

GRADE LEVEL: 5-8 | TIME REQUIREMENT: 3 HOURS

EARTH AND SPACE SCIENCE: WATER CYCLE

1 READING | 2 ACTIVITIES

INTRODUCTION

Water is so ubiquitous that it is easy to forget how important it is. Yet clean water was a very important part of logistics planning in World War II. Prior wars and the growth of urban areas had shown that deadly diseases like cholera can spread when clean water isn't available. Tropical diseases like malaria that are associated with stagnant water had killed millions in previous conflicts.

World War II covered territories from the deserts of North Africa, the arid Mediterranean, the mountains of the Alps, and the forests of Europe. The geography of the campaigns included the brutal ice of Greenland and the drenching rains of the tropical Pacific. In all these areas, troops needed clean water to drink and bathe to avoid disease.

OBJECTIVE

These resources focus on different aspects of the water cycle, framed by the challenge of finding potable water in the Pacific Theater during World War II. Testing water samples and building a solar still, students investigate the water cycle and the physical properties of water.

STANDARDS

NGSS DCI ESS2.C
The Roles of Water in Earth's Surface Processes

NGSS SEP
Developing and Using Models

NGSS SEP
Planning and Carrying Out Investigations

NGSS CCC
Systems and System Models

NGSS CCC
Scale, Proportion, and Quantity

PERFORMANCE EXPECTATIONS

NGSS 5-ESS2-2
Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

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

READING (1)**1. WATER EVERYWHERE****Description**

This reading describes the Pacific Theater of World War II, which was dominated by expanses of ocean, drenched jungles, and wide rivers. In spite of all this water, finding clean water to drink and bathe in was a big challenge. You might use a diagram of the water cycle along with this reading. You could also perform a demonstration of the water distribution model. For this demonstration, start with a liter of water in a clear container so that students can watch. Remove the appropriate amounts of water, in sequence, into smaller and smaller containers, as outlined in the student handout. You could also have students make bar graphs of the relative amounts of water to practice their quantitative skills.

ACTIVITIES (2)**1. MEASURING WATER****Description**

This is an activity that can be done in combination with Water Everywhere. This activity will require you or your students to collect samples of local water sources, on field trips, at school, or at home.

Supplies

Water Samples
pH paper
Thermometer
Other water quality tests (optional)

Instructions

You will need water samples that your students have collected. If that isn't possible, you could just make your own samples by adding dirt or other material to water or by taking it from a fish tank or other source. Recording temperature data only works if you are collecting water in the field. You will also need pH paper, which you can get inexpensively at a pet store or from a science materials supplier. You could easily add other water quality tests with some simple supplies. For example, pool and aquarium kits allow you to measure ammonium or salinity. Additionally, if you are in the field, you can use tools to measure how far into the water you can see or to record what animals and plants you see in the water.

2. SOLAR STILL**Description**

This is an investigation activity that is perfect to follow the previous two. Please note that this activity is best done outside in groups on a warm, clear day. You can modify it to be done inside with heat lamps or an incandescent bulb.

Supplies

1 Small bucket
1 Small plastic cup
2 Cups of water, to which you have added some salt or dirt
Clear plastic (you may be able to use plastic wrap)
A small rock

Instructions

Have the students put the dirty water (or you can use salt water) in the bottom of the bucket. Then place the small cup upright in the middle of the bucket. Cover the bucket with the plastic, placing the weight on it in the middle so that the center of the plastic is lower than the edges. Then place the bucket in a warm spot outside. The water will slowly evaporate as it warms in the bucket, and some of it will condense on the plastic. Because the plastic is lower in the center of the bucket, the condensation will run down toward the center. If it is very warm and sunny outside, this will happen over a couple of hours. If it is cool, it may take longer.

To accelerate the process, you could add a heat lamp and keep it inside. When enough condensation builds up, it will drip into the cup. This is a model of the evaporation-condensation portion of the water cycle. This is also a rudimentary demonstration of a water purification method that was used by American servicemen during World War II.

READING

WATER EVERYWHERE, BUT NOT A DROP TO DRINK

Imagine that you are a pilot or a sailor during World War II, and you are sent to serve in the Pacific Ocean. You travel across the vast Pacific, dotted with islands, small and large. When you finally arrive at your base, by air or by sea, it's on an island, wet with soaking rains, green with lush plant life, and crossed by rivers and streams. But what can you drink? Can you drink the water from the ocean? Can you drink the water from the rivers and streams on the island, which might hold bacteria and protozoa that cause dysentery, cholera, and other illness? What can you drink?

During World War II, there were some water treatment plants that removed living things and contaminants from water so that it could be used by troops. There weren't very many places that had water treatment plants. Americans serving in World War II needed water to cook, to wash clothes and dishes, to drink, and to bathe. They conserved water by not bathing much. Sometimes they used water purification tablets to disinfect water in their canteens, but it was still extremely hard to get enough clean water.

The Earth is a water planet—most of its surface is covered by water, such as lakes, rivers, or oceans. Mountain ranges like the Himalayas and the Alps are covered in ice year-round. Antarctica in the Southern Hemisphere and Greenland and much of the Arctic in the Northern Hemisphere are covered in ice. Water flows through rocks underground on all the continents. But do we have enough water to drink? Let's look closer at all that water. Your teacher will demonstrate with a model.

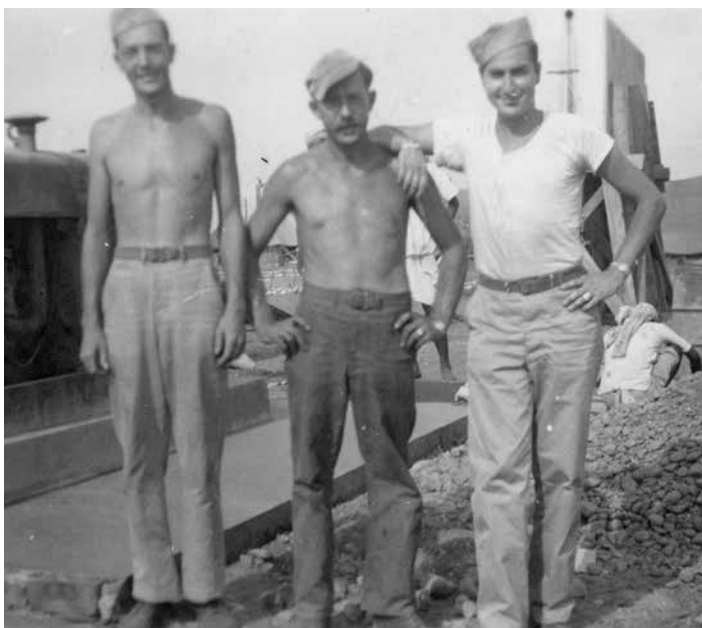
To make it easier to think about, we'll use one L of water to represent all the water on Earth. That's 1000 ml (milliliters) of water.

Ninety-seven percent of the Earth's water is saltwater in the oceans. Of this 1000 ml, how many ml are saltwater? How many ml are fresh?

Of the fresh water on Earth, 69 percent is frozen in glaciers and ice caps; 30 percent is groundwater flowing through rocks underground; and one percent is surface water.

Of our original 1000 ml, many ml are frozen, how many ml are underground, and how many ml are on the surface?

The water on Earth isn't static—it moves. Lakes flow into rivers, and rivers into the oceans. Water on the surface, including the oceans, evaporates into the atmosphere. Some of what evaporates forms clouds and falls back to the surface as snow or rain. When rain falls on land it either runs over the surface and then sinks into groundwater, or it flows into rivers and lakes. This is called the water cycle.



Three United States Army Air Force engineers standing in front of a water distilling pump and generator, probably India. (Image: The National WWII Museum, 2011.407.015.)



View of a glacier in Iceland, 1943. (Image: The National WWII Museum, 2013.606.084.)

NAME:**DATE:**

1. Draw a diagram of the water cycle, showing the changing states of water and the locations of Earth's water:

2. All living creatures including humans need water to survive. How much fresh water is available and accessible to humans? Is that amount of fresh water significantly larger or significantly smaller than the amount of salt water?

3. Using what you know about the water cycle, brainstorm some ways that US troops in World War II could access clean water or to make water safe for use. Outline your best idea in the space below. If you are having trouble imagining that, pretend there is a natural disaster, and you need to get clean water. Brainstorm how you could collect water and clean it for your use.