INVESTIGATION 3.1: VISUALIZING EARTH'S WATER

LESSON SNAPSHOT

- ☑ Read and Connect
- ☑ Analyze Data
- ☑ Discuss Models
- ☑ Group Work and Invent
- ☑ Gallery Walk and Feedback
- ☑ Synthesize and Reflect

2 50-MINUTE PERIODS

MATERIALS

PER STUDENT

- **Student Sheet 1: Water Distribution**
- **Student Sheet 2: Gallery Walk Feedback**
- **Student Sheet 3: The World's Water Graph**
- **Student Reading 1: Visualizing Earth's Water**
- Graph paper (optional)
- Calculator (or cell phone)
- Computer (optional)

PER GROUP

- Chart paper
- Markers
- Sticky notes
- Rulers
- Compass and/or protractor (for drawing circles)

WHOLE CLASS

(OPTIONAL VISUAL MODELS)

- A 1-gallon jug
- Measuring cups and spoons
- Containers to hold measured quantities of water
- Globe (inflatable beach ball globe will work best)
- Find videos and other visual models at **denverwater.org/werg**

STUDENT OUTCOMES

- Students will create and evaluate models of water distribution on Earth.
- Students will understand that most of the water on Earth is not readily available for human use or consumption because of salinity, location or pollution.
- Students will understand that most of Earth's fresh water is unavailable, locked in glaciers and ice caps.
- Students will understand that most of the fresh water readily available for human consumption on Earth is in the form of groundwater.

INQUIRY QUESTIONS

- How is water distribution data best represented?
- How is Earth's water distributed within and around the planet?
- How do models help us better understand scientific data and concepts?

OVERVIEW

Students have an opportunity to see different models of how water is distributed across Earth. A very simple model (the globe toss) and a more complex model (the 1-gallon jug) provides students with a reference when they create their own model or representation using a data table.

Students will be placed in groups of three to create their initial representation. They will then rotate to a new group of three to explain their representation and their reasons for choosing it to their new group. They will then return to their original group of three to discuss and synthesize the similarities, differences, pros and cons of the different representations. You may choose to have students make changes to their representations in addition to the reflection.

*Note: This investigation makes use of Think-Pair-Share, various reading strategies and a Gallery Walk. For more information on each of these instructional practices and more, please see **Instructional Resources** in **Section 2: Additional Resources.***

TEACHER BACKGROUND INFORMATION

Water is a vital resource, and it is important to understand how much is available, where the water we consume comes from, the process required to make it safe and how to make sure we will have enough drinkable water in the future. We play an important role in how much water we use during different activities, even at a young age, and the more we understand about the availability and movement of water, the better we are at making decisions that protect this resource.

If you look at a globe or map of Earth, approximately 71% of the surface is covered by water. Of that total water, approximately 97% is in the oceans and is undrinkable without desalination. Most fresh water exists as glacial ice or is trapped underground (see **Student Sheet 1**). Of the remaining fresh water, less than one-half of 1% is available in surface sources like lakes, rivers and swamps and is readily available for human use.

A demonstration can be helpful in building understanding of both the distribution of water on Earth and the concept of models. Have students visualize that the Earth's water is contained in a 1-gallon jug. Using the gallon jug, measuring cups and spoons, students will be able to see how water is distributed. Use the breakdown below for the demonstration.

The documents and student sheets throughout this lesson address the breakdown of water on Earth differently. It may appear that the percentages are different, but if you look carefully you will notice that they are accurately portrayed for what they are specifically referencing. The emphasis throughout the investigation should be on the concept that there is a vast amount of water on this planet that is not available for human consumption, not the specific numbers or percentages. Please point out these discrepancies to students so they are aware of the differences that each data set or reading is referencing.

1-GALLON JUG MODEL

	% of all Earth's water	out of 1-gallon
Oceans and other saline water	97.5%	15 ⅔ cups
Fresh water	2.5%	⅓ cup

Fresh water can further be broken down:

	% of fresh water	out of 1-gallon
Ice & glaciers	68%	11 tsp
Groundwater	30%	4 ¾ tsp
Other (surface water, atmosphere)	2%	¼ tsp

ENGAGE

WHAT EDUCATOR DOES	WHAT STUDENTS DO
Globe toss • Using an inflatable globe, toss the globe to a student. When the student catches the globe, ask them if their right thumb is on water or land. • Have that student toss the globe to another student and ask the same question, "Is your right thumb on water or land?"	Engage in the globe toss activity. What do you notice and wonder as you see the difference between water and land responses?

ENGAGE

WHAT EDUCATOR DOES	WHAT STUDENTS DO
• Tally the responses on the board. Water should get about three-fourths of the responses while land gets about one-fourth of the responses. Make sure to toss the globe to enough people so that the numbers work out. • Ask students to notice and wonder as the responses are tallied. Demonstrate the distribution of water with a 1-gallon jug Ask students to consider the two models or representations they just saw. • What are the strengths of each model? • What are the limitations of each model?	Observe the 1-gallon jug demonstration
Offer students a visual (a globe, picture(s) of Earth from space, video of Earth from space, map, etc.). **Think-Pair-Share** (see **Section 2: Additional Resources**) to activate background knowledge and set the purpose for the lesson. Possible questions to pose: • How is water distributed in and around Earth? • What do you know about the importance of water? • How much of Earth's surface is covered with water? • How much of Earth's water is available for human use?	Think on own, discuss in pairs and then as a whole class one or more of the questions to the left.

EXPLORE

WHAT EDUCATOR DOES	WHAT STUDENTS DO
Pass out **Student Reading 1: Visualizing Earth's Water** Using your preferred reading strategy (coding text, reciprocal reading, partner reading, etc.), have students read and annotate the article.	Read and annotate the article. Analyze and annotate the data tables. Ask questions and make observations.

EXPLORE

WHAT EDUCATOR DOES	WHAT STUDENTS DO
Discuss the models in the reading. Ask students: • What components of the models are most effective at communicating the information?	Participate in the discussion and respond to the question to the left.
Scaffolding Option Give students **Student Sheet 1: Water Distribution Data Table** Students will use the data tables to determine how many of the squares to color in for each data point. Have students calculate the number of squares out of 1,000 that represents each water source and record their answer on **Student Sheet 1.**	Calculate the number of squares out of 1,000 that represent each water source and write your answer on **Student Sheet 1.** Determine a color key for the data in **Student Sheet 1: Water Distribution Data Table** and add the key to **Student Sheet 3.** Use the data table to determine how many squares to color in for each data point. Analyze final grid. Compare the amount of water on Earth to the varying amounts of specific water sources and to what is available for human consumption.
Divide students into small groups and provide examples of visual representations, such as bar charts, pie graphs, relative-size drawings or comparisons. Model the thought process of a scientist choosing a specific representation to represent data. Use these inquiry questions to help students make choices for their visual representations: • Why would a scientist choose a bar graph for this data? • Why would a scientist choose a pie graph in this situation? Direct students to be original and inventive to show the distribution of water on Earth. Guide some groups to get away from mimicking the examples given while allowing groups who need that support to use the given examples. Students will need to think through why they chose their particular representation. This will help students be more prepared for the next step in the investigation. Students will next break into new groups, so be clear that each person has to understand the text and images on their representation in order to present the information effectively to their new group.	In groups of three, use the data to determine a way to visually represent how water is distributed on Earth. Create your model of water distribution on Earth. You will need to be able to explain why you chose the representation you did and state evidence for the choices you made. • Why did you represent the data this way? • How does it visually help us grasp water distribution on Earth? • What are the pros and cons of your representation?

EXPLORE CONTINUED

WHAT EDUCATOR DOES	WHAT STUDENTS DO
Host a Gallery Walk *(see **Section 2: Additional Resources** for more information on a Gallery Walk).* Give specific directions about where groups will start and what the rotation will look like. ** During the Gallery Walk: Knowing students should walk away understanding that most of the water on Earth is unavailable for human use and also the benefits and limitations of models, strategically select models that highlight accuracies and inaccuracies in the data. Students will present these models during the "Explain" part of the lesson and clarify anything that the whole class needs to understand.* You may have students use sticky notes to provide feedback so that each group retains a record of feedback from their peers and is better able to use that feedback for discussion.	As the new groups rotate, each member will showcase their previous team's representation by explaining: • Why did the group choose this way to represent the data? • What do you understand better because you represented it this way? • What are the pros and cons of the representation? The students listening to the explanation of the data should record their answers to the following questions on **Student Sheet 2: Gallery Walk Feedback**: • What do you notice? • What do you wonder? • How does this representation help you better understand the data? • What are the limitations of this representation? • What are some changes you would suggest to this group to improve this visual representation?
Have students come back to their original groups and discuss the feedback they received from their classmates. What feedback do they agree with? What is helpful? What advice might they take from their classmates?	Discuss the feedback you have received from your classmates with your original small group.

EXPLAIN

WHAT EDUCATOR DOES	WHAT STUDENTS DO
Bring the students together as a whole class and discuss the strategically selected models that students have created. Make sure to highlight: • The strengths and weaknesses of the models. • How Earth's water is distributed within and around the planet. • How models better help us understand scientific data.	Participate in the whole class discussion.

DEBRIEF AND REFLECT

WHAT EDUCATOR DOES	WHAT STUDENTS DO
Choose a whole group discussion or small group discussions. Post the following questions publicly for students to reference. • How is water distribution data best represented? • What were some of the challenges of representing the water distribution data accurately? • Where is most of Earth's water located? • Which representation did you like best? Why? • Which representation was most effective? Why? Ask groups if anyone wants to share something from their small group discussion that they found particularly helpful, insightful, perceptive, useful, etc.	Discuss the following questions: • How is water distribution data best represented? • What were some of the challenges of representing the water distribution data accurately? • Where is most of Earth's water located? • Which representation did you like best? Why? • Which representation was most effective? Why?

ASSESSMENT OPTIONS

1. Individually have students write a response to one or more of the following questions. You may choose the questions, or they could choose the questions to discuss.

Possible Reflection Questions

- What can you conclude from the representations of data?
- Which representations (models) are most effective at comparing the different water sources?
- What are the limitations of these models?
- What might make the model stronger?
- With the new understanding of how little fresh water there is for humans to use, how can we change our behavior to be more efficient?
- What are you wondering now?
- What was your biggest "aha moment" during the gallery walk?
- How was your learning enhanced by this method?
- What role did collaboration play in your success?
- Why was the individual responsibility component of today's lesson so important?

2. Have students turn in their diagram with an explanation of why they chose to represent Earth's water the way they did. After seeing other students' work, would they change it? Why or why not?

ADDITIONAL RESOURCES

Videos for this lesson are available at **denverwater.org/werg**

NAME _____ DATE _____

WATER DISTRIBUTION TABLE

STUDENT SHEET 1 STUDENT SHEET

PERCENT OF TOTAL GLOBAL WATER

WATER SOURCE	% OF GLOBAL WATER	# OF SQUARES OUT OF 1000	ADDITIONAL METHOD TO REPRESENT DATA
OCEANS	96.5%		
OTHER SALINE WATER	1%		
FRESH WATER	2.5%		

PERCENT OF TOTAL FRESH WATER

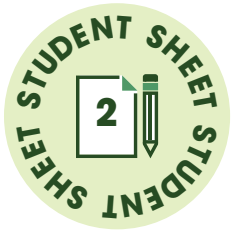
WATER SOURCE	% OF GLOBAL WATER	# OF SQUARES OUT OF 1000	ADDITIONAL METHOD TO REPRESENT DATA
GLACIERS AND ICE CAPS	68%		
GROUNDWATER	30%		
SURFACE AND OTHER FRESH WATER	2%		

PERCENT OF TOTAL OTHER FRESH WATER

WATER SOURCE	% OF GLOBAL WATER	# OF SQUARES OUT OF 1000	ADDITIONAL METHOD TO REPRESENT DATA
GROUND ICE AND PERMAFROST	69%		
SURFACE WATER (LAKES, RIVERS, SWAMPS)	24%		
OTHER (ATMOSPHERE, LIVING THINGS, SOIL)	7%		

NAME _____ DATE _____

GALLERY WALK FEEDBACK



FOR YOUR REPRESENTATION, YOU WILL EXPLAIN TO YOUR NEW GROUP THE FOLLOWING:

1. Why did your group choose this way to represent the data?
2. What do you understand better because you represented it this way?
3. What are the pros and cons of the representation?

AS YOU LISTEN TO YOUR CLASSMATES' EXPLANATIONS, PLEASE USE THE FOLLOWING CHART TO HELP YOU ORGANIZE YOUR THOUGHTS AND PROVIDE HELPFUL AND SPECIFIC FEEDBACK.

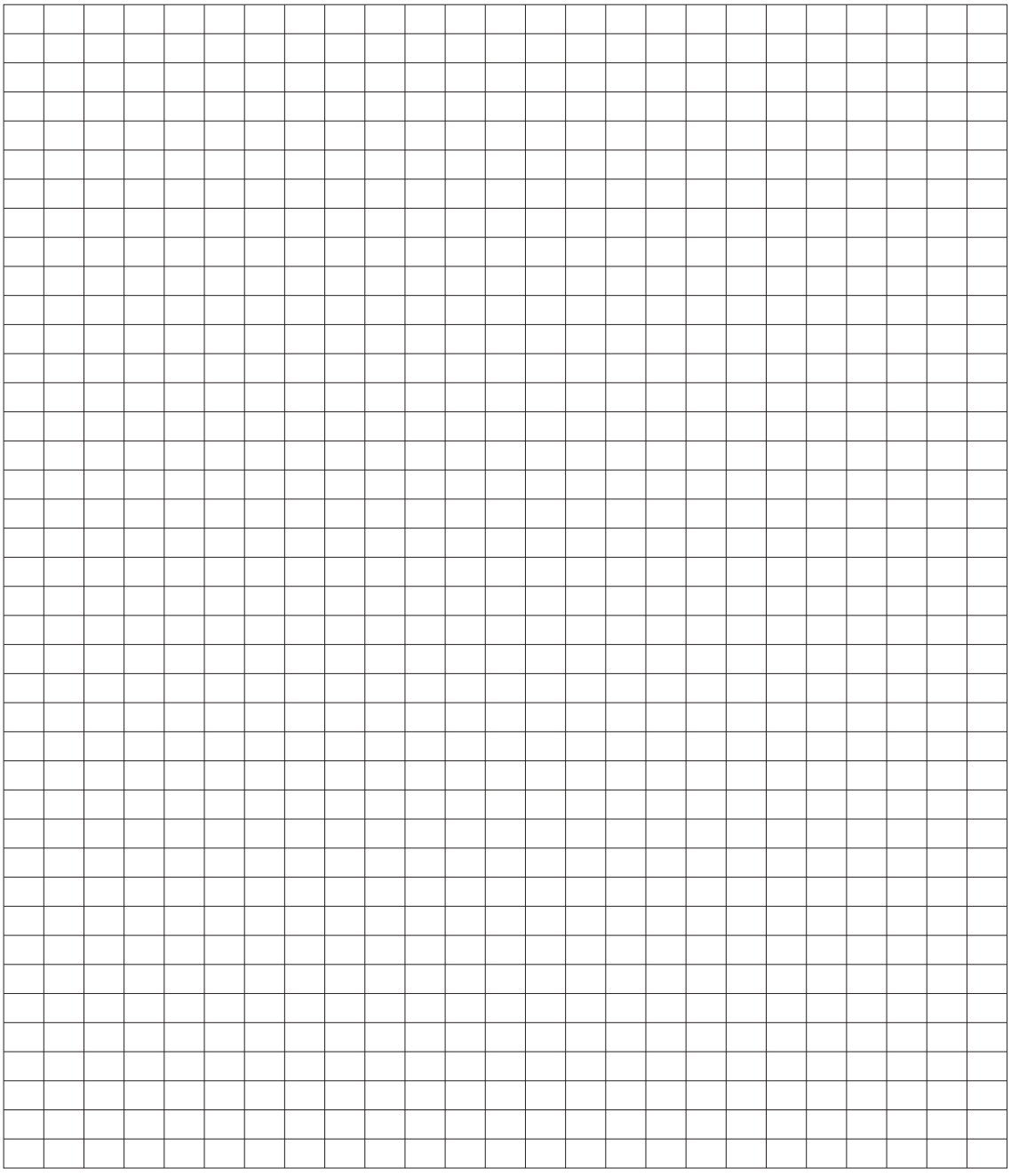
Group members' names or title	
What do you notice?	
What do you wonder?	
How does this representation help you better understand the data?	
What are the limitations of this representation?	
What are some changes you would suggest to this group to improve this visual representation?	

NAME _____ DATE _____

WORLD'S WATER GRAPH

STUDENT SHEET 3

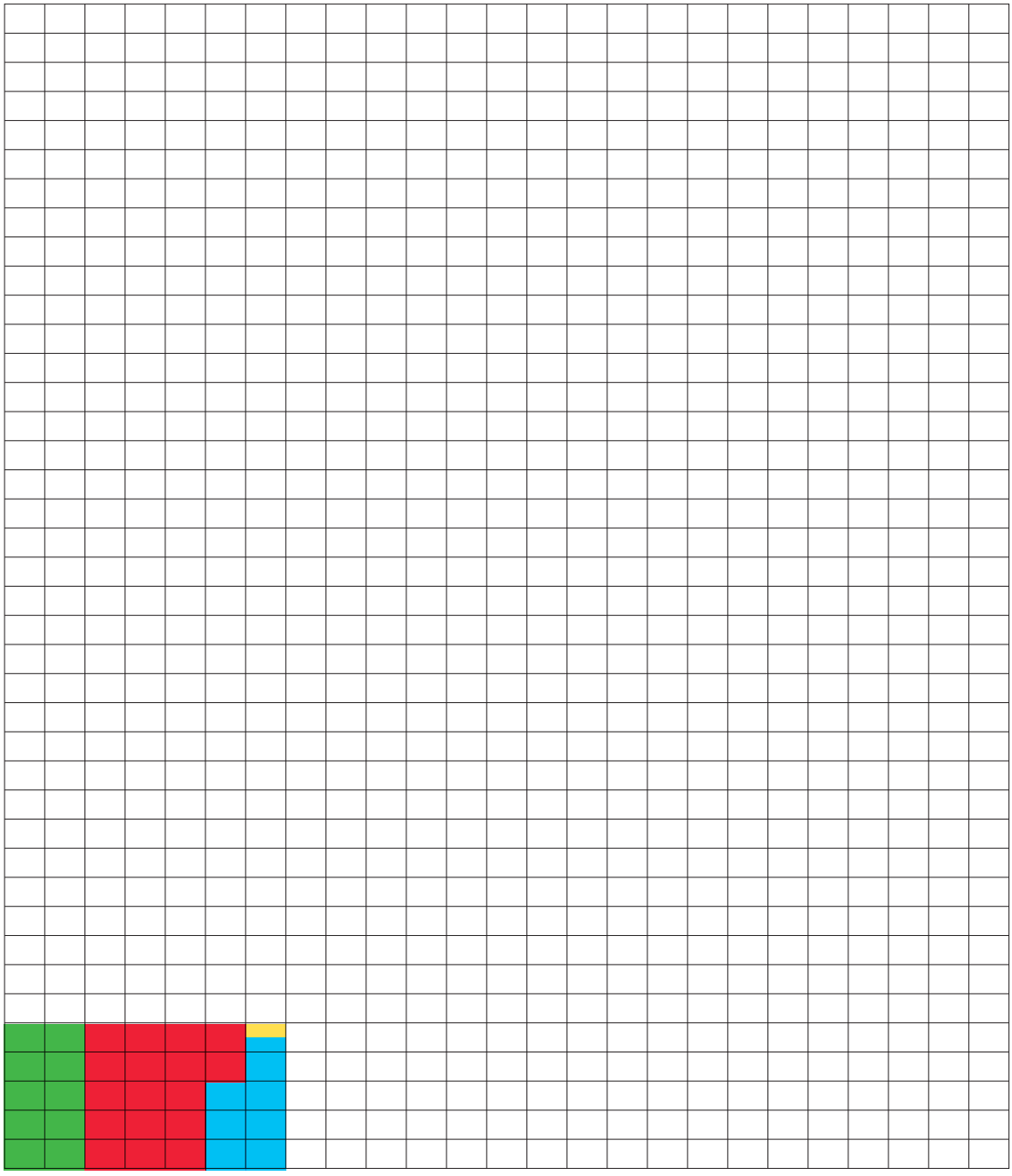
1,000 Squares = Total Global Water



Use the table on **Student Sheet 1** to fill in the rest of the grid with the number of squares that represents water percentages around the globe. Color code water sources and create a key. Make sure to label each water source the percent of water it represents.

ANSWER KEY: WORLD'S WATER GRAPH

1,000 Squares = Total Global Water



frozen glaciers & ice caps (68% of freshwater, 17 squares)

groundwater (30% of freshwater, 7½ squares)

other saline (1% of total water, 10 squares)

other freshwater (2% of freshwater, ½ square)

oceans (96.5% of total water, 965 squares)

VISUALIZING EARTH'S WATER

The Earth is a watery place. But just how much water exists on, in, and above our planet? About 71% of the Earth's surface is covered by water, and oceans and other saline water account for about 97.5% of all Earth's water. Water also exists in rivers and lakes, ice caps and glaciers, the air as vapor, the ground as soil moisture and as aquifers, and even inside you and your dog.

Water never sits still. Thanks to the water cycle, our planet's water supply constantly moves from one place to another and from one form to another. Things on Earth would get pretty boring without the water cycle.

Here are a few ways to visualize or think about water on (and in) the Earth.

1) VISUALIZE THE FOLLOWING SITUATIONS:

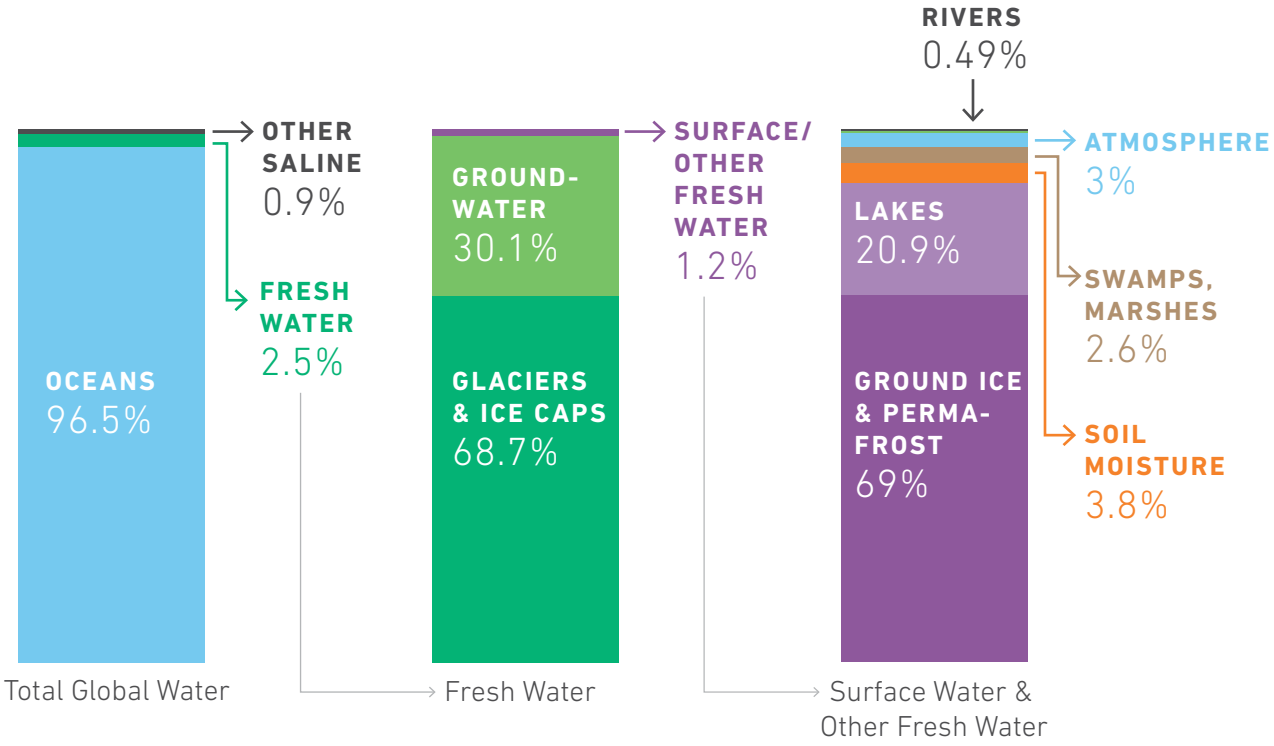
- If all of Earth's water (oceans, ice caps and glaciers, lakes, rivers, groundwater and water in the atmosphere) were put into a sphere, the diameter of that water ball would be about 860 miles, or 1,385 kilometers. That's a bit more than the distance between Denver to St. Louis, Missouri. The volume of all water would be about 332.5 million cubic miles (mi^3), or 1,386 million cubic kilometers (km^3). A cubic mile of water equals more than 1.1 trillion gallons. A cubic kilometer of water equals about 264 billion gallons.
- About 3,100 mi^3 (12,900 km^3) of water, mostly in the form of water vapor, is in the atmosphere at any one time. If it all fell as precipitation at once, Earth would be covered with only about 1 inch of water.
- The 48 contiguous (lower 48) U.S. states receive a total volume of about 4 mi^3 (17.7 km^3) of precipitation each day.
- Each day, 280 mi^3 (1,170 km^3) of water evaporate or transpire into the atmosphere.
- If all of the world's water were poured on the contiguous United States, it would cover the land to a depth of about 107 miles (145 kilometers).
- Of the fresh water on Earth, much more is stored in the ground than is available in lakes and rivers. More than 2 million mi^3 (8.4 million km^3) of fresh water can be found below the Earth's surface, most within the top one-half mile. But most fresh water is stored in the 7 million mi^3 (29.2 million km^3) of water found in glaciers and ice caps, mainly in the polar regions and in Greenland. This is generally unavailable for human use.

2) YOU CAN ALSO THINK ABOUT THE AVAILABILITY OF FRESH WATER IN THIS WAY:

The vast majority of the Earth's total water supply is saline (or too salty for humans to consume without treatment). Most of that saline water is located in oceans. Of the fresh water on Earth, most is locked away from humans in ice. Almost all the remaining fresh water is in the ground, and humans can tap into some of that. Surface water makes up the most of the remainder of the Earth's fresh supply. Rivers provide most of the surface water people across the Earth use, but they only constitute about 300 mi^3 (1,250 km^3). That's about 1/10,000 of one percent of planet's total water!

The table below gives a visual representation of where and how Earth's water is distributed.

WHERE IS EARTH'S WATER?



Source: Igor Shiklomanov's chapter "World freshwater resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guides to the World's Fresh Water Resources. NOTE: Numbers are rounded so percent summations may not add to 100.

3) VISUALIZE THE AVAILABILITY OF WATER LIKE THIS:

Source: watersaving.com/media/filer_public/2013/08/26/freshwater-on-earth.jpg