



Revised 6/00

Lesson #6 Surface Water Model

Grade Level: K-2
(can be used for grades 3-4)

Teachers, this is a basic lesson plan that you may modify at your discretion.

Modifications to video: There have been several changes to the lesson plan since the video was made. This lesson plan reflects the latest changes made as a result of suggestions from teachers who have presented the lesson during the daytime program. Please continue to send us your ideas!

Overall educational objective: Students will experience the effects of pollution and erosion on a model of a watershed and explore ways to change the outcome.

Associated Standard and CORE objectives:

- 3030-01 Students will explore ecosystems and discover relationships among living organisms and the nonliving world.
- 3030-0102 Identify the relationships among living organisms in a habitat.
- 3030-02 Students will analyze the influence of people in ecosystems.
- 3030-0201 Relate effects of technology on local ecosystems.
- 3040-03 Students will explain the water cycle.
- 3040-0301 Explain the processes of melting, precipitation, evaporation, condensation, percolation and erosion.

Materials list:

- 1 - EnviroScape Nonpoint Source model
- 4 - spray bottles
- 2 - "oil" shakers (filled with soy sauce)
- 2 - "fertilizers" shakers (filled with baby powder)
- 2 - "industrial waste" shakers (filled with koolaid)
- 2 - "dirt" shakers (filled with cocoa mix)

Lesson activities:

1. Introduce the water cycle (hydrologic cycle). Discuss the concept of a watershed.
2. Show the model of a EnviroScape Nonpoint Source. Use spray bottles to "rain" on the model. Watch how the water flows. Have the students note the clarity of the water.

3. Begin a discussion about pollution. Teachers/students then apply examples of “pollution” to the model. Then allow students to make it “rain” again. Discuss how pollutants are carried across the surface of the model/earth. Question students on ways to avoid water pollution. Discuss the use of berms, vegetation, fences, and wetlands.
4. Discuss the effects of pollution on rivers and streams. Have the students note the clarity of the water.
5. After cleaning up from the previous “rain,” add berms, vegetation, fences, and wetlands to the model. Add pollutants again and let it “rain.” See if there were any differences in the outcome.
6. Reinforce the idea that “every little bit of effort counts.”

Note to teachers: The felt container does not have a lid so that the felt can dry out by the next day.

BACKGROUND INFORMATION: Surface Water

To better understand surface water, it is necessary to examine a number of its basic components.

Watersheds:

The word means a parting, a shedding of waters, but a watershed is also a gathering place. It is a place where hills and plains and people’s lives are connected by falling rain and flowing water. Hilltops and ridges that act as boundaries measure a watershed. It is shaped by the hills, valleys, and plains that act as the landscape and is tempered by the forests, fields, lakes, and marshes that serve as habitats for its creatures. Most of us know a watershed through its streams and rivers that connect forests with farms, farms with cities and, cities with the Great Basin--and each of us changes the watershed day by day, bit by bit, as we go about the business of our lives.

Water cycle:

In a watershed, rain, rivers, lakes and wetlands--even our drinking water--are all parts of an intricate cycle. Rain falls onto the land and soaks into the earth. Some runs off to streams; some evaporates before it ever reaches the earth. The water that soaks into the ground becomes part of the groundwater and feeds streams and wetlands and supplies much of our drinking water. Surface runoff forms streams, then rivers that eventually empty into the ocean. Rivers are the sign that the cycle is working, returning water to the oceans where it evaporates, forms clouds, and falls again.

Watersheds and people:

A change in the watershed affects our lives; a change that we make in the landscape affects the watershed. It’s all connected. Nature’s changes can be as subtle as branches building up behind a fallen log and changing the path of a stream, or they can be as dramatic as a winter flood. Our actions, too, can be subtle or very dramatic, but they all affect someone or something. When we cut forests; clear land; lay concrete and asphalt; and build houses and towns, we cause changes in the watershed. Those changes mean the water cycle works differently. Rain striking the ground has fewer places to soak in gradually; runoff is faster and more violent, causing erosion and flooding. Water quality deteriorates as water drains from farms and cities, carrying pesticides, animal waste, oil, and heavy metals into our groundwater and streams. Streams and fish habitats are damaged. The watershed, the water cycle, and our lives are all connected. Any action, anywhere, affects the land, the water, and ultimately, us. **We all live downstream.**

Watershed terminology:

1. *Headwaters*: source of a stream.
2. *Watershed*: the land from which rain collects and runs to a single point.
3. *Groundwater*: water that lies beneath the earth's surface.
4. *Infiltration*: the slow movement of water from the surface to the groundwater.
5. *Hydrologic*: related to water in all its forms.
6. *Aquifer*: an underground water supply flowing through rock.

Streams:

A stream is the expression of its watershed. Whatever happens on the land will affect the waters. For the creatures that dwell in streams, the requirements for life must be present, provided at the whim of nature or taken away at the whim of humankind. Streams are dynamic and constantly changing, shaped by the interaction between the flowing water and the surrounding landscape. Channels shift in their valleys; bed and banks erode, providing the gravel that form spawning beds for fish and crannies for aquatic insects. Pools form where flows scour the streambed or plunge over and around fallen trees. These downed logs and trunks from the streamside are critical to the structure and function of many streams. All of these elements, interacting in complex ways, form the habitats of our streams and rivers, habitats that are rich with life. Fish are the essence of life in streams, a measure of the condition of the stream and its watershed.

Stream terminology:

1. *Aquatic*: pertaining to water, commonly fresh water, or dwelling in fresh water.
2. *Detritus*: dead and decaying plant and animal matter. Forms a large portion of the food base in streams.
3. *Habitat*: the living place where an organism feeds, reproduces, rests, hides, etc.
4. *Large woody debris*: trunks and large branches of trees that have fallen into a stream.
5. *Pool*: a deep, scoured portion of a stream where water flows slowly: a feeding and resting place for fish.
6. *Riparian zone*: the area of vegetation adjacent to a body of water that influences (and is influenced by) the water.

Wetlands:

It means simply: land that is wet, land that is saturated with water. The fens and moors of Europe; the waterholes of the African Savannah; the bogs, marshes, ponds, and wet meadows--all of these are wetlands. Cattails and Sitka spruce, salamanders and great blue herons, white-tailed deer and juvenile salmon; wetlands are overflowing with life. Wetlands are not "useless swamps," as they have often been perceived, but are among the most productive ecosystems in the world. We are now learning that not only does wildlife depend on wetlands, **we depend on wetlands**. Wetlands do much more than provide a home for wildlife:

they also keep water clean for us. Wetlands are the filters of the water cycle, the intertwining roots, leaves, and fibers of the dense plant life that remove sediment and pollutants from the slow-moving water. When water runs out of the wetland and returns to the stream, it is once again clean. Wetlands are also nature's sponges. When floodwaters overflow the banks of streams and rivers, the porous soils and plants of wetlands soak up tremendous amounts of the excess water. Water then seeps slowly back into the streams to prevent downstream flooding. In times of drought, wetlands are fed by groundwater, which is then released into streams to keep them flowing year-round.

Wetlands and people:

Since colonial times, we have filled or otherwise destroyed more than half of America's wetlands. This has increased flooding, erosion, water pollution, property damage, and reduced wildlife populations. If we don't stop filling and draining wetlands, these problems will only get worse. There are ways to repair some damaged wetlands, but there is no substitute for those that remain undisturbed. The next time you find yourself standing on the shore of a shallow, moss-covered pond, surrounded by dense willow, cattail, or Sitka spruce, look at the diversity of life around you. A wetland is the only place you will see many of these plants and animals. In fact, their ancestors may have inhabited this wetland since the last ice age. Take a minute to realize that this wetland needs your respect to survive--and that we need wetlands.

Wetland terminology:

1. *Emergent*: plants with root systems submerged in water.
2. *Detritus*: decaying organic debris that forms a silt-like layer on the floor of a wetland.
3. *Groundwater*: water that flows underground and keeps wetlands wet and streams flowing during drought.

Lakes: Lakes are much more than places for groundwater, surface water, and precipitation to collect. They also control flooding, provide habitat for fish and wildlife, and give us places to swim, boat, and fish. In addition, many people value lakes for their aesthetic appeal. Each lake is unique in appearance, chemistry, biology, and physical characteristics. Even within lakes these attributes can vary. For instance, water at the surface of deep lakes may be chemically and biologically different than water at the bottom. In shallow lakes, the differences between top and bottom waters are less. Lakes change with the seasons. During spring and early summer, a lake's surface warms up, and its water separates into layers of different temperatures and densities. As the weather cools in the fall, so does the water, and the layers become mixed until the next spring. Moderately deep lakes undergo a natural aging process known as eutrophication. They gradually fill in, becoming ponds, marshes, wetlands, and, eventually, forests. Depending on their trophic states (or how biologically productive they are), lakes can be clear, nutrient-poor, and with little life (oligotrophic); murky, nutrient-rich and full of life (eutrophic); or somewhere in between (mesotrophic). How a lake functions and ages is determined in part by its size and volume, how much sunlight it receives, the length of its shoreline and the health of its watershed.

We all want lakes to be healthy, with clean water and good recreational possibilities, plenty of fish and wildlife, and with no pesky insects or weeds. However, our everyday actions can profoundly affect these fragile aquatic ecosystems, degrading the very qualities that attracted us to them in the first place. For example, nutrients in fertilizers, detergents, failing septic systems, eroding soil and animal waste can cause algae to bloom and aquatic plants to grow and multiply rapidly. Algal blooms can greatly reduce water quality, and too many aquatic plants can clog lakes, interfering with swimming, boating, and other recreational uses. There are

many other ways we can affect lakes. By removing dirt and native plants from a shoreline, we can unintentionally encourage erosion or allow non-native plants to take over. Realistically, few lakes can satisfy all our individual desires. At best, we can strive for a balance--to keep each lake healthy and to serve our needs too.

There are many ways **you** can help lakes: Stream or river banks are riparian areas, and the plants that grow there are called riparian vegetation. Riparian vegetation is extremely important because of the many functions it serves. The roots of riparian trees and shrubs help hold stream banks in place, preventing erosion. Riparian vegetation also traps sediment and pollutants, helping keep the water clean. As dying or uprooted trees fall into the stream, their trunks, root wads, and branches slow the flow of water. Large snags create fish habitat by forming pools and riffles in the stream. Riffles are shallow, gravelly sections of the stream where water runs faster. Many of the aquatic insects that salmon eat live in riffles. Salmon also require riffles for spawning. They use pools for resting, rearing and refuge from summer drought and winter cold. Salmon and trout, during the freshwater stage of their life cycle, eat mainly aquatic insects. Aquatic insects spend most of their life in water. They feed on leaves and woody material such as logs, stumps, and branches that fall into the water from stream banks. Standing riparian vegetation is habitat for other insects that sometimes drop into the water, providing another food source for fish. Riparian vegetation shields streams and rivers from summer and winter temperature extremes that may be very stressful, or even fatal, to fish and other aquatic life. The cover of leaves and branches brings welcome shade, ensuring that the stream temperature remains cool in the summer and moderate in the winter. Cooler, shaded streams have less algae and are able to hold more dissolved oxygen, which fish need to breathe. During high stream flows, riparian vegetation slows and dissipates floodwaters. This prevents erosion that damages fish spawning areas and aquatic insect habitats. Riparian vegetation is essential for maintaining high water quality in streams, rivers, lakes, and along shorelines. However, riparian vegetation remains relatively unprotected from poor agricultural practices, residential and commercial construction, landscaping, and logging.

Storm Water Retention/Detention (R/D) facilities:

A Retention/Detention (R/D) facility can be either a pond, an underground tank or vault, or an infiltration system specifically designed to capture, store, and then slowly release storm water runoff downstream or into the surrounding ground. A detention pond stores accumulated storm water runoff. A flow control structure regulates the release rate of the stored water. Some detention ponds are designed to hold water only during a storm while others may have some water in them on a permanent basis. Retention or infiltration ponds collect storm water and allow it to soak into the soil. This infiltration process helps recharge groundwater. Underground tanks and vaults function the same way detention ponds do: storing rainwater from a storm and then slowly releasing the water downstream. Tanks and vaults can be located underground in the road right-of-way, parking lots, easements on private property, or any designated tract of land. Infiltration tanks or pipes are located underground and release water into the soil where it is absorbed. In addition to helping prevent flooding and erosion, R/D facilities enhance water quality by filtering out sediments, excess nutrients and toxic chemicals. In some cases ponds can provide feeding, nesting, breeding and hiding places for many species of fish, birds, and reptiles. As we cut woodlands clear land, pave roads and parking lots, and construct houses and buildings, we change the permeability of the ground. Falling rain has fewer places to soak in gradually. Runoff on hard surfaces occurs faster and in greater volumes. Increased storm water runoff can worsen flooding, erosion, and water pollution, and destroy stream habitat.

Classroom organization: Alternate students at the watershed model to increase the hands-on participation. If there is anything that can be done by a student, take advantage of that opportunity to involve as many students as possible. It is also important that everyone is properly situated, so they can see what is going on. Arrange chairs so that everyone can see and participate in an orderly fashion.

References:

Bioscience v45, Mar '95, p.193-203 "Hierarchical Approaches to the Study of Water Quality in Rivers"

This article discusses the most probable sources of threat to the health of river ecosystems.

Scientific American v260, May '93, p.134-6 "Mapping to Preserve a Watershed"

This article discusses how different land types can affect the watershed and how mapping out these areas can help.

Please make your students aware that this lesson relates to the following:

Career Fields: SCIENCE, SOCIAL-HUMANITARIAN, TECHNICAL

Occupations: Hydrologist: Study the distribution, circulation, and physical properties of underground and surface waters. They study the form and intensity of precipitation, its rate of infiltration into the soil, movement through the earth, and its return to the ocean and atmosphere. Their work is particularly important in environmental preservation and remediation.



Education: Master's Degree

Review Questions:

1. What is the water cycle?
2. How can we affect it negatively? Positively?
3. What is a riparian zone? Why is it important?
4. What is a wetland? Why is it important?
5. What are some common causes of water pollution?
6. What harm can come from polluting our water?

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