

Extension Activities

- **Introduce erosion and make connections between erosional processes and landform shape.** “When water flows downhill, does anything else flow with it? Water flowing through a watershed often carries eroded sediment. How does erosion relate to the landforms we have explored?” Ask visitors to make or observe a sandbox landform with steep slopes, along with a landform with gentler slopes. Ask them to predict on which landform erosion would be the strongest and help them discuss their logic. Steeper slopes result in faster flowing water which has more energy and can carry larger loads of material increasing the amount of erosion and deposition. Relate the concept of erosion back to the landforms you created, e.g., ask visitors why the Grand Canyon is so deep.
- **Explore depositional processes.** “What happens to the sediment carried by the river when it reaches the bottom of the hill?” Deposition happens when the energy needed for sediment transport is too little - when it is no longer sufficient to overcome the . Then the soil or sediment is left on the earth’s surface, often while the river or transporting force moves elsewhere. Relate the concept of deposition back to the landforms the visitors created. For example, ask visitors how deposition may lead to the creation of dunes.
- Ask visitors to think about how **human activities** affect erosion and deposition. Construction, road building, and other activities can increase the amount of erosion flowing through the watershed by exposing sediment that was protected under the soil surface. This increased erosion can negatively impact the health of lakes and streams. Climate change is expected to reduce the snowpack in many mountain regions. This would decrease the flow rate of rivers, which would reduce erosion rates and the timing of deposition.

Additional Resources for Landforms Lessons

- Wikipedia’s list of landforms
http://en.wikipedia.org/wiki/List_of_landforms
- An introduction to stream geomorphology
<http://glaquarium.org/wp-content/uploads/2012/11/A-Meandering-Story.pdf>

Hydrology

Background

Hydrology is the study of how water on earth moves and is distributed in the atmosphere and on and under the earth’s surface. Water is one of earth’s most limited resources -- the overall amount of water on the planet is constant. The planet’s water is involved in a continuous process of movement and transformation -- called the **water cycle** -- between phases (liquid, gas and solid) and between locations (oceans, bodies of water, atmosphere, and land).

Water on land is organized in regions called **watersheds**. The sandbox can be used to help visitors describe and demonstrate what a watershed is and discuss how human impacts on watersheds can affect us and the ecosystems in which we live.

Primary Activities

- Ask visitors to hold their hand over the sand box to **make virtual rain** fall to the surface below. Recall that visitors may need help to hold their hands at the right height. You can remind them by showing them the height of the hand on the sandbox sign. “Notice how water appears on the surface below. As you move your hand away, where does the water go?”



Visitors at the ECHO Lake Aquarium and Science Center use their hands to make rain in the watershed. (Photo credit: Julie Silverman)

- Encourage visitors to observe the **movement of the virtual water with respect to landforms**. Ask them to hold their hand over a steep peak, a gentle hill, and a valley. “What happens to the water each time? Water flows from higher areas to lower areas. In lower areas, the water collects, but in high areas with steep slopes it flows down.”
- **Explore what defines a watershed**. Ask visitors if they know what a watershed is (if you haven’t done so already). “A watershed is the area of land that drains into a lake, river or other body of water. Watersheds are separated from one another by higher parts of the landscape: ridges, hills, mountains, etc.”

Ask visitors to **build a long ridge** that divides the sandbox into two separate regions. “If you make it rain here [motion to a location above the ridge] where do you think the water will travel?” Once they’ve made their predictions, ask a volunteer to make it rain above the ridge. Explain that the water that flows into the first region is part of one watershed, while all the water that flows into the second region is part of a separate watershed. Note that there are different kinds of watersheds. Some involve very steep terrain while others are part of very subtle topography. In all cases, precipitation that falls on the watershed flows over land to reach the lowest point – an ocean, lake, river, stream, or groundwater source.

Extension Activities

- **Model your local watershed**. Ask visitors where the water they drink and use comes from. Explain that they live in a watershed and most likely some of their water supply comes from the rain that falls in their watershed.

You can look up the watershed you live in and find out more information about it at the following links:

Surf Your Watershed: <http://cfpub.epa.gov/surf/locate/index.cfm>

Science in Your Watershed: https://water.usgs.gov/wsc/map_index.html

Show visitors a topographic map, photograph or raised relief map of the local watershed. Challenge them to build a model of their watershed in the sandbox. When they’re finished, point out a location in the watershed and ask where they think rain that falls on that location might travel. Then ask for a volunteer to make it rain and test the hypotheses. Help visitors locate their homes within the watershed and solicit observations about the water resources that they might be aware of in their neighborhoods.

Discuss possible sources of **pollution** and ask guests to think about how pollution occurring in one part of a watershed could affect the entire watershed. As water flows over the land, it picks up sediment, soil chemicals, and pollutants and transports them to lakes, rivers, streams and groundwater.

- **Dig a lake.** Encourage visitors to make lakes of different shapes. Discuss with visitors how lakes are formed from glaciers, faulting, or warping of the Earth’s crust. Some lakes are human-made. There are different lakes around the world with different depths, shapes, chemistries, and ecosystems.

Explore the Lakes of the World Google Earth tour to learn about the striking diversity of lakes and the role that they play in their local communities: <http://tinyurl.com/jvwhmru>

- Discuss the **water cycle**. Ask visitors what they think happens to the water once it travels down over landforms and into bodies of water and the soil. Ask them where they think the rain that they are modeling with their hands comes from. Explain that water is involved in a neverending cycle. Once rainwater runs off into rivers and other bodies of water, energy from the sun evaporates the water into the air. Atmospheric winds move the water vapor around and it eventually forms clouds, water vapor that has cooled and condensed into a collection of liquid water. When those clouds get heavy enough, they produce rain or snow and the whole cycle starts over again.
- **Make a dam.** Instruct visitors to build a dam: build a large sand wall next to a discrete depression and fill up the depression with water. See the following video for a sandbox dam demonstration: https://www.youtube.com/watch?v=d_ZHsgKjNNk

Ask visitors to place Lego or other figures representing urban structures (houses, offices, roads) in the landscape around the dam. “Add virtual water until you ‘break’ the dam. Think about where people build cities, and what risks might there be in building in various different places.”

Discuss floodplains, rivers, and settlement. “How do rivers both encourage (with trade and traffic) and discourage (with flooding) settlement? Why does one bank of a large river aid the growth of a large city, while the other bank is sparsely populated? This might occur if one bank is higher and flood-free, and the other is historically flood-prone.”

One example is Omaha, Nebraska on the high west bank of the Missouri River, versus Council Bluffs, Iowa on the flood-prone east bank. Omaha grew faster than Council Bluffs and remains the primary city in the region to this day. Discuss the importance of a city to be on a flood-free site, higher than the floodplain. Ask visitors if they would change where they build their cities after the discussion. Encourage visitors to share local stories of how floods have affected their communities. How has flooding changed in their community over time?

- **Simulate drought.** Ask visitors to hold down the ‘Drain’ button for a few seconds until all the water in the sandbox disappears. “What happened to all the water? What happens if we can’t make it rain? What is a drought; what does it make you think of?”

‘Dry,’ ‘hot’ and ‘dusty’? A drought happens when a region has less precipitation (rain or snow) than it usually has for a few months or even longer.”

1. Discuss reasons for drought. Discuss with visitors that droughts can happen for many reasons and ask them if they know of any. Changes in **climate** can cause drought – if the way that clouds and moisture move through the atmosphere changes, it can prevent an area from receiving rain. If people live in a place where most of the water they use comes from a river, a drought can be caused when the land upstream doesn’t receive enough moisture. For instance, when the Sierra Nevadas in California (a region that includes Lake Tahoe) doesn’t get a lot of snow in the winter, it can lead to a drought in the summer because the melting snow supplies much of California with its water.

People can also play a big role in drought. Water is a limited resource in many regions of the world. If humans use too much water during times of normal rainfall, there might not be enough water for everyone in dry years.

2. How could drought affect our lives? What are the human impacts of drought? Ask visitors how water is important to them and their families. Possible answers include drinking, food, cleaning, bathing, cooking, energy (hydroelectric), recreation (swimming and boating).

Drought can cause many social effects:

- people can become sick or die without enough water or food
- excess dust can cause health problems
- economic losses due to drought (failed crops and businesses)

3. What are other possible effects of drought? What other ways is water important? Discuss the environmental impacts of drought. All plants and animals need water. Ecosystems are threatened in a drought. Also, water regulates our climate.

Drought can cause many environmental effects:

- more wildfires
- soil erosion and poor soil quality
- loss of wetlands
- increase in disease of wild animals due to reduced food and water supplies
- migration of wildlife

3. Discuss how we can prevent drought or lessen its impacts.

Examples include learning about what causes droughts, conserving water by taking shorter showers, turning off the faucet when you brush your teeth, fixing leaky faucets, xeriscaping, and water recycling.

Additional Resources for Hydrology Lessons

- San Francisco Bay watershed curriculum: <http://www.savesfbay.org/sites/default/files/WatershedCurriculum.pdf>
- Find your watershed: <http://cfpub.epa.gov/surf/locate/index.cfm>
- Lakes of the World Tour: <http://tinyurl.com/jvwhmru>
- 4H's drought for kids guide: <http://drought.unl.edu/DroughtforKids.aspx>

G. Glossary

- **Bathymetry:** the measurement of depth of water in oceans, seas, or lakes, often conducted using SONAR (sound navigation and ranging) technology
- **Contour line:** a line on a map joining points of equal height above or below sea level
- **Contour interval:** the height difference from one contour line to the next
- **Dam:** a structure built across a river to hold back water for a variety of reasons, including protecting areas from floods, storing water, and generating power
- **Deposition:** material (soil, rock, or organic matter) that is laid down on the earth's surface after being transported by wind or water.
- **Divide:** the ridge separating two watersheds
- **Drought:** extended period of time (usually several months or longer) when there is less rainfall than expected.
- **Elevation:** vertical distance above mean sea level
- **Erosion:** a process that wears down the earth's surface, causing material (soil, rock or organic matter) to move from one place to another. Erosion occurs naturally from wind or water but can be intensified by land use practices related to farming, residential or industrial development, road building, or forestry.
- **Flood:** high streamflow that overtops the natural or artificial banks of a stream
- **Floodplain:** an area of low, flat ground adjacent to a river, lakes and oceans and subject to periodic flooding.
- **Geomorphology:** the study of the landforms on the earth's surface and the processes that shape them. The field of geomorphology seeks to understand why landscapes look the way they do, to understand landform history and dynamics and to predict future changes.
- **Ground water:** moisture that seeps underground and can be accessed by wells or springs.
- **Hydrology:** the movement, distribution, quality and characteristics of water on and below the surface of the land and in the atmosphere.
- **Lake** - a body of fresh or salt water of considerable size, surrounded by land.
- **Landforms:** Features of the earth's surface. Landforms are categorized by characteristic physical attributes such as elevation, slope, orientation, stratification, rock exposure, and soil type. See Wikipedia's [list of landforms](#) for a detailed list and descriptions of landforms.
- **Precipitation:** the amount of rain, snow, hail, etc., that has fallen at a given place within a given period, usually expressed in inches or centimeters.