Before Rain Gardens: Topography and the Water Cycle

Where does rain come from? How does rain flow in an ecosystem? What is topography and why is it important? How do the shape of the land and fast-moving water affect the world around us?

In this module, students will explore how water moves through the environment via the water cycle and how the land's shape, or topography, guides its flow. Students will learn how water changes form: evaporating, condensing, and falling as precipitation, and how once it hits the ground, it travels downhill, collecting in low areas or running off hard surfaces.

Flowing water can carry pollutants, cause erosion, and impact ecosystems. By building simple models and observing water behavior, students will begin to understand how topography and gravity influence runoff, and why this knowledge is key to creating sustainable solutions like rain gardens in future modules.

Contents:

Science State Standards:

Activity 1
- 5-ESS2-1, 5-ESS3-1, MS-ESS2-4

Activity 2
- 4-ESS2-1, K-ESS3-3, 2-ESS2-2

Activity 3
- K-ESS3-3, 2-ESS2-1

Teacher's Guide

Objective:

The goal of this module is to:

- Discuss the roles that the water cycle and topography play in local ecosystems
- Learn about the potential side effects of rainwater runoff
- Help students identify how water interacts with different surfaces and terrain
- Facilitate hands-on simulations to visualize topography and runoff patterns
- Lay the groundwork for understanding why managing stormwater is important
- Highlight connections between water and environmental concerns like erosion and pollution
- Introduce rain gardens as a tool that aid in water quality and quantity management

Vocabulary List

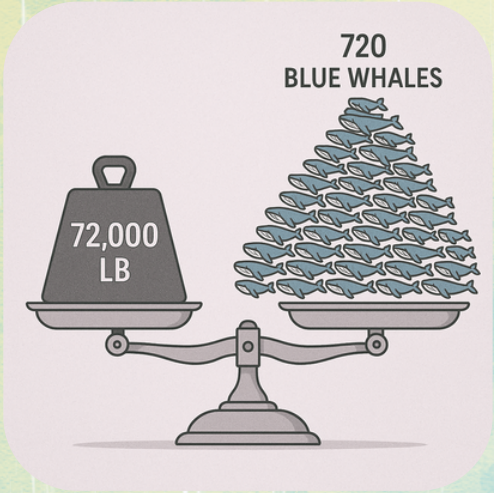
Water Cycle - The continuous movement of water on, above, and below the surface of the Earth.
Evaporation - The process of a liquid turning into a vapor.
Condensation - The process of a vapor turning into a liquid.
Precipitation - Rain, snow, sleet, or hail that falls to the ground.
Topography - The arrangement of the natural and artificial physical features of an area.
Runoff - Precipitation that does not soak into the soil but instead moves on the Earth's surface toward streams.
Pollution - The presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects.
Pollutant -A harmful substance that contaminates water, air, or soil (e.g., fertilizer, oil, pet waste).
Rain Garden - A shallow, landscaped depression designed to capture and soak up stormwater runoff.
Stormwater - Water from rain or snowmelt that flows over land or surfaces like roofs and pavement and doesn't soak into the ground.
Infiltration - The process of water soaking into the ground.
Erosion - The wearing away of soil caused by wind, rain, or moving water.
Elevation - How high or low a point of land is compared to others around it, especially sea level.
Surface - The outermost layer of the land, including natural and built environments that water flows over.
Slope - A measure of how steep or flat a surface is, which affects the speed and direction of water flow, as well as runoff and infiltration.
Gravity - The natural force that pulls water downhill, causing water to flow downward on land, and rain, snow, and hail to fall from clouds.
Permeable - A surface or material that allows water to pass through it.
Impermeable - A surface that does not allow water to soak in, causing more runoff (e.g., concrete, asphalt).

Introduction

The Power of Rain

Rain is much more than just water falling from the sky; it is one of the most vital forces on our planet. Rain not only provides nourishment to plants and animals, but it is also integral for cooling off our planet. For scale, let's take a look at Fort Wayne as an example of the power of water. Fort Wayne is a large city, covering 110 square miles.

Imagine a rainstorm sweeps through Fort Wayne and covers the city in one inch of rain. For every one square mile covered in one inch of rain, there is approximately 17.4 million gallons of water weighing over 72,000 tons. That's about the same weight as 720 blue whales! Stretching across the entire city of Fort Wayne there would be almost 2 billion gallons of water, just from one inch of rainfall!



Fort Wayne receives approximatively 35 inches or rainfall annually. This means that Fort Wayne sees almost 67 billion gallons of water on average every year! If you could collect all of that rain and properly treat it, it would be approximately enough water to supply the entire city for 5 years.

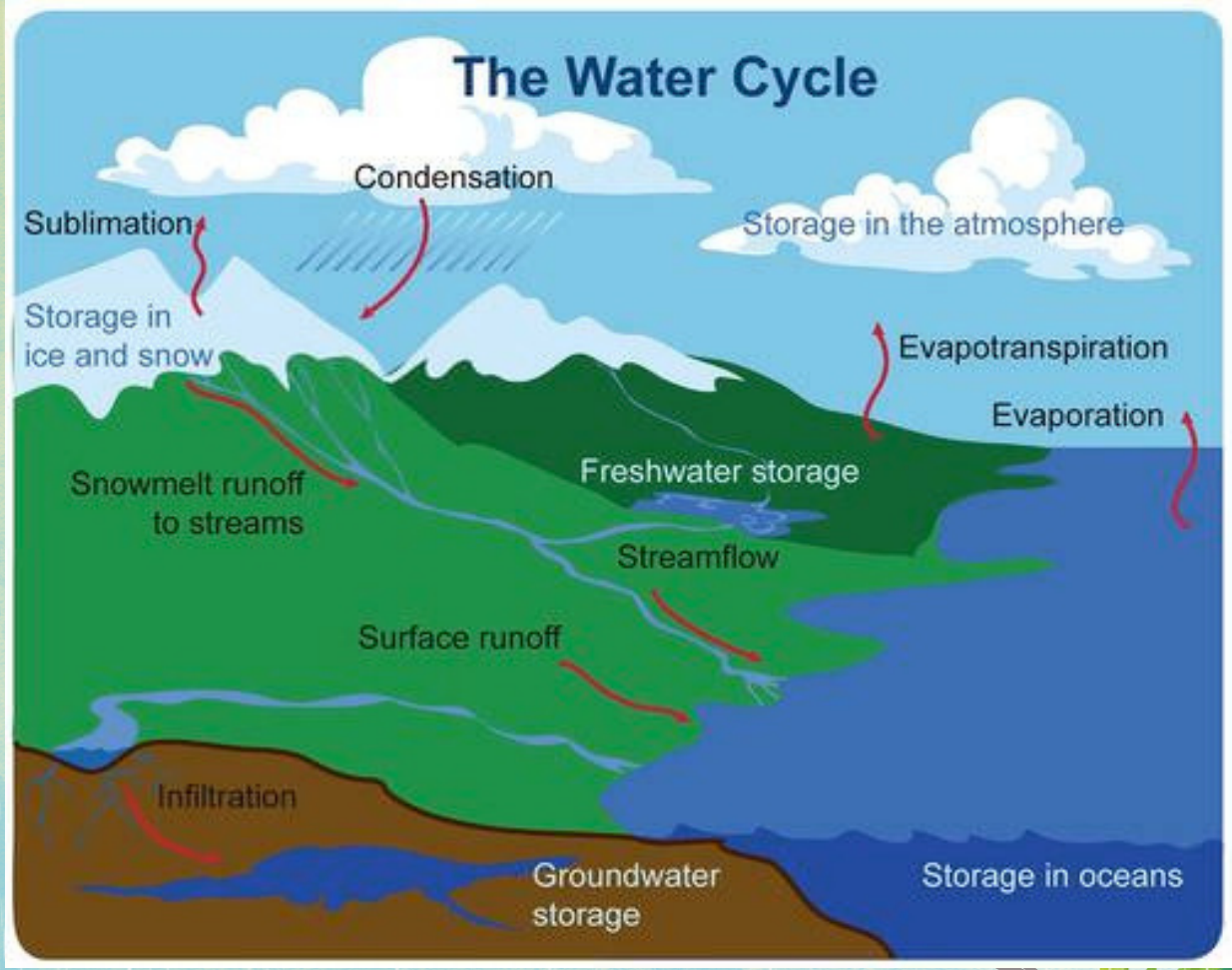
Unfortunately, it is not possible to catch every single drop of rain as it falls. It is impossible to stop rain from collecting on roadways or fields, where rainwater can combine with harmful substances, such as herbicides or oil. Eventually, water filled with those substances (known as pollutants or pollution) can runoff, contaminating water supplies, damaging local ecosystems, and contributing to erosion. Sediment run off from erosion is the number one water quality pollutant by volume in Indiana. This brings up an incredibly important question: how do we prevent as much damage as possible from polluted rainwater runoff?

An effective, natural solution is building a rain garden. Rain gardens are specially designed gardens that help manage rainwater. Instead of letting water rush off hard surfaces like roads and rooftops—carrying pollution with it—a rain garden collects that water and lets it soak slowly into the ground all while providing nourishment to native plants.

But to really understand how rain gardens work, we need to look at how water moves through the environment. That means exploring two key ideas: the water cycle and the shape of the land, or topography.

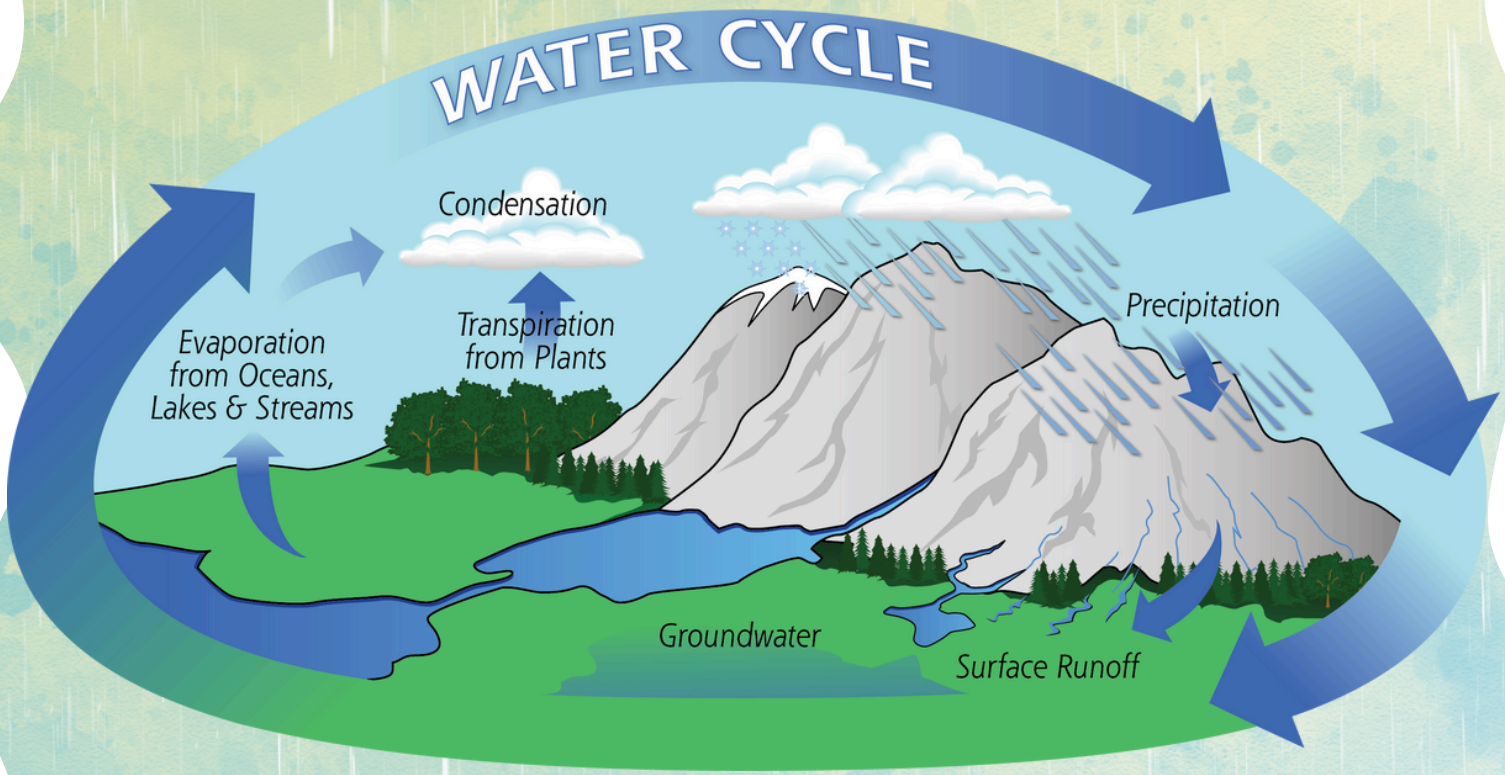
The Water Cycle

As the only currently known planet that supports water, Earth does a phenomenal job of moving moisture to the places that need it for survival. The way that water is transported is aptly named the water cycle. While the word “cycle” implies circular motion, that would not be a completely accurate representation of how water travels throughout the world.



Liquid water is constantly moving and changing forms. It is at all times being acted upon by forces like heat and gravity, as well as local factors like temperature and location. All of these variables create conditions for water to move and change form-- allowing it to rain (precipitation), travel down streams (runoff), or become a vapor that rises back into the atmosphere and reforms as clouds (evaporation and condensation).

The most important parts of the water cycle in this module are precipitation, evaporation, condensation, and runoff. Let's take a closer look at these principles in an activity.



Topography

Once the water cycle brings rainfall into an environment, the topography of the landscape determine how the rain water moves. Topography is the arrangement of the natural and artificial features of an area. Simply put, topography looks at the shape, slope, and elevation of the land to determine where rainwater flows, how quickly it travels, and where it collects. Water, being pulled on by gravity, seeks to find the easiest path to the ground. Steep slopes can lead to faster runoff, increasing the risks of erosion and flooding, while areas that are flatter or slightly concave allow more water to soak into the ground.

Learning about topography helps communities manage stormwater effectively, reduce pollution, and protect natural waterways. By paying attention to where water will flow in an area, we can make educated decisions about land use, drainage systems, and the placement of rain gardens.

Creating topographical maps are important tools when developing landscaping plans. To get a better understanding of topographical maps, lets build one!

Activity 1: Water Cycle in a Bag

The water cycle is responsible for transporting water all around the Earth. The water not only changes location, but it changes forms constantly as it is subject to the forces of evaporation, condensation, and precipitation. This activity explores all of these concepts in a small plastic bag!

Activity Time:
15 minutes to create, observe hours - days after creating

Grade Level:
K - 3

Group Size:
Per student

Objectives:

By the end of this activity, students will be able to:

- Name different form that water takes in the water cycle
- Explain how water travels within the water cycle
- Relate how the water cycle is connected to stormwater runoff

Materials Needed:

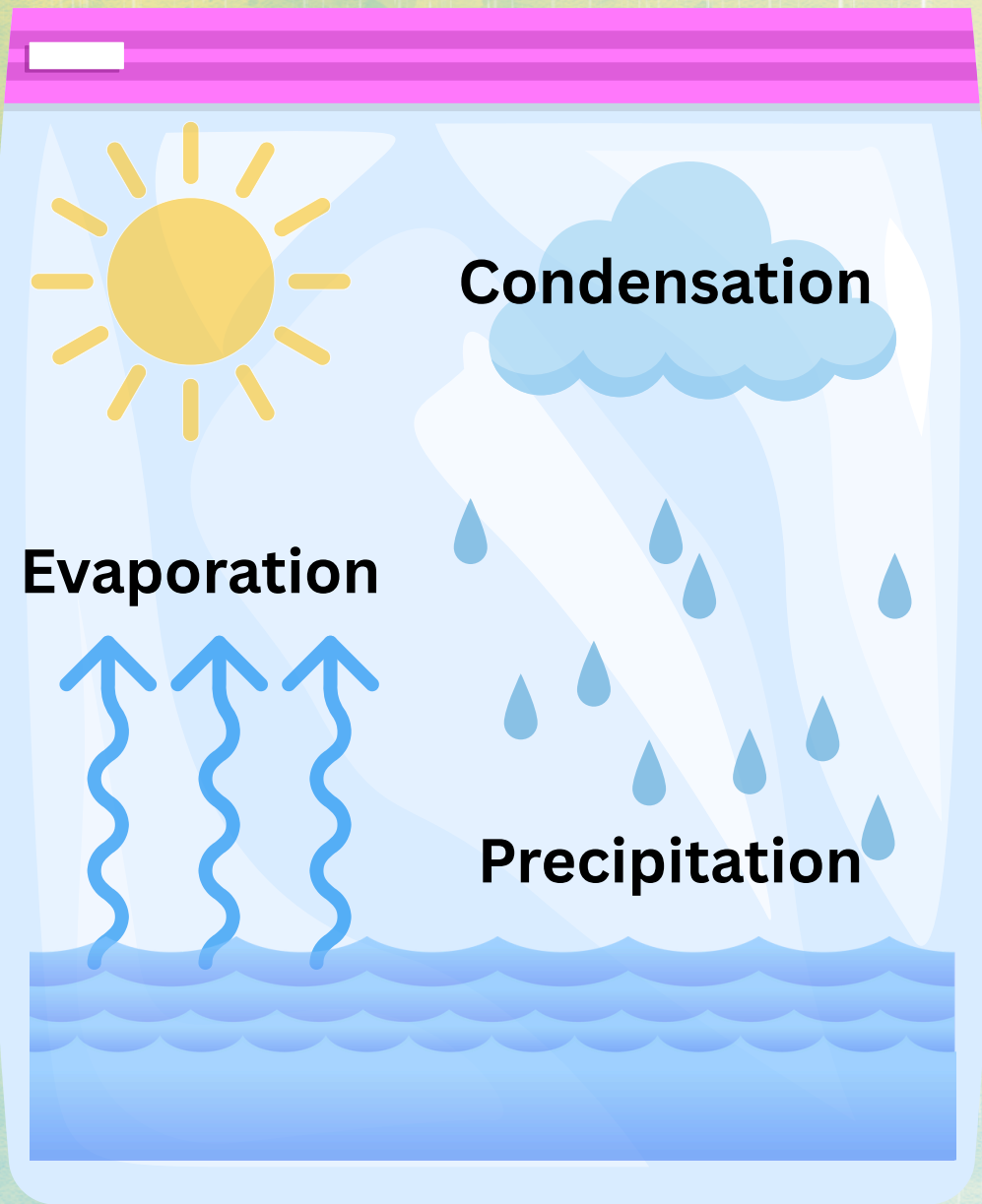
- Resealable plastic bag
  - quart size or larger
- Permanent markers
  - multiple colors
- Blue food coloring (optional)
- Window with access to direct sunlight
- Tape

Activity Instructions

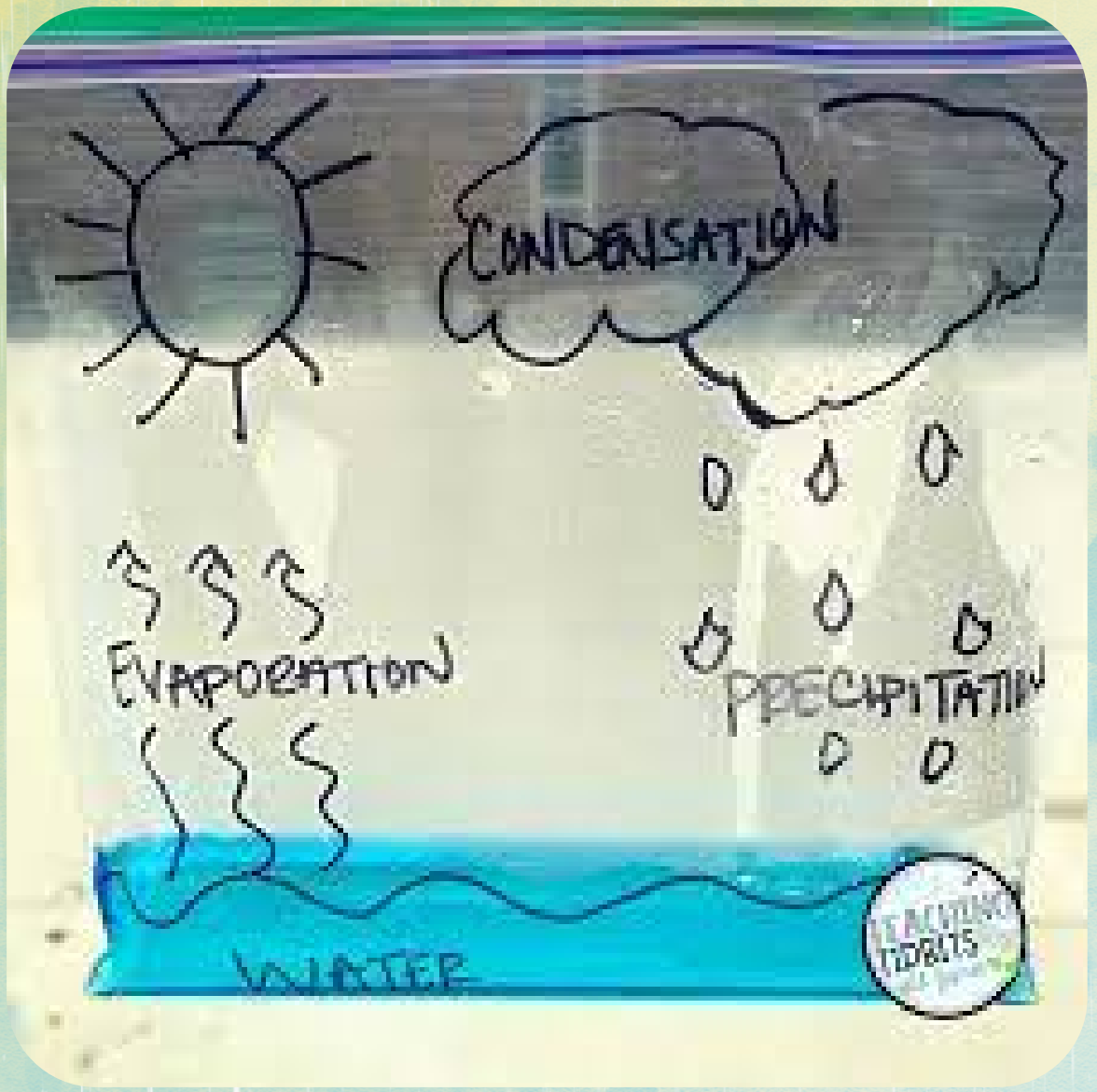
1. Place the plastic bag on a flat surface. Using the permanent markers, draw the sun, clouds, and water on the bag. Also label the bag with the words evaporation, precipitation, condensation, and water using the image included as a reference.
2. Fill the bag with about ¼ cup of water. Optionally, add a drop of food coloring.
3. Seal the bag tightly.

4. Tape the bag securely to a window that has access to sunlight.
5. Observe the bag over a long period of time. Water forming on the inside of the bag represent condensation. Once the droplets are large enough, they will run down the bag representing precipitation.

Reference Image: Water Cycle in a Bag



Reference Image: Water Cycle in a Bag



Activity 1: Water Cycle in a Bag Reflection

1. What happened to the water in your bag after it sat in the sun?

_____

_____

2. Did you see small drops form on the inside of the bag? What do you think those drops are?

_____

3. In this activity, you saw the water change forms. Write or draw what happened in each step:

Evaporation	Condensation	Precipitation

4. Where does water go when it rains outside?

_____

_____

5. Why is it important for water to soak into the ground instead of running off hard surfaces like roads?

_____

_____

Activity 2: Topography Play-Doh

Topographical maps are used by architects, surveyors, and urban planners to help develop safe building projects. They study these maps, noticing problem areas like steep slopes or uneven ground. In this activity, students will study a topographical map and then create their own using Play-Doh!

Activity Time:
15-30 minutes

Grade Level:
K - 6

Group Size:
Per Student

Objectives:
By the end of this activity, students will be able to:

- Distinguish high and low points of elevation of a topographical map
- Create a hands-on model of a topographical map
- Understand the relationship between elevation and the movement of water in an area

Materials Needed:

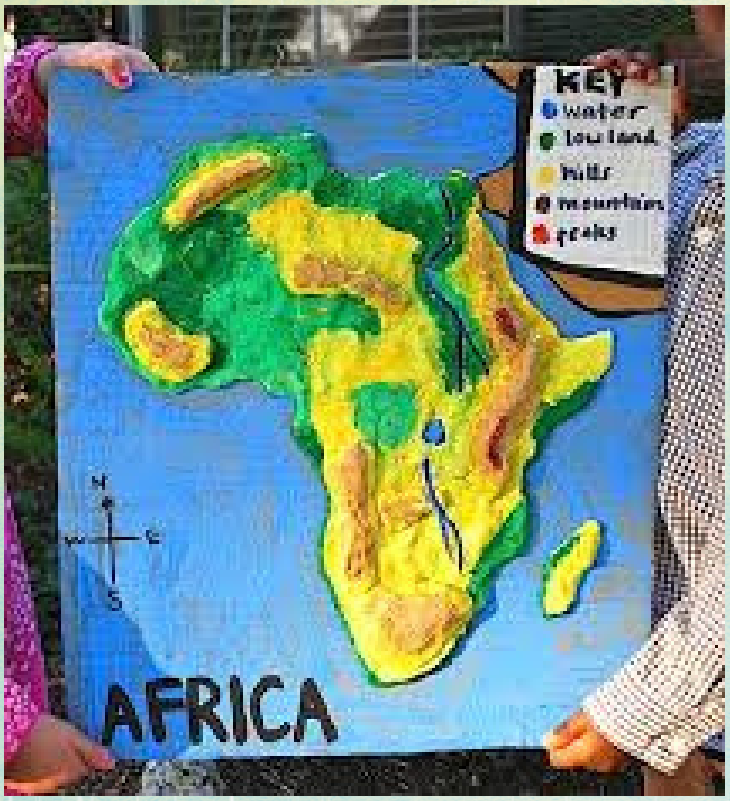
- Play-Doh
  - 4-6 different colors per student, at least 1 oz per color
- Disposable plates or cardboard squares, 1 per student
- Small rolling pin, 1 per small group or table
- Popsicle sticks, as needed
- Toothpicks, as needed
- Small cups of water, 1 per student
- Fine tip marker and white paper, as needed per student

Setup & Prep:

- Prepare enough materials for each layer and each group.
- Cover table or group area with a newspaper or plastic to make cleanup easier.
- Create a sample model before starting for the students to reference
- Discuss with students about what happens on a hill vs. flat surface
  - Optional: print out or project additional aids, like topographical maps

Activity Instructions

1. Using a small rolling pin, flatten one color of Play-Doh to create one layer. Place it on a plate or piece of cardboard to represent the lowest level of elevation. Add small details with the same color on top to represent hills and mountains (elevation changes).
2. Using a different color, add additional layers on top of the higher points of elevation created in the previous layers.
3. Repeat step 2 and add as many different layers as needed to represent the elevation.
4. After adding all layers of Play-Doh, view your topographical map by looking straight down.
5. Take a small cup of water and gently pour it on top of the Play-Doh topographical map, taking note of where the water flows.



Activity 2: Topography Play-Doh Reflection

1. What happens to water on a hill? _____

_____

2. What happens to water on a flat surface? _____

_____

3. Why do you think topography is important when planning where to build houses, roads, or rain gardens?

_____

_____

4. What might happen if we don't pay attention to topography before building in an area?

_____

_____

5. Look back at your model. What surprised you about how water moved on your Play-Doh topography?

_____

_____

Activity 3: Protect the Park!

Fast-moving water (or sheet flow) can cause a lot of damage, washing away soil, flooding parks, and polluting streams. In this activity, students become landscape engineers tasked with protecting a miniature park from a rainstorm. They'll use simple materials to simulate elevation, slope, and barriers, and experiment with strategies to slow water down and protect key areas.

Activity Time:	**Grade Level:**	**Group Size:**
30-45 minutes	6 - 12	Small groups of 2 - 4

Objectives:

By the end of this activity, students will be able to:

- Understand the damage that large amounts of flowing water can create in an area.
- Develop strategies to minimize damage to a simulated park.
- Relate the topics of elevation and topography back to the flow of water.

Materials Needed:

- 1 Large plastic trays or cookie sheets
- Play-Doh, modeling clay, or sand (to build land features)
- Water
- Cups
- Watering can or apparatus
- Natural materials: popsicle sticks, rocks, sponge pieces (simulate barriers)
- Paper towels or rags for cleanup
- Optional:
  - Mini park features: small paper trees, buildings, benches (optional)

Setup & Prep:

- Each group builds a model of a small park in a tray using Play-Doh or sand.
- They must include:
  - At least one high elevation area
  - At least one low-lying zone (like a play area or picnic spot)
  - A "creek" or path where water may flow

Activity Instructions

1. Build the landscape. Students model a park with hills, flat areas, paths, and low zones.
2. Predict damage. Ask: “Where will water flow?” “What areas are most at risk?”
3. Test it. Slowly pour water from the high point to simulate a storm.
4. Observe. Note where water flows, pools, or causes “damage.”
5. Redesign. Groups add features like sponge “rain gardens,” clay berms, or rock barriers.
6. Retest. Run the storm again and compare the results.
7. Reflect. Discuss which strategies worked and why.

Activity 3: Protect the Park Worksheet

1. Draw a quick sketch of your group's park model below. Label these areas: High elevation (hills), Low elevation (valleys, play areas), and Creek or water path.

2. Before testing, predict:
Where you think the water will flow first:

_____

Which parts of your park might flood:

_____

3. After pouring water, answer:
Where did the water move fastest:

_____

Which areas were most damaged by the water?

_____

Did any water pool in one spot? If so, where?

_____