10. We can see that half our daily water usage goes towards producing our food. We are going to further explore food and water use in today's activity. Brainstorm with a partner: why do you think it takes a lot of water to produce food? (Q2 on datasheets)

Let's Explore! Create a Meal Activity

1. Divide students into groups of 3 or 4 and give each group one set of food cards, a plate and some scratch paper.
2. They have to pick 3 cards to create one balanced meal (either lunch or dinner). Tell students that a balanced meal should contain one entrée or main dish; and 2 side dishes.
3. Once they finish creating the meals, instruct them to flip over their food cards and explain that the numbers indicate how much water it took to produce that food.

   Teacher tip: *For elementary age students it helps to remind them what a gallon is by pointing to the 1 gallon container. Give a few examples to highlight the relationship between gallons of water and a portion of food: It takes 20 gallons of water to produce 1 orange or 70 gallons of water to produce 1 egg.*
4. Instruct students to fill out the Q3 table on their datasheets.
5. Call out for volunteers from each group to call out their food cards and their total water footprint values. Draw a table on the board for different groups' water footprints.

Group	Entrée	Side Dish #1	Side Dish #2	Total
A	Steak 346 g	Potato 23 g	Spinach 6 g	375 gallons
B				
C				
D				
E				

6. Display the chart with a two examples of a "typical" American meal (lunch / dinner). Tell students to play around with the cards and create "water conscious" meals - meals that are balanced, nutritious and use less water than the typical meals. Allow them to explore making different meals with the food cards (Q4).

   Teacher tip: *While they are exploring with the cards, remind students that their meal has to be healthy and balanced. They cannot have a meal that only has sides or only vegetables.*

Whole group discussion questions

a. Can you make a balanced nutritious meal that uses minimal amounts of water? (Q4a)

b. What patterns do you notice? Are there certain types of foods that take more or less water? (Q4b)

   Teacher tip: *You can ask students to make comparisons between animal-based foods such as beef, lamb, pork and plant-based foods such as beans, grains or vegetables. Refer to your food cards for specific examples and numbers. Meat generally tends to use more water than plant-*

based foods. Also different types of meats use different amounts of water – for example – beef use a lot more water than chicken).

c. Why do animal products like beef take more water than plant-based foods like grains? (*To produce food from animals like cows, pigs etc. water is needed to grow the animal's food, for the animal to drink and for cleaning and maintaining the farmhouse facilities; See Educator Background for detailed numbers on beef production)*

d. Droughts are becoming common in many places which can make it tough not only for humans but also for animals and wildlife. How do you think human food choices affect wildlife and their ability to survive? (Q5).

Wrap- Up

- Do a *Think-Pair-Share* with the students. Propose the questions below (or write them on the board). Students can *think* about it and turn to a partner *(pair)* to *share* their ideas.
  - What is one thing you would like to change about your food habits that will help you conserve water?
  - What are some ways we can continue to eat meat (or beef) and still conserve water *(meatless Mondays, meatless three days a week, substituting chicken for beef, consuming half the amount of beef every week, etc.)*
- Give students the "Take Action!" handout card. Encourage them to write down their pledge and conserve water by making one or more small changes to their diet. The card also has a list of foods with low, medium and high water footprint that students can share with their families, take with while they go grocery shopping or to a restaurant.
- Call out for volunteers from each group to share what they talked about with the entire class
- Ask students how they will celebrate their pledge success. Ex stickers on a chart for meals with low water ingredients, some sort of prize when a specific number of stickers have been accumulated.

Extensions

Droughts impact on animals

Have students explore how animals and plants are impacted by the drought. Have students look into how local animals use fresh water and how they are impacted by times of drought. If you live in an area that has experienced recent drought look for articles about how local animals responded for to the drought. Here are some sample articles from the California drought.

- http://america.aljazeera.com/articles/2014/2/18/drought-threatenscaliforniawildlife.html
- http://calwil.wordpress.com/2014/02/08/drought-and-the-impact-on-californias-wildlife/
- http://www.calacademy.org/sciencetoday/drought-hurting-animals-plants/5514104/

Where does your water come from?

Have students explore where your water comes from? Some possible questions for exploration could include: Is your water available mostly from local sources or is it delivered via infrastructure from far

away. Who else uses your local water source (Human, animal, or both)? Does your water come from an aquifer? What watershed are you located in? Is water availability seasonal?

Aquifer map of the United States https://water.usgs.gov/ogw/aquifer/map.html
You can find your local watershed here https://water.usgs.gov/wsc/map_index.html

Background for Educators

Fresh water is a vital but scarce resource on this planet. Although three-fourths of the Earth's surface is covered in water, more than 97% of this water is salty. Another 2.0 % is locked in glaciers, snow and ice. And that means only 1% is available as fresh water that we can use for drinking, cooking, growing food, and manufacturing products (Fry, 2005). With the world population increasing every year, water demand is just going to keep increasing unless we change how we use it. Scarcity of fresh, clean water affects nearly 2.7 billion people worldwide (Drinking Water and Sanitation, n.d.)

Average American Water Footprint

People use lots of fresh water for drinking, washing, cooking and watering lawns, but even more for producing food, clothes and electricity. The water footprint of a person is the total amount of fresh water used by that person every day. This includes direct and indirect water use. The average person in the United States has a water footprint of around 2000 gallons a day! Only 10% of this (~ 200 gallons) is our direct water footprint, i.e., water that we use for showering, cleaning, cooking and watering lawns. The remaining 90% (~ 1800 gallons) is our "hidden" or indirect water footprint – water that is used to produce the food that we eat, energy that we consume, and products that we buy (Water Footprint Calculator, n.d.).

Average American Water Consumption (per person per day)	
Home and personal use *(drinking, showering, flushing toilets, gardens, etc.)*	200 Gallons
Products *(clothes, electronics, furniture, etc.)*	200 Gallons
Energy *(production of gasoline, electricity)*	600 Gallons
Food production *(farming and food industry)*	1000 Gallons
Total	2000 Gallons

(https://water.usgs.gov/edu/qa-home-percapita.html)

Water Footprint of Food

As we can see above, a large proportion of fresh water is used for producing the food that we eat. On a national and global level, food production accounts for 50 to 70% of freshwater use (United Nations International Year of Water Cooperation: Facts and Figures, 2013). Much of this water goes towards animal agriculture i.e., raising farm animals for producing meat, dairy and eggs. If we intend to reduce our water footprint in a way that is impactful, then we should look critically at our diets in addition to our water use in the kitchen, bathroom, and garden.

Water footprint of any food item is the total volume of fresh water that goes into producing that food. It includes all the fresh water that goes into raising livestock, growing food crops, processing and transporting food (Hoekstra, 2008).

Raising farm animals for meat is generally more water-intensive than growing fruits, vegetables and grains (Mekonnen and Hoekstra, 2012; Hoekstra, 2012). Foods like steak, hamburgers, and ground meat come from cattle, and raising cattle takes a huge amount of water. Beef production is especially water intensive and here's why: A cow lives for around 3 to 5 years before it is slaughtered to produce approximately 450 pounds of boneless beef (on an average). It takes around 810,000 Gallons of fresh water to grow a single cow's lifetime's supply of food (alfalfa, grains, hay, pasture) and 6000 Gallons of water for the cow to drink during its lifetime. Add another 2000 gallons of water (per cow) for producing and transporting beef. That's a total of 818,000 gallons of water per cow to produce 450 pounds of beef, or 1800 gallons per pound of beef. And that's an average of 700 gallons of water per steak!! (Morelli, n.d.). By comparison, it takes around 100-200 gallons to produce high-quality plant-based proteins such as tofu, beans and legumes. So, one way to conserve water is to eat less beef! In general, the more plant-based foods we eat, the less water, fossil fuels and other precious natural resources we consume.

Cutting down on beef is not only better for the environment but also better for our health. Reducing meat and increasing plant-based foods (whole grains, legumes, leafy greens, fresh fruits, vegetables, and nuts) in our diets has many health benefits. Plant-based foods have been shown to prevent lifestyle diseases like obesity, diabetes, heart attacks, and cancer that are often associated with a high intake of meat, especially beef.

Drought and Water Crisis

Abnormally low rainfall can lead to drought and water crisis. These can affect both humans and wildlife. Drought has serious implications on urban water use, agriculture, as well as water available for plants and wildlife. For example in 2014 the San Diego Free Press highlighted the effects of the California Drought this way:

> *"The drought is hitting the farm industry and its workers particularly hard. The Central Valley, one of the world's richest food-producing regions, is up against what geologists are calling the 500-year drought. Fresno County, the heart of the Central Valley's San Joaquin Valley farm belt—and the number one farming county in the nation—may lose up to a quarter of its orchards and fields this year for lack of water. Growers in Shasta Valley were expected to have only enough water to irrigate what equals a single irrigation on about half of their acreage. The state's farmers will leave about 800,000 acres idle this year, according to estimates by the California Farm Water Coalition, which will negatively impact the state's entire economy. As a result, consumers can be expected to pay more at the grocery store for a wide range of staple foods. The Department of Agriculture warns that "major impacts from the drought in California have the potential to result in food price inflation above the historical average." (Weathers, 2014)*

A multitude of animals, birds, fish, reptiles, amphibians depend on fresh water for their very survival. During times of severe drought wildlife can die out in large numbers. For example, many species of the Pacific salmon migrate hundreds of miles upstream from the ocean to fresh water rivers and creeks during winter to lay their eggs. If the rivers and creeks are dry the salmon are stranded in the ocean unable to reproduce (Fimrite, 2014; Marois, 2014). Managing water so that there is enough for the different stakeholders is challenging, as illustrated by this quote from Aquafornia:

> *"Water is a limited resource; there is only so much of it to go around. Managing California's finite water supply in the future so that it is sustainable and reliable will require striking a balance between the three stakeholders: urban users, agricultural*

users, and the environment. As the state continues to grow, it's going to require rethinking how we view and use water throughout the state, and we're all going to have to be more efficient in how we use it." (Aquafornia, 2008)

To determine if your area is currently in a drought go to the US Drought Monitor from NOAA https://www.ncdc.noaa.gov/monitoring-content/sotc/drought/2017/08/20170829_usdm.png

Correlated NGSS Standards

Scientific & Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concept
•Developing and using models •Analyzing and interpreting data •Using mathematics and computational thinking •Designing solutions	(5-LS2-1) A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. **Organisms obtain gases, and water, from the environment.** (MS-LS2A) Organisms and populations are dependent on their environmental interactions both with other living things and with **nonliving factors**, any of which can limit their growth. (MS-LS2C) Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (HS-LS2A) Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem.	» Cause and effect » Systems and system models » Stability and change » Patterns

	(HS-LS2.C) If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state or become a very different ecosystem, depending on the complex set of interactions within the ecosystem.	

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