

Watershed Wonders

Augmented Reality Sandbox Exploration

Topic(s): Earth systems and human activity, rainwater runoff, erosion, topography

Grade level(s): 5th – 8th grades

Time: 60 – 80 minutes

Maine Science and Engineering Standards: MS-ESS2-2, MS-ESS2-4, MS-ESS3-3

ACTIVITY OVERVIEW

In this lesson, students use an AR sandbox to explore how the landscape and water cycle affect one another. The AR sandbox helps to visualize the translation from topographic map to landform and shows how water would flow over the surface. Students are tasked with planning and building a city with various features, and they must consider water runoff, erosion, accessibility, sea level rise, and impact on neighboring communities as they build.

ALIGNMENT TO STANDARDS

5-ESS2-1 Earth's Systems: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-ESS3-1 Earth and Human Activity: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

MS-ESS2-2 Earth's Systems: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-4 Earth's Systems: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

LEARNING OUTCOMES

Upon completion of the AR Sandbox lab, students will be able to:

- Visualize a landscape based on a topographic map
- Understand the water cycle and how water moves over the Earth's surface
- Define and identify watersheds
- Design a city that will work with and withstand Earth's natural water-related processes.

CAREER CONNECTIONS

Agricultural Workers

Duties: Agricultural workers plant, care for, and harvest crops and tend to livestock. They often operate heavy machinery and to physically demanding tasks. They also spend time planning things like irrigation systems, crop placement and rotation, and land use.

Work Environment: Agricultural workers work outdoors year-round.

Median Salary: \$36,000 annually

Source: <https://www.bls.gov/ooh/farming-fishing-and-forestry/agricultural-workers.htm>

Cartographers and Photogrammetrists

Duties: Cartographers and photogrammetrists collect, analyze, and interpret geographic information to create and update maps and visual representations of the Earth's surface. The resources they create can be used for planning, research, education, etc. A cartographer creates maps, while a photogrammetrist uses aerial photos and remote sensing data to create maps and 3D models of the Earth's surface.

Work Environment: Much of their work is done in an office, but sometimes their projects require site visits so they can see the areas they are mapping in person.

Median Salary: \$78,380 annually

Source: <https://www.bls.gov/ooh/architecture-and-engineering/cartographers-and-photogrammetrists.htm>

Hydrologists

Duties: Hydrologist study water and how it flows over the Earth's surface and through its crust. They collect and analyze data on forecasts of floods, droughts, and plan solutions for sustainably managing water. They focus on environmental protection and conservation through a water-focused lens.

Work Environment: Hydrologists work in offices and in the field. They do laboratory analysis and computer modeling and may need to do research and data collection in lakes, streams, and other water sources.

Median Salary: \$92,060 annually

Source: <https://www.bls.gov/ooh/life-physical-and-social-science/hydrologists.htm>

BACKGROUND INFORMATION

What is an AR Sandbox?

An **AR (Augmented Reality) Sandbox** is an interactive model of Earth's surface that consists of sand, a projector, and a depth-sensing camera. The depth-sensing camera scans the topography of the sand while the projector overlays colors, contour lines, and water onto it. As you move and shape the sand into various landforms like hills, valleys, rivers, or lakes, the virtual landscape changes, letting you see how elevation, water flow, and landforms work together. You can simulate a rainstorm by waving your hand over the surface of the sand. This allows you to see how water runoff moves over the landscape and where it settles. AR Sandboxes are fantastic tools to teach how landforms, elevation, and contour lines are represented on maps. It also helps students explore real-world processes like watersheds, erosion, flooding, and how human activities affect the landscape.

Contour Lines

Contour lines are lines on a map that show places that are the same height above sea level. They show the shape of the land (the topography)—whether it's flat, hilly, or mountainous. When contour lines are close together, the land is steep, like a cliff. When they are spread out, the land is flatter, or the slope is more gradual. At the top of hills or mountains, the lines make complete circles. They also make complete circles around lakes where water runoff settles. By looking at contour lines, we can picture 3D land shapes on a 2D map.

Watersheds

A **watershed** is an area of land where all water runoff is channeled into the same body of water. Watersheds may also be called "drainage basins." When it rains or snow melts, the water flows downhill, following the shape of the land, and collects at the lowest point. Ridges divide where the water flows. A gully on the side of a hill would be where water would flow until it reaches the lowest point. Watersheds can be small, like a neighborhood stream, or very large, like the Mississippi River Basin. They are important because they impact the land, water, and people.

What happens in one part of a watershed, such as pollution or flooding, can affect ecosystems, communities, and landforms downstream.

Erosion and Sediment Deposition

Erosion occurs when wind, rain, or moving water wears away rocks and soil, changing landforms, and carrying that removed material to new locations. In a watershed, rivers and streams pick up particles of sand, soil, and rocks—called **sediment**—and carry them downstream, depositing some along the way and carrying some all the way to the lowest point where the water settles. Sometimes this builds new landforms, like sandbars or deltas, and other times it can cause problems, like washing away farmland or filling in lakes.

PRE-LABORATORY ENGAGEMENT

Landforms

To familiarize students with various types of landforms, have them explore this interactive map of world landforms: <https://mrnussbaum.com/world-landforms-interactive-map-and-scavenger-hunts>

POST-LABORATORY ENGAGEMENT

Local Watersheds and

Use the EPA’s “My Waterway” website to visualize and explore your local watershed, and learn about water quality monitoring in your area: <https://mywaterway.epa.gov/community>

LABORATORY SETUP

Photo of station

MATERIALS

- AR Sandbox (kinetic sand is 2% ratio: 227g/8oz dimethicone per 25 lbs sand)
- Gloves
- City blocks
- Trees and shrubs

EQUIPMENT PREP

AR Sandbox (see setup document for more detail)

- Attach projector bracket by lining up the clamp with the markings on the pole, then tighten the screw.
- Attach the Kinect sensor cord to the USB insert cord that is attached to the computer.
- Attach power cord and HDMI cord from the computer to the projector. The HDMI cord should be unplugged and plugged back in right before turning things on to ensure it connects correctly.
- Plug power strip into the floor.
- To show the sandbox projection on the TVs, plug the HDMI cord that is connected to the ethernet cord into the computer below the HDMI cord that is already there.

LESSON PLAN**Slide 1: Introduction**

We will be exploring how topographic maps work and how water flows over landforms. Your team will be tasked with building a city, consisting of various features, in a way that will be sustainable. You want your city to be accessible while also taking into consideration the Earth's natural processes and how those might impact your settlement.

Slide 2: Maps

- You've probably seen a map like this before. Let's break down what it all means.

Slide 3: Maps and Contour Lines

- Introduce the concept of contour lines.
- **Contour lines** are lines on a map that show places that are the same height above sea level. They show the shape (the topography) of the land.

Slide 4: Maps and Contour Lines (cont.)

- The closer together the lines are, the steeper the slope is.
- A closed circle without more lines inside it signifies either a peak or a low point such as a valley or lake.

Slide 5: Maps and Contour Lines (cont.)

- Which landform matches the contour lines on the left?
- Advance the slide to show that the bottom landform is the correct match.

Slide 6: Maps and Contour Lines (cont.)

- These contour lines show what each of these landforms look like as a topographic map.

Slide 7: Maps and Contour Lines (cont.)

- Which landform matches the contour lines on the left?
- Advance the slide to show that the top landform is the correct match.

Slide 8: Maps and Contour Lines (cont.)

- These contour lines show what each of these landforms look like as a topographic map.

Slide 9: Maps

- When you compile these landforms and contour lines, you get a map!
- Talk through some parts of the map. Show the peaks, valleys, and the riverbeds. Talk about how you know which way the water is flowing by which direction the points of the contour lines are pointing.

Slide 10: Maps

- A cartographer is someone who makes maps. They might put together a map like this with shading, color showing tree cover, landform names, etc.

Slide 11: The Water Cycle

- It is important to understand the landscape so that we can understand and predict how Earth's natural processes will function with the land. We want to know where water runoff, erosion, and flooding will occur.
- Moisture enters the atmosphere via evaporation and transpiration.
- That water vapor then goes through condensation and changes back to liquid.
- It is then returned to the earth through precipitation (rain, snow, hail).
- Water then runs off the surface and can carry sediment with it (erosion).
- Some water also seeps into the earth, enters aquifers, and becomes groundwater.

Slide 12: What is a watershed?

- A watershed is an area of land where all water runoff is channeled into the same body of water.
- Larger watersheds are made up of many smaller ones called subwatersheds.

Slide 13: Watersheds in Maine

- Maine has ten watersheds, all of which have smaller ones within them.

Slide 14: US Watersheds

- All of Maine's watersheds are part of the New England watershed which flows into the Atlantic Ocean.

Slide 15: Building a City

- Each table is a team.
- The sandbox will be set up with various land features. Each group will be assigned a portion of the box to build their city in. They should not alter the landscape at this time.
- As a team, discuss where runoff will flow and where water will settle. Which parts will experience lots of erosion? Where would building materials be able to be transported (i.e. probably not the very top of a mountain)? Where would people have access to resources (water, farmland, etc.)?
- **Features that must be included:** city center/downtown area, neighborhood, hospital, city forest, agricultural area, road access to water. (Remember that farmland needs proper irrigation.)
- After a team makes a plan, they can come build it in the sandbox and make it rain. They should observe where water is running off, where there is erosion, and if sea level rise destroys the city. They should take notes, then improve their design back at their table. Then they can try in the sandbox again.
- Once a team successfully builds their city, they can alter the landscape in their quadrant and then build a city in that new landscape.

Project the AR Sandbox

- Show how it works and show a few land features (mountains, lakes, river delta formation, etc.)
- Landforms to show and talk about (choose a few):
 - Lakes
 - Rivers
 - Oceans
 - Mountains
 - Valleys
 - Islands
 - Peninsulas
 - River deltas and alluvial fans
 - Calderas
 - Archipelagos
 - Ridges
 - Straights
 - Isthmus

- River meandering and oxbow lakes

The City Challenge

Each table will get a bag of town pieces and trees to design their city. The pieces will be placed on the landscape in their section of the sandbox. The goal is to develop their city in a way that water runoff and erosion will not destroy it. Their city must consist of several features: a neighborhood, a downtown district, a hospital, roads, farmland, and a natural area. The buildings and roads must be safe from flooding, but farmland must get proper irrigation.

Considerations:

- What landscape features are not ideal to build on?
- What types of land features should certain city elements be near? Would a neighborhood be better on the top of a hill, on a slope, or next to a lake?
- Why would building in a certain spot be easy or difficult? Think about resource accessibility. Can you get the needed building materials to the site easily?

The Farm Challenge (to extend lesson for longer classes)

Remove all city pieces and create a farm plot that would have areas for plants that need wet soil, dry soil, and moderate moisture. You may need to shape the landscape for irrigation. Make it rain to see where the water flows and pools. Where is the runoff carrying agricultural chemicals like pesticides, herbicides, and fertilizers?