/factsheet.html
Background information about the Eastern Iowa Basin study unit.

Kalkhoff, S.J., Barnes, K.K., Becher, K.D., Savoca, M.E., Schnoebelen, D.J., Sadorf, E.M., Porter, S.D., and Sullivan, D.J. 2000. Water Quality in the Eastern Iowa Basins, Iowa and Minnesota, 1996–98: U.S. Geological Survey Circular 1210. 37 pp.
http://pubs.water.usgs.gov/circ1210/
Summary report prepared using data from the 1996-1998 water quality assessment in the Eastern Iowa Basins. Provides background information about the study unit and presents the major findings of the data collected.

U.S. Army Corps of Engineers. RiverGages.com. Iowa River at Marengo
http://www2.mvr.usace.army.mil/WaterControl/stationinfo2.cfm?sid=MROI4&fid=MROI4&dt=S
Stream gage information for the Iowa River at Marengo.

USGS Complete Listing of NAWQA's Study Units and Summary Reports.
http://water.usgs.gov/nawqa/studies/study_units_listing.html
Clicking on the name of the study unit will access the state water resources summary page for that location. Clicking on the study unit Summary Report (e.g. Circular 1210) will provide more detailed background information, including a summary of the data collected during the 1991 – 2001 study period.

USGS Iowa Water Science Center
http://ia.water.usgs.gov/
Links to real-time data as well as reports published by the Iowa Water Science Center.

USGS National Water Quality Assessment (NAWQA) Program. About NAWQA Study Units.
http://water.usgs.gov/nawqa/studyu.html
Choose selected study unit from the drop-down menu for a list of resources about that site.

USGS Real-Time Water Data for Iowa. USGS 05453100 Iowa River at Marengo, IA
http://waterdata.usgs.gov/ia/nwis/uv/?site_no=05453100&PARAmeter_cd=00065,00060,72020
USGS Stream gage information for the Iowa River at Marengo. Reports most recent stage and discharge readings.

USGS Surface Water for Iowa: Peak Streamflow
http://nwis.waterdata.usgs.gov/ia/nwis/peak?site_no=05453100&agency_cd=USGS&format=html
Dates of peak streamflow during each year from 1957-present at the Iowa River Marengo stream gage. Reports streamflow in cfs and gage height in feet.

USGS The Water Cycle: Streamflow. Water Science for Schools
http://ga.water.usgs.gov/edu/watercyclestreamflow.html
Provides an overview of the role of streams in the water cycle and discusses factors that can affect streamflow. A sub-page of the USGS's Water Science for Schools site.