FLOOD!
Transport of Contaminants in Floodwater

White Pelicans fishing at a Mississippi River
dam during the 2010 ATEEC Fellows Institute.
If possible, please use computers instead of paper.

This set of activities is a product of the 2010 ATEEC Fellows Institute:

A. Chemical Stream Assessment

Date: June 27, 2010
Might be used in courses such as: Environmental Science, Biology, Physical Science, Ecology
Approximate time to complete activity: 1-2 hours
Source of idea or activity: ATEEC 2010 Fellows Institute – IOWATER web site
Materials/resources needed:

1. Access to a small stream
2. EPA safety consideration sheet
    - Found at the following EPA web site
    - http://www.epa.gov/volunteer/stream/vms23.html
3. ATEEC Stream Assessment Tutorial (ATEEC Tips)
4. Materials –
    - pH kit
    - Phosphate kit
    - Chloride kit
    - Dissolved oxygen kit
    - Nitrate/Nitrite kit
    - Water clarity tube
    - Stopwatch

Submitted by: Jeff Newmeister – North Scott High School – Eldridge, IA 52748

What level of learning does this activity aim to stimulate?
This is an introductory activity is designed to allow the student to collect data for a stream in order to understand the concepts of nutrient transport. This could then lead to further research in which the student will propose, design, conduct and analyze an individual water assessment research project based on the scientific method of research.

Necessary background knowledge:

1. Understanding of the basic parameters that could influence the transport of nutrients or contaminants in a flowing body of water.
2. Understanding the protocol for conducting a chemical assessment of a stream
3. Use of Excel spreadsheet (or similar program) to construct visual of collected data
4. The ability to use algebra to analyze data sets
5. The ability to convey research in a written format

Detailed description of activity:
Students will follow established protocol to collect and assess the nutrient transport in a body of water. A more detailed description is attached.

Suggested extensions:
*A*TEEC Activity – The Impact of Precipitation on the Total Amount of Nutrients in a Steam

Stream Chemical Assessment:
Background and Sampling Techniques

The following is designed to provide background information as to the implication of various nutrients that are commonly transported in a steam.

The basis of this information was derived from www.iowater.net. A more detailed description can be found at http://www.iowater.net/Publications/Level1Manual/Chapter6.pdf.

pH

pH is a measure of a water's acid/base content and is measured in pH units on a scale of zero to14. A pH of seven is neutral (distilled water), while a pH greater than seven is basic/alkaline and a pH less than seven is acidic.

The pH level of stream water is influenced by the concentration of acids in rain and the types of soils and bedrock in the state. The typical pH of rainfall in the U.S. is slightly acidic, ranging from 5.0 to 5.6. As rainwater falls, it dissolves carbon dioxide from the atmosphere, thus forming a weak carbonic acid and lowering the pH of the precipitation.

Low pH levels (acidic) can have a harmful impact on the health of aquatic communities. Very acidic water or acid rain can allow toxic substances, such as ammonia and heavy metals, to leach from our soils and possibly be
taken up by aquatic plants and animals (bioaccumulation).

Dissolved oxygen

Dissolved oxygen (DO) is necessary for nearly all aquatic life to survive. Certain processes add oxygen to a stream, while others remove or consume oxygen. Oxygen is added to a stream from the atmosphere through mixing in turbulent areas. Plants also contribute oxygen through photosynthesis.

Dissolved oxygen is measured in milligrams per liter of water (mg/L). Iowa standards, which are set to protect aquatic life, call for a minimum of 5 mg/L of DO in warm water streams and 7 mg/L in coldwater streams.

DO in streams can be affected by:

- **Water Temperature** – Cold water holds more oxygen than warm water.
- **Season** – DO levels are higher in winter than in summer.
- **Time of Day** – On a sunny day, DO levels rise from morning through the afternoon as a result of photosynthesis, reach a maximum in late afternoon, and steadily fall during the night, reaching their lowest point before dawn.
- **Stream Flow** – DO will vary with the volume and **velocity** of water in a stream; faster moving water mixes readily with atmospheric oxygen, thus increasing DO.
- **Aquatic Plants** – Plant and algae growth in a stream will affect the oxygen contributed by photosynthesis during the day and depleted by plant **respiration** at night.
- **Dissolved or Suspended Solids** – Oxygen dissolves more readily in water that does not contain high amounts of salts, minerals, or other solids.

• **Human Impacts** – Lower DO levels may result from human impacts including organic enrichment, urban stormwater runoff, riparian corridor removal, stream channelization, and dams.

Nitrate-N / Nitrite-N

Nitrogen is an essential plant nutrient, but excess nitrogen can cause water quality problems. Too much nitrogen and phosphorus in surface waters causes nutrient enrichment, increasing aquatic plant growth and changing the types of plants and animals that live in a stream. This process, called eutrophication, can also affect other water quality parameters such as temperature and dissolved oxygen.

Nitrate and **nitrite** are two forms of nitrogen. Nitrate is very easily dissolved in water and is more common in streams. Sources of nitrate include soil organic matter, animal wastes, decomposing plants, sewage, and fertilizers. Nitrate is more soluble in water than phosphorus and can move more readily into streams. Nitrite is another form of nitrogen that is rare because it is quickly converted to nitrate or returned back to the atmosphere as nitrogen gas. Due to its instability, detectable levels of nitrite in streams and lakes are uncommon. Detectable nitrite levels in streams may indicate a relatively fresh source of ammonia.

Phosphate

Phosphorus is an essential nutrient for plants and animals and is usually present in natural waters as dissolved orthophosphate. Plant growth in surface waters is generally limited by the amount of orthophosphate present. It is the simplest form of phosphorus found in natural waters and is most available for plants to use. In most waters, orthophosphate is present in very low concentrations. The amount of phosphate dissolved in water is expressed in milligrams per liter of water (mg/L). The HACH test kits uses measure **orthophosphate**, which will be referred to as simply “phosphate.”

There are natural sources of phosphorus, such as certain soils and rocks, but most elevated levels of phosphorus are caused by human activities. These include human, animal, and industrial wastes, as well as runoff from fertilized lawns and cropland. Excess phosphorus in water speeds up plant growth, causes algal blooms, and can result in low dissolved oxygen, or hypoxic, conditions that can lead to the death of certain fish, invertebrates, and other aquatic animals.

Chloride

Chloride is a chemical found in salts, which tend to dissolve easily in water. In natural waters, elevated levels of chloride may indicate inputs of human or animal waste, or inputs from fertilizers, many of which contain salts. During winter months, elevated chloride levels in streams may occur as a result of road salt runoff to nearby streams. Chloride can be used as a "conservative" measure of water contamination since other natural processes, such as breakdown by bacteria, do not affect it.

The amount of chloride dissolved in water is expressed in milligrams per liter of water (mg/L). Average chloride concentrations for streams in Iowa range from 20 to 30 mg/L.

Water Assessment Kit Directions:

Use the following directions or links to obtain specific directions for each of the chemical test demonstrated in the ATEEC Tips video clips.

CHEMets® Kit – Phosphate (K-8510)
http://www.chemetrics.com/products/i8510.pdf

CHEMets® Kit – Dissolved Oxygen (K-7512)
http://www.chemetrics.com/products/i7512.pdf

HACH® AquaCheck® Water Quality Test Strips – Nitrate-Nitrite (27454-25)

1. Dip a strip into water for 1 second (or pass under gentle water stream) and remove. **Do not shake** excess water from the test strip.
2. Hold the strip level, with pad side up, for **30 seconds.** Compare the NITR**I**TE (lower) test pad to the nitrite-nitrogen color chart on test strip bottle,
3. At **60 seconds** (or 30 seconds after estimating nitrite concentration), compare the NITR**A**TE(upper) test pad to the nitrate-nitrogen color chart on test strip bottle.
4. Estimate results if the color of the test pad falls between two color block.

HACH® Quantab® Titrators - Chloride (27449-40)

1. Remove a titrator from bottle and replace cap immediately.
2. Insert the lower end of titrator into solution. Do not allow solution to reach the yellow completion band at the top of the titrator.
3. Allow solution to completely saturate wick of the titrator. Reaction is complete when yellow band turns dark.
4. Note where the tip of the white chloride peak falls on the numbered Quantab® scale. This represents the Quantab® unit value.
5. Refer to the table on the Quantab® test strip bottle to convert Quantab® units into salt concentration.

HACH® AquaCheck® Water Quality Test Strips – pH (27456-50)

1. Dip a test strip into water and remove immediately.
2. Hold strip level for **15 seconds**. Do not shake water from the test strip.
3. Compare the pH test pad to the color chart on test strip bottle. Estimate results if the color on the test pad falls between two color blocks.

B. The Impact of Precipitation on the Total Amount of Nutrients in a Stream

Date: June 27, 2010

Might be used in courses such as: Environmental Science, Biology, Physical Science, Ecology

Approximate time to complete activity: 3-4 hours over extended time period

Source of idea or activity: ATEEC 2010 Fellows Institute

Materials/resources needed:

- Access to a small stream
- Water test kit(s) from HACH, CHEMets, or equivalent
- Lab background sheet
- Student research plan
- ATEEC video clips demonstrating how to sample the data

Submitted by: Jeff Newmeister – North Scott High School – Eldridge, IA 52748

What level of learning does this activity aim to stimulate?

This is an introductory activity designed to allow the student to propose, design, conduct and analyze an individual water assessment research project based on the scientific method of research.

Necessary background knowledge

- Understanding of the basic parameters that could influence the transport of nutrients or contaminants in a flowing body of water.
- Understanding the protocol for conducting a chemical assessment of a stream
- The ability to use the Excel spreadsheet (or some similar program) to construct a visual of the collected data
- The ability to use algebra to analyze data sets
- The ability to convey research in a written format

Detailed description of activity

The lab activity is attached below.

The Impact of Precipitation on the Total Amount of Nutrients in a Stream

Background Information:

Recent worldwide events have brought more focus on the impacts of flooding of streams and rivers. In addition to monetary losses, flooding can result in a shift of the basic parameters that could influence the transport of nutrients or contaminants in a flowing body of water.

- **Stream chemical assessment** is used to collect and analyze any chemical that may find its way into the watershed. Common contaminants that can easily be collected by a student at the introductory level include, but are not limited to, Nitrate-N, Nitrite-N, Phosphate, and Chloride.

- **Chemical test kits** can be obtained from HACH® or CHEMets® in addition to other sources. The use of these test kits is not required for this activity. These kits allow for the determination of the dissolved concentration levels of many chemicals.

- **Load** (often called flux) is the amount (mass) of a chemical in a river that passes a given point over a given period of time. It is calculated by multiplying the average stream flow (discharge) of the river by the average concentration of that chemical in the river over that time period. Additional information can be found at the University of Wisconsin, Stevens Point web site: http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/fluvial_systems/geologic_work_of_streams.html

- **Definition of nutrient loads versus nutrient concentrations**
  The nutrient ***load*** refers to the total amount of nitrogen or phosphorus entering the water during a given time, such as "tons of nitrogen per year." Nutrients may enter the water from runoff, groundwater, or the air (in the form of wet deposition such as rain or snow as well as dry deposition).

  The nutrient ***concentration*** refers to the amount of nitrogen or phosphorus in a defined volume of water (such as milligrams of nitrogen per liter of water). Total nitrogen concentration is the total amount of nitrogen in one liter of water; total nitrogen includes both dissolved nitrogen in the water column and particulate nitrogen contained in algal cells and in organic detritus such as degrading leaves from trees. Like nutrients, concentrations of oxygen, algal abundance (measured as chlorophyll *a*), and total suspended solids are a measure of how much oxygen, chlorophyll *a*, or total suspended solids are in a defined volume of water. The relationship between nutrient concentration and nutrient load can vary and depends on the flow, the volume of water in the river, and watershed characteristics.
  Source: Department of Natural Resources – Maryland, USA
  http://www.dnr.state.md.us/coastalbays/water_quality/nutrient_load.html

- **Calculating stream flow**
  Investigators should be familiar with the technique of calculating stream flow of a moving body of water. A description of this technique can be found at the EPA web

site as follows: http://www.epa.gov/volunteer/stream/vms51.html

- A data form for calculating stream flow can be found at the EPA web site: http://www.epa.gov/volunteer/stream/ds5a.pdf

- Follow the general directions to complete an individualized research project.

Safety Considerations:

Safety precautions can never be overemphasized. Be sure to take safety into account by not conducting an experiment beyond the expertise of the investigator. Some common factors to consider include, but are not limited to the following.

- Always monitor with at least one partner.
- Develop a safety plan.
- Have a first aid kit handy and knowledge of any important medical conditions of team members
- Listen to weather reports. Never go sampling if severe weather is predicted or if a storm occurs while at the site.
- Never wade in swift or high water. Do not monitor if the stream is at flood stage.
- Use caution when conducting stream assessments.

Detailed EPA safety list: http://www.epa.gov/volunteer/stream/vms23.html.

Steps for the Research Assignment

Research Problem:

Each spring, many waterways are inundated with rainfall and melting of snow from the previous winter. What is the impact of this influx of water on the concentration and total load of the various nutrients or contaminants? Identify a specific research subset question for this topic. Be sure to keep your research narrow enough that it can actually be completed with the available resources and time allotment. Also, be sure that data can be safely collected from this site both before and after a rainstorm event.

For example:

- What happens to the concentration per unit of water and the total transport of phosphate as a result of a rainstorm near a small creek?
- What is the impact on the levels of chlorine (concentration and total load) in a stream as a result of a rainstorm?

The research project is open as to the content, but should focus on the influence of rainfall (which may lead to flooding) and the concentration and total amount of the nutrient or contaminant in both normal and flooding periods, as is often experienced during a rainfall event.

Hypothesis:
Construct a hypothesis that deals with a specific parameter that can be analyzed in reference to various water events (rainfalls). Be sure that the hypothesis is one that can be tested given the access to both the chemical test and research site. The hypothesis needs to focus on the research problem and must be narrowed to one independent variable. In this case, based on the written problem, the obvious independent variable is the amount of water transported down the stream as a result of a precipitation event.

Alternative Hypothesis:
After writing the hypothesis focusing on one independent variable, construct a hypothesis of no difference.

Procedure:
Using the hypothesis from above, provide a detailed explanation of what needs to be done to test its validity. Be sure to identify both the independent, dependent, and control variables of the experiment.

Data:
As the experiment is conducted, construct and complete a detailed data table. Then, use a graphing program, such as MS Excel to construct a graph of the results. Be sure to use the appropriate variables on the graph.

Conclusion:
Once the data has been collected and graphed, reflect back on both the hypothesis and null hypothesis constructed for the problem. In doing so, accept or reject each hypothesis. Be sure to base this on the data sets collected.

Discussion:
Now that each hypothesis has been accepted or rejected, explain why this conclusion was derived. It is essential, that the collected data is the driving force, and that data values of the results are cited to reflect the conclusions.

Lab Report:
After completion of the activity, prepare a type written report to submit the process of the experimentation and resulting conclusions.

C. EPA On Calculating Stream Flow

Date: June 27, 2010

Might be used in courses such as: Environmental Science, Biology, Physical Science
Approximate time to complete activity: 1-2 hours
Source of idea or activity: ATEEC 2010 Fellows Institute and EPA Web Site
Materials/resources needed:

__Access to a small stream

__EPA safety consideration sheet

- Found at the following EPA web site
- http://www.epa.gov/volunteer/stream/vms23.html

__Lab background sheet

- Found at the following EPA web site
- http://www.epa.gov/volunteer/stream/vms51.html

__Data Sheet

- Found at the following EPA web site
- http://www.epa.gov/volunteer/stream/ds5a.pdf (copy/paste URL, if needed)

__Materials

- Heavy-duty string and four stakes
- Tape measure (at least 20 feet)
- Waterproof yardstick or other implement to measure water depth
- Twist ties (to mark off intervals on the string of the transect line)
- An orange and a fishing net (to scoop the orange out of the stream)
- Stopwatch (or watch with a second hand)
- Calculator (optional)

Submitted by: Jeff Newmeister – North Scott High School – Eldridge, IA 52748

What level of learning does this activity aim to stimulate?

This introductory activity is designed to allow the student to collect data for a stream in order to understand the concepts of stream velocity and stream flow. This could then lead to further research in which the student will propose, design, conduct and analyze an individual water assessment research project based on the scientific method of research.

Necessary background knowledge:

- Understanding of the basic parameters that could influence the transport of nutrients or contaminants in a flowing body of water.
- Understanding the protocol for conducting a chemical assessment of a stream
- The ability to use the Excel spreadsheet (or some similar program) to construct a visual of the collected data
- The ability to use algebra to analyze data sets
- The ability to convey research in a written format

Detailed description of activity:

This lab is found at the Environmental Protection Agency (EPA) web site. The web address for the activity is:

http://www.epa.gov/volunteer/stream/vms51.html

Suggested extensions:

*A*TEEC Activity – The Impact of Precipitation on the Total Amount of Nutrients in a Stream

D. Resources: Articles, Activities, and Films for Water Quality and Flooding

Articles:

Plant Genes Modified to Fight Pollution:
Learning Objective: Students will get an understanding of how genetically engineered grass and trees could help remove toxins and explosive residues from the environment
http://www.msnbc.msn.com/id/21313185/

Nutrient Pollution Chokes Marine And Freshwater Ecosystems:
Learning Objective: Students should get an introduction to Water pollution and adverse effects upon water bodies (lakes, rivers, oceans, groundwater) caused by human activities.
http://www.sciencedaily.com/releases/2009/02/090219141533.htm

Freshwater Pollution Costs US At Least $4.3 Billion A Year:
Pollution by phosphorous and nitrogen isn't just bad for lakes, streams and other bodies of fresh water. According to researchers at Kansas State University, it's also bad for Americans' pocketbooks.
http://www.sciencedaily.com/releases/2008/11/081112124418.htm

Getting Plants to Rid Themselves of Pesticide Residues:
Learning Objective: Students will learn of new how new a natural plant hormone, applied to crops, can help plants eliminate residues of certain pesticides.
http://www.sciencedaily.com/releases/2009/09/090909103116.htm

Water Pollution Effects, Nutrient Pollution:
Learning Objective: Students will become familiar with Waterborne Infectious Diseases, Nutrient Pollution, Chemical Contamination, Mining, Marine Debris, and Thermal Pollution as Water Pollution Effects On Animals, Humans, Plants, and Ecosystems
http://www.grinningplanet.com/2006/12-05/water-pollution-effects.htm

Water Pollution Solutions:
Learning Objective: Students will get an understanding to some solutions to water pollution by Reducing Nutrient and Pesticide Pollution, Reducing Sewage Pollution, Improving Storm Water Management and Watershed Monitoring, Stopping Deforestation, Opposing Coastal Development, Reducing Mercury Emissions, Cleaning Up Mining Practices Reducing, and Cleaning Up Chemical Pollution, Pollution from Oil and Petroleum Liquids
http://www.grinningplanet.com/2008/01-08/water-pollution-solutions-article.htm

Why Plant for Clean Water (article and movie):
Learning Objective: The U.S. Environmental Protection Agency has named storm water runoff as our nation’s biggest water quality threat. This article will provide the student with some ways to create clean water naturally.
http://bluethumb.org/why/

Marsh Plants that Clean Grey Water:
Learning Objective: Students will obtain a better understanding of Gray water and how to design a Wetland to conserve and Reuse Water
http://bogs-marshes.suite101.com/article.cfm/marsh_plants_that_clean_grey_water

Phytoremediation: Usng Plants to Clean the Soil.
Students will be introduced to phytoremediation and the great potential for cleaning up toxic metals, pesticides, solvents, gasoline, and explosives and will investigate technologies used after the accident at Chernobyl Nuclear Plant Reactor 4 in the Ukraine
http://www.mhhe.com/biosci/pae/botany/botany_map/articles/article_10.html

Activities:

Urban Stormwater Quality
Example Lesson Plans meeting Colorado Standards for Science, Geography and Civics. Includes lesson plans for grades 6-12
http://www.cdphe.state.co.us/wq/permitsunit/MS4/urbansw.pdf

Weather:
In this unit we look at several sorts of flooding, the damage they cause, and why they occur. We also explain how a thunderstorm is formed.
http://www.atmosphere.mpg.de/enid/277895e392df82eb7d55a6d1c2ceb78b,0/more/1__Floods___Thunderstorms_49t.html

Unit on Environmental chemistry:
Learning Objective: The students will be able to identify how air, water and soil pollution affects vegetation, and cite specific effects on agricultural crops and forests.
http://www.pat-med.k12.ny.us/schools/hs/departments/science/coveney/4Plants.htm

Films related to sediment, clean water and pollution:

Abyss, The (1989)
Starring: Ed Harris, Mary Elizabeth Mastrantonio, Michael Biehn
DESCRIPTION: A civilian oil rig crew is recruited to conduct a search and rescue effort when a nuclear submarine mysteriously sinks. One diver (Ed Harris) soon finds himself on a spectacular odyssey 25,000 feet below the ocean's surface where he confronts a mysterious force that has the power to change the world or destroy it.
→ Check out DVD on Amazon.com

FLOW – How Did a Handful of Corporations Steal Our Water? (2008)
(Documentary) *(Note: Also released as "FLOW: For Love of Water")*
DESCRIPTION: Many experts point to water as the most important political and environmental issue of the 21st century. *FLOW* maps out the problem and gives viewers a look at the people and institutions providing practical solutions to the water crisis. But there is a serious undercurrent—a growing effort among international corporations to

privatize the world's dwindling fresh water supply. *FLOW* identifies many of the governmental and corporate culprits behind the water grab, with an unflinching focus on politics, pollution, human rights, and the emergence of a domineering world water cartel.
→ Check out DVD on Amazon.com
→ Check it out at the film's web site

Green Green Water (2006) (Documentary)
DESCRIPTION: Wanting to know where her electricity comes from, the film maker undertakes a trip to northern Manitoba, where the Cree peoples are coping with the environmental and cultural impact of a nearby hydroelectric dam. Despite the fact that the current dam has increased poverty and environmental devastation, there is division among the northern Manitoba Cree about whether to build more local hydroelectric-power infrastructure. Moneyed interests and their pawns vs. those trying to protect their land and traditional way of life—who will win?
→ Check it out at the film's web site

Sea Change, A* *(2009) (Documentary)
Imagine A World Without Fish
DESCRIPTION: *A Sea Change* documents how the pH balance of the oceans has changed dramatically since the beginning of the Industrial Revolution: a 30% increase in acidification. Experts predict that over the next century, steady increases in carbon dioxide emissions and the continued rise in the acidity of the oceans will cause most of the world's fisheries to experience a total bottom-up collapse—a state that could last for millions of years. This film broadens the discussion about the dramatic changes we are seeing in the chemistry of the oceans, and conveys the urgent threat those changes pose to our survival, while surveying the steps we can take to reduce the severity of climate change.
→ Check out DVD at Bullfrog Films

Thirst* *(2004) (Documentary)
DESCRIPTION: Is water part of a shared "commons," a human right for all people? Or is it a commodity to be bought, sold, and traded in a global marketplace? *Thirst* tells the stories of communities in Bolivia, India, and the United States that are asking these fundamental questions.
→ Learn more at the film's web site

Mississippi River flood of 1927
An 18-minute silent film documenting the Mississippi River flood of 1927, featuring images of the flood, the damage it caused, the victims who suffered, and the relief efforts that helped rebuild. Although this was poorly transferred to video, it is in relatively good condition, and a shot-list is provided. The file is available as MPEG-4 streams and downloads at two different levels of quality, as well as MPEG-1 and -2 files for download.
http://www.archive.org/details/mississippi_flood_1927