Lesson 2: The Hydrologic Cycle and Los Angeles Watersheds

Overview

This lesson introduces students to watersheds and the basic hydrologic cycle. Students will learn about their local watershed and describe the components of the water cycle and the water balance equation. Then they will gain insight into the Los Angeles climate and how it affects water sources, especially in light of the ongoing drought. The lesson concludes with an interactive activity where students construct a watershed model to illustrate its functions and consider changes in the LA watersheds over time.

Lesson Time

- One class period - 50 minutes

Objectives

Students will:

- Define watersheds and identify the components of the natural hydrologic cycle.
- Construct a watershed model to understand the natural water cycle and identify the diverse topography of watersheds.
- Create a concept map to compare a watershed in Los Angeles today versus 200 years ago, and assess the effects of urbanization on the water balance equation.

NGSS Standards Addressed (Click here for complete standards)

- HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ESS3-3**:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

CCSS Standards Addressed

ELA/Literacy

- **RST.11-12.2**: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **RST.11-12.7**: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Mathematics

- **MP.2**: Reason abstractly and quantitatively.
- **HSN.Q.A.2:** Define appropriate quantities for the purpose of descriptive modeling.

Materials

- Watershed *Handout 2A* for each student in the group
- ~36 inch sheet of heavy-duty aluminum foil
- 3 or 4 empty plastic bottles
- Spray bottles for water
- Baking pans with edges
- 2-3 tablespoons of each of the following materials that represent pollutants:

Material	**Representation**
Binder clips, paper clips	Houses, industries, buildings
Food coloring (2+ colors)	Point source pollution
Molasses	Oil spills
Rolled oats or paper confetti	Trash
Coffee grounds or cocoa powder	Nonpoint source pollution
Chocolate syrup	Dog feces
Vegetable oil	Motor oil

Focus Discussion: The Hydrologic Cycle and Water Balance Equation
(10 minutes)
The teacher should begin by reminding students that nearly 97% of the world's water is salty/undrinkable and another 2% is locked in ice caps and glaciers. This leaves only 1% for all of humanity's needs. Then introduce the hydrologic cycle (also known as the water cycle). In this lesson students will learn about the natural water cycle and then move on to the urban water cycle in the next lesson. Teachers should begin by asking the following questions, soliciting responses from students, and explaining the correct answers. Images of the water cycle may be useful to show.

- What is the hydrologic or water cycle?
  The continuous movement of water in its various stages, including liquid, solid [ice], and gaseous [water vapor] forms.

- What are the different components of the water cycle?
  Teachers should show an image or draw the water cycle on the board as students provide answers. They should be sure to include:
  - *Precipitation - rain, snow, sleet, or hail that falls to the ground*
  - *Evaporation - Water from rainfall returns to the atmosphere largely through evaporation. It is the process of changing liquid surface water into a gaseous state. The amount of evaporation depends on temperature, solar radiation, wind, atmospheric pressure, and other factors*

- *Transpiration - the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere.*
- *Infiltration - the process by which surface water percolates into the soil and recharges groundwater*
- *Runoff - the draining away of water from the surface of an area of land toward waterways and into the ocean.*

Teachers would finally help the students create a balanced equation from the different components of the water cycle. To illustrate, write an equals sign on the board and explain that one side is water inputs and the other is outputs. The final **water balance equation** should look like this:

Precipitation = Evapotranspiration + Infiltration + Runoff

Teachers should give students the opportunity to give responses to what components should be put under inputs or outputs. If students are struggling, guide them to the correct equation with directed questions such as:

- How does water get to the land?
- What happens to water once it falls to the ground?
- How does the water return to the atmosphere?

Teachers should make sure to define each component of the water balance equation as they go along. Students should be able to understand that we get water from precipitation and once it falls to the ground, the water either runoffs toward the ocean infiltrates into groundwater, or evaporates from the land or plants. Teachers should then have a discussion about why we use the water balance equation by asking the questions below.

Ask students:

- How is the water balance equation useful?
  1. *We can assess how different landscapes affect water supply and quality.*
     a. *For example, infiltration and runoff would change depending on whether we are in an urban or natural landscape.*

  2. *We can calculate differences in water use from year to year to predict how much water an area has locally.*

  3. *We can predict the effects of climate change on future water supplies by comparing water variations through time in a specific region.*

  4. *We can use this information to implement changes that will ensure our water supply in times of drought.*

a. *For example, governments could invest in more stormwater capture or water recycling projects to increase water supply.*

Focus Discussion: Watersheds and Water Quality
(10 minutes)
The teacher should now introduce watersheds by explaining that to ensure that people have continuous access to clean drinking water we need to manage water at the watershed level. To help students understand why watersheds are important, the teacher should pose the following questions, solicit responses from students, and explain the answer.

- What is a watershed?
  An area of land where all the water drains to the same location. This is usually defined by topography such as mountains and hills, as well as by urbanization, such as storm drain systems (show image of watershed). This includes surface water and groundwater.

- What watershed are we located in?
  Explain that everyone lives in a specific watershed. Southern California has several watersheds. The websites below will help you identify your local watershed based on the location of your school (https://cfpub.epa.gov/surf/locate/index.cfm)

- Why is understanding watersheds important?
  To ensure clean and healthy waterways, we must understand the contours of a watershed. Everything upstream impacts everything downstream. For example, if you are looking for the source of a pollutant in your local stream, you need to know what area you should be looking in to find the source. In order to restore a waterway, we need to think about all of the surrounding land uses, not just about the river corridor itself.

The teacher should then discuss how pollutants flow through a watershed and its effects on water quality. Show students that as we learned before, the components of the water balance equation change in different landscapes. This means that the flow of water and pollutants will be determined by whether we are in a natural or urban watershed. There are two types of pollution:

1. **Point source pollution** - a single, identifiable source of pollution such as a pipe, sewer, or factory.
2. **Nonpoint source pollution** - pollutants that are widespread and have multiple sources that all get carried away by rainfall such as trash, metals, pesticides, and fertilizers.

Teachers will now transition into the activity by telling students that they will investigate the flow of water and pollutants in a watershed.

Focus Activity: Constructing a Model Watershed
(25 minutes)
Teachers should introduce the activity by telling students that they will build their own model watershed and observe how water and pollutants flow through the landscape. Then they will create a diagram explaining how the water balance equation has changed from the natural watershed of Los Angeles 200 years ago to the urban watershed of modern Los Angeles.

Instructions
1. Distribute *Handout 2A* to each student.
2. Put students in groups of 3-5.
3. Provide each group with a model watershed set that includes all the materials listed at the start of the lesson.
4. Instruct the groups to build their watershed model and answer the questions in *Handout 2A* as they move along through the activity.
5. Explain that at the end they will create a diagram to compare how the water balance equation for Los Angeles has changed over time.

Debrief
(5 minutes)
Teachers should go through the diagram from the end of the activity with students and allow them to share their responses to each portion. Feel free to review the diagram verbally or write out the answers on the board as students respond (answer key provided). Conclude the lesson by explaining that due to LA's urbanized landscape, we will be looking at the **urban water cycle** next week to further examine the impacts on our waterways.

Optional Introductory Activity: How Much of the Earth is Covered by Water?
(5 minutes)
1. Ask students if they know how much of the earth's surface is covered in water. *Approximately 71% of the earth's surface is water.*
2. Have students toss inflatable globe around the room 20 times so that 20 different people catch it.
3. Tell each student to call out whether their thumb lands on water or land.
4. Instruct one student to record this data.
5. After 20 passes, calculate the percentage of water vs. land. *It should be approximately 14 times on water vs. 6 times on land.*

Handout 2A

Constructing a Model Watershed

Directions: Follow the instructions for each step and answer the questions as you construct your model watershed. Then create a diagram explaining how the water balance equation has changed in Los Angeles today compared to 200 years ago.

Materials List

- Sheet of aluminum foil (~36 inches)
- Baking pan
- Spray bottle (with water)

Material	**Representation**
Binder clips, paper clips	Houses, industries, buildings
Food coloring (2+ colors)	Point source pollution
Molasses	Oil spills
Rolled oats or paper confetti	Trash
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Chocolate syrup	Dog feces
Vegetable oil	Motor oil

Step 1- Take a sheet of aluminum foil and shape it to simulate a watershed. Make sure to include areas that represent mountains, streams, and rivers. Collectively, the features that depict the shape, height, and depth of a landscape are called topography. Elevate part of the watershed to create mountains and have a low elevation point where the water can drain out of the watershed into the “ocean”.

Step 2 - Use the spray bottle to simulate precipitation in a mountainous area of the watershed.

1.) Describe how water flowed through the watershed from the mountains to the ocean. For example, how did the topography impact the water flow through the watershed?

Step 3 - Now fast forward 200 years to Los Angeles today. Imagine how the watershed has changed in the last 200 years. Imagine all of the buildings, highways, roads, streets, and parking lots in the watershed. These are referred to as impermeable surfaces because water cannot permeate or soak through these surfaces. Sprinkle cocoa-powder across the watershed to represent nonpoint source pollution. Nonpoint source pollution is widely distributed pollution that does not come from a single source. Simulate precipitation again and observe.

2.) Describe how nonpoint source pollution moves through the watershed.

Step 4 - Imagine the apartment buildings, houses, and factories in current day Los Angeles; add binder clips and/or paper clips to represent apartment buildings, houses, and factories. Place some factories at a high elevation and some at a low elevation site. Place a few drops of one color of food coloring near the factories at low elevation and a few drops of another color of food coloring near the factories at a higher elevation. The food coloring represents point source pollution or pollution that comes from an identifiable source. Simulate precipitation and observe.

3.) Describe how the point source pollution moves through the watershed. How does point source pollution compare to nonpoint source pollution?

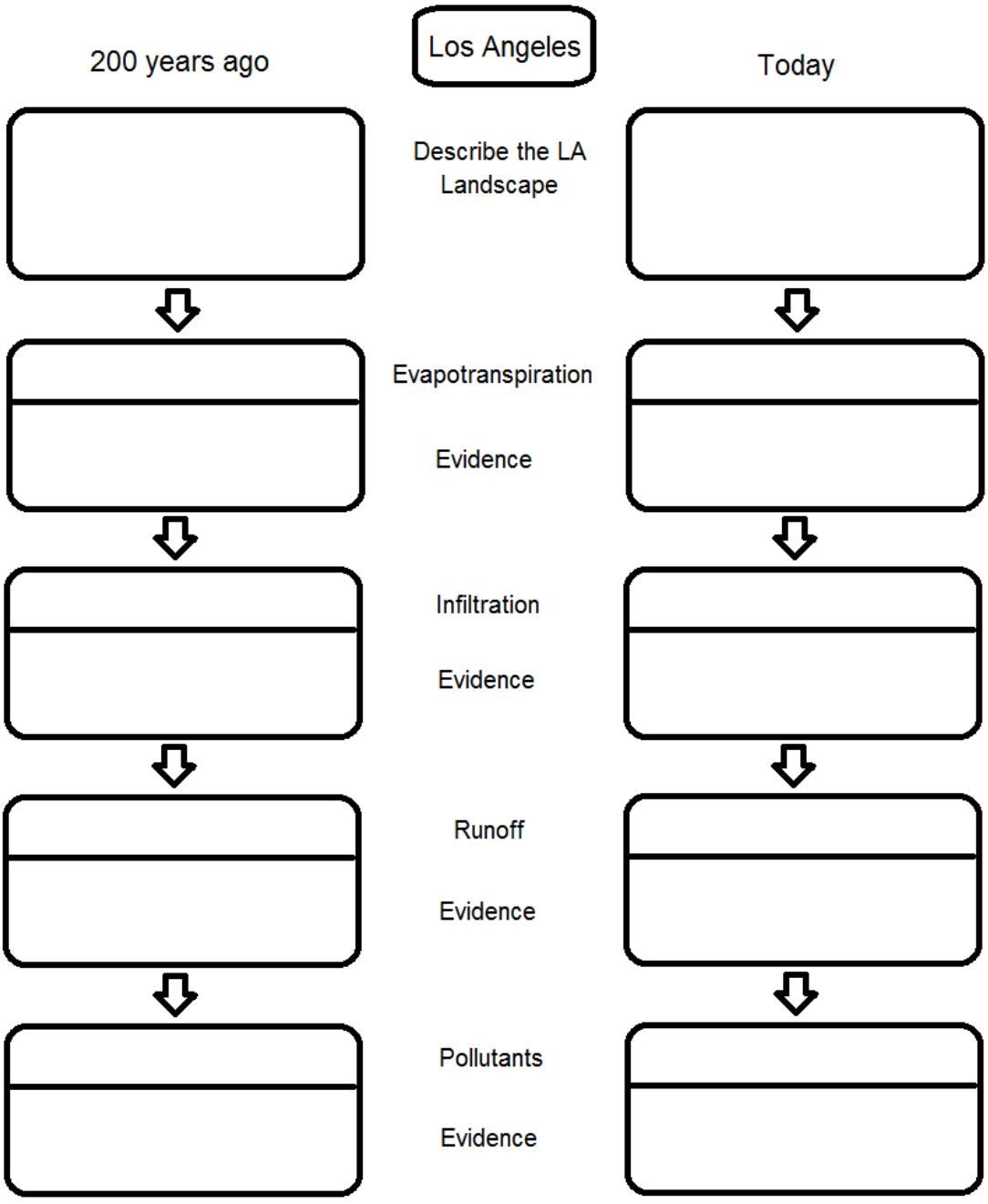
4.) What differences did you observe when pollution was distributed at a high elevation (upstream) versus a low elevation (downstream)?

Step 5 - Now imagine all the other types of pollutants that end up on the streets in Los Angeles. Sprinkle rolled oats around to represent trash. Pour some vegetable oil and chocolate syrup around to represent motor oil from cars and dog poop. And finally throw on a glob of molasses to represent an oil spill from a malfunctioned refinery. Simulate precipitation and observe.

5.) Identify each pollutant as either point source or nonpoint source.

6.) Describe what happens to all the pollutants on the street when it rains? Where does it all eventually go?

Now you will create a diagram to illustrate how the components of the water balance equation have changed using evidence from the model watershed activity. First begin by describing the landscape of modern LA versus LA from 200 years ago. Then rate each of the following criteria as HIGHER or LOWER to compare how LA has changed over time. Provide evidence for you conclusions.



TEACHER ANSWER KEY: