# RAINFALL SIMULATION

A program by Oklahoma 4-H Youth Development & Oklahoma Water Resources Center

## SKILL: SCIENCE TIME: 20-30 MIN

## OBJECTIVES:

Students will learn:

- The importance of rainwater and surface water in recharging aquifers.
- The different interactions of water with varying types of ground surfaces.
- The importance of grasses and grasslands in recharge zones.
- How water can become polluted.
- The basic principles of water erosion.
- How wildlife habitats are affected by different land types.

## LESSON PREP:

Set up rainfall simulator by placing the four land plots on the top shelf and placing the labeled containers on the bottom shelf. From left to right, the labeled containers should be placed ground water, runoff water, ground water, run off water, etc. Prime each land plot so that water freely runs through either the ground waterspout, the runoff waterspout, or both. Remove the water that was caught in the labeled containers. Place a few drops of dishwashing soap on the Impervious Surface plot. To review how to demonstrate the rainfall simulator, view this YouTube video from Texas A&M AgriLife Extension.

https://www.youtube.com/watch?v=RmdvmVGl7d4

**VOCABULARY**

- Aquifer
- Air Pores
- Permeable
- Recharge
- Groundwater
- Well
- Spring
- Groundwater
- Runoff Water
- Hypothesis
- Impervious Surface
- Turf Grass
- Overgrazed Rangeland
- Native Grassland
- Erosion

# 4H2O: RAINFALL SIMULATION

## LESSON ACTIVITY:

Water is important to all living things - plants, animals, humans, and other tiny organisms. Without water, life would die. We use water every day for many different purposes: to drink, to wash with, to cook with, for irrigation, for play, and for transportation. Our lives would be very different if we did not have water.

**Where does Oklahoma get its water?** Oklahoma gets its water from rivers, lakes and aquifers. Lakes and rivers provide about half of our drinking water. The other half is from aquifers.

**What is an aquifer?** An **aquifer** is where we store water underground. Aquifers are made up of underground rocks. Air spaces are created between the rocks called **air pores.** These small openings, or pores, allow underground water to slowly flow through the rocks. Did you know that some rocks can hold water? Think of a sponge – when you pour water on the sponge, it soaks it up and holds on to that water. Rocks can do that, too! These sponge-like rocks are called **permeable** rocks, meaning these materials can absorb and hold on to water.

**Where does aquifer water come from?** The only way that an aquifer can be filled with water, or **recharged**, is for water to soak into the ground. When it rains, water soaks, or percolates, into the soil beneath us. This underground water is known as **groundwater.** But wait – if the water is going through dirt, is it safe to drink? Yes! As groundwater soaks deep into the ground, it is filtered by layers of limestone rock. When this water reaches the aquifer, it is very clean water.

**MATERIALS**

- Rainfall Simulator Frame
- Impervious surface plot
- Turf Grass plot
- Overgrazed Rangeland plot
- Native Grass plot
- Four tubs with holes (depends on the simulator model) or a watering can
- Four ½-gallon containers labeled “Run Off Water”
- 4, ½-gallon containers labeled “Ground Water”
- Dishwashing Soap
- Water

# 4H2O: RAINFALL SIMULATION

**How do we access groundwater if it is underground?** To get to the groundwater in aquifers, we must drill a hole in the ground, called a **well,** to pump out the water. This is a manmade tool to access the water, but there is a natural way to get the water, too. Water can come to the surface through a naturally occurring crack or hole in the Earth's surface. This is called a **spring.** Some springs are very small. Others are very large and powerful.

**What happens to water that is not soaked into the ground?** When rainwater does not soak into the soil, it runs over the surface of the soil, called **runoff water.** This runoff water goes into ditches, storm drains, rivers or streams, or just sits on top of the ground in a puddle. Some of this water may run off and soak into the ground later on, but because it is difficult to determine how much becomes groundwater, we will assume that runoff water does not recharge the aquifer for today's lesson.

**Let's look at the four different land plots on our rainfall simulator.**

Each land plot is very different from the other. When it rains on these types of land, water will do one of two things - it will either run off or it will soak in and become groundwater. As we look at each plot of land, let's come up with a **hypothesis** or educated guess about what water will do on each plot of land.

**Land Plot #1: Impervious Surface**

The first type of land we have is an **impervious surface.**

**Does anyone have an idea what the word impervious means?** An impervious surface is a surface that will not allow water or other fluids to pass through it.

**Can anyone think of an example of an impervious surface?** Some examples of impervious surfaces are sidewalks, roads, building foundations, and even a plastic bottle. Is wood an impervious surface? No! Water can soak into the wood, making it warp and even rot. However, there are ways to help make wood more impervious. You could paint the wood to seal any air pores and prevent water from soaking into it.

**As we look at this impervious surface, what do you think water will do when it falls on it?** Will it run off or will it soak into the ground?

**Land Plot #2: Turf Grass**

Our second plot of land is **turf grass.** This could represent someone's yard at their house, a playground at school, or even a park. This grass is usually short. Because of where this grass is usually located, a lot of people walk on it, sometimes packing down the soil and making it hard.

**When it rains on turf grass, where do you think that the water will go?** Will it run off or will it soak into the ground?

As we look at this land, let's think about wildlife for a moment. Some things that most all creatures need to live is sunlight and oxygen. **What are some other requirements for life?** Three other requirements for life include water, food, and shelter.

**As we look at the turf grass in front of us, is this good habitat for wildlife?** Turf grass is a good wildlife habitat. It does provide the basic requirements for life: food, shelter and water. **What types of wildlife might you see on this type of land?** You might see birds, squirrels, raccoons, and deer.

**Land Plot #3: Overgrazed Rangeland**

Our third land plot is an example of an **overgrazed rangeland.**

**Who can tell me what "overgrazed" means?** Land can become overgrazed when there are more animals on the land than there is food and habitat for those animals. As an example, consider your school cafeteria. Suppose that your class went to lunch one day and the cafeteria staff said that they only had three sandwiches to feed your whole class. What would happen? You would eat all the sandwiches, but you would still be hungry.

This is what has happened on this overgrazed land. The animals ate all the food that was there. In this case, the food for animals is plants and other animals.

**If there is no food, what will happen to the wildlife there?** They will either become weak from lack of food or even die from starvation. The weak animals will be easy prey for predators. Once the food is gone, these animals might even go in search of more food.

**So, as we look at this overgrazed rangeland, is this a good wildlife habitat?** No, it is not because there are not enough resources left to support the wildlife.

**Will the water runoff or will it soak into the ground on this type of land?** The water will run off because there isn't enough plants or vegetation, the soil becomes hard, and the water cannot soak in.

**Land Plot #4: Native Grassland**

Our last type of land is a **native grassland.** These tall grasses have been in this area for hundreds of years and have adapted to the climate conditions of Oklahoma. Examples of these types of grasses include bluestem, little bluestem, switchgrass and Indiangrass, the official state grass of Oklahoma. These grasses have a deep root system, which helps to keep them anchored in the ground.

**Do you think that these types of grasses provide good wildlife habitat?** Yes, these grasses provide excellent wildlife habitat. A person might see a wide variety of wildlife on this type of land. All the basic requirements for life are met.

**What will happen when it rains on these native grasses?** Will the water runoff or will it soak into the ground?

For each of our four plots of land, we were concerned with whether water ran off or soaked into the ground.

**Why are we concerned that water soak into the ground?** We want the water to soak into the ground because this creates groundwater, which is the only way to recharge an aquifer.

**Make it Rain!**

**NOTE:** If using watering cans to make it rain, select a student to pour the water for each type of land. If using the tubs mounted on the top of the rainfall simulator, pour the water into the tubs yourself. Most likely, students will not be able to reach the tubs.

Let's test your hypothesis and see if you predicted what will happen when we make it rain on each type of land. Let's start with the Impervious Land. I need some help each time by getting you guys to shout, "Make It Rain!" before we pour the water. On my count of 3, you say it!

1, 2, 3! "Make It Rain!"

**Discussion**

Impervious Surface

**What is happening to the rain when it falls on the impervious land?** The water runs off the top into the runoff water tub below.

**Why did the water run off?** The water could not soak into the ground because it is too hard for the rain to penetrate through it.

**Does this type of land help to recharge the aquifer?** No!

While they do not allow water to soak into the ground and recharge the aquifer, they are important to our quality of life. We walk on impervious surfaces, we drive on them, we build our houses on them. It is important to make sure that as we build more impervious surfaces that we have a balance with those types of land that help put water into the ground.

As we look at the water that was collected as runoff, we notice some suds on top of the water.

**What might these suds represent?** These suds represent oil, gas and chemicals that might have been dropped on an impervious surface. When it rains, water can pick up these substances, thus polluting the water.

Turf Grass

**Where did the water go when it rained on our turf grass?**

(If done correctly, some water should go into the runoff container. Most of the water should flow into the groundwater container.)

It looks as though most of the water went into the ground.

**Is this good? Why or why not?** This is good because water is going into the ground to recharge the aquifer. However, if we look in our runoff container, we did end up with some runoff water. If you remember, earlier I said that these types of land usually get a lot of people walking on them. As they walk on them, they pack down the soil. In some cases, the soil might be packed down so much that it might resemble an impervious surface. This would cause some of the water to run off.
These grasses also have a shallow root system.

**How do you think the shallow roots impact where the water goes?** Think of the root system like underground tree branches. The larger the branches, the more water the roots can catch. Since we have a shallow root system, the roots can only catch a small amount of water. The water that the branches (roots) do not catch runs off. That is why we collected some runoff water.

Overgrazed Rangeland

**What is happened to the rain that fell on the overgrazed rangeland?**

(If done correctly, water should have flowed into the groundwater container and the runoff container. The water in the runoff container should have particles of soil in the water).

Let's look at the runoff water. We did get quite a bit of runoff water. But what do you notice about this runoff water? What you see in this water is soil. Because there was no grass protecting the soil it was carried with the runoff water. This process is called **Erosion** in which water picks up soil particles and washes it away. Erosion can also occur when wind blows the soil away.

**How does erosion happen in overgrazed rangelands?** When it rains, there is nothing protecting the soil. Each raindrop that fell acted like a tiny missile. As each drop hit the ground, it "exploded," causing soil to be moved. Because of the large amount of rain that was falling, a large amount of soil was moved. Why did this not occur in the turf grass plot? We did not get any erosion on the turf grass plot because the blades of grass acted as a cushion as the raindrops fell.

**Is erosion a good or a bad thing? Erosion** is a bad thing. It washes the good soil away. It takes the Earth about 500 years to make a 1-inch layer of soil! Even though we did get some groundwater in the process, this type of land is not good because of the large amounts of soil lost through erosion.

Native Grassland

**What happened to the water on our Native Grass plot?**

(If done correctly, most of the water should have gone to the groundwater container. Very little water, if any, should be in the runoff container.)

All our water was soaked into the ground. Very little water, if any, ran off. These native grasses have a deep root system. They act like a very large branch that extends beneath the soil to catch lots of water. Because of this, more water can soak into the ground, making this a great land type to recharge the aquifer!

**Let's Clean Up and Review**

**Which type of land gave us the most groundwater?** (Native Grassland)

**Which type of land gave us the most runoff water?** (Impervious Surface)

**Why is it important that water soak into the ground?** (We want the water to soak into the ground because this creates groundwater, which is the only way to recharge an aquifer.)

**What is the only way that an aquifer can be recharged?** (By water soaking into the ground!)

**What can you do to reduce pollution in our water?** (Keep oil, gas, and chemicals off impervious surfaces! When it rains, water can pick up these substances, thus polluting the water.)

**What is erosion? How can erosion be prevented?** (Erosion is when unprotected soil particles are picked up and moved by either water or rain. Erosion can be prevented by using appropriate soil conservation techniques, such as planting deep root plants to hold on to and protect the soil. This is why the short root grass in the overgrazed rangeland made the soil susceptible to erosion!)

**Oklahoma Aqua Times Related Lessons:**

- Groundwater Activity
- Wells and the Water Table
- Groundwater Leaching
- Infiltration: Groundwater Flow Model 1
- Infiltration: Groundwater Flow Model 2

Lessons can be found at: https://4h.okstate.edu/projects/science-and-technology/oklahoma-aqua-times/index.html

Lesson adapted from 4-H2O For You: Outdoor Water Conservation, Texas A&M AgriLife Extension Service, Guadalupe County County

OKLAHOMA WATER RESOURCES CENTER

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## PASS Standards

| Grade Level | Standard | Science and Engineering Practices | Cross Cutting Concepts |
|---|---|---|---|
| **4th** | 4.ESS2.1: Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion. | Planning and Carrying out Investigations | Cause and Effect |
| **4th** | 4.ESS3.2: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. | Designing Solutions | Cause and Effect |
| **5th** | 5.ESS2.1: Develop a model to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. | Developing and Using Models | System and System Models |
| **5th** | 5.ESS2.2: Describe and graph amounts of saltwater and freshwater in various reservoirs to provide evidence about the distribuion of water on Earth. | Using Mathematics and Computational Thinking | Scale, Proportion, and Quantity |
| **5th** | 5.ESS3.1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environments. | Obtaining, Evaluating, and Communicating Information | System and System Models |
| **6th** | 6.ESS2.4: Develop a model to describe the cycling of water through earth's systems driven by energy from the sun and force of gravity. | Developing and Using Models | Energy and Matter |
| **7th** | 7.ESS3.1: Construct a scientific explanation based on evidence for how the uneven distrbutions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. | Constructing Explanations | Cause and Effect |
| **7th** | 7.ESS3.3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment. | Constructing Explanations | Cause and Effect |
| **7th** | 7.ESS3.4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. | Engage in Argument from Evidence | Cause and Effect |