FutureWater Exercise Option 2: Would climate change reduce groundwater recharge?

Lesson Objectives:
Students will understand that groundwater is the water present under the Earth's surface in rocks and soil. They will use the data gathered from the FutureWater website to understand groundwater in their area, and how it affects their everyday lives. To demonstrate that they have learned these concepts, they will apply their knowledge in Part B to complete the activities.

Lesson Plan:
Below is an outline of how you can prepare for completing the worksheet.

1. Begin by individually writing down where you think your everyday water comes from.
2. Watch an informational video about groundwater and how it impacts the environment: https://youtu.be/oNWAerr_xEE
3. Come up with a definition for groundwater and how it might affect your everyday life.
4. Read about the definition and processes of aquifers and groundwater recharge: https://www.carleton.edu/departments/geol/links/alumcontributions/antinoro_03/smcwebsite/AquiferNRecharge.htm
5. Go to the FutureWater site and play around with the different features for a few minutes to get a feel for how the site works.
6. Follow the steps listed on the worksheet to begin answering the questions in Part A.
7. Write down your ideas about how the variations in groundwater recharge would affect your everyday life.
8. Complete Part B of the worksheet.

Student Worksheet

1. Define groundwater.
   Water available in the subsurface in the pore spaces of rocks and soil.

2. Discuss how groundwater is used in our everyday lives.
   - **Fresh water availability for drinking and other household use**
   - **Irrigation**
   - **Plant growth**

3. How does that relate to groundwater recharge?
   (Natural) groundwater recharge is the process of precipitation percolating through the soil to the aquifer. If water is withdrawn from the aquifer faster than it is replenished or recharged, the level of the aquifer will decrease.

A.

Step 1:

Go to futurewater.indiana.edu science gateway

Step 2:

Click on "Explore Model Forecasts"

Step 3:

Set **Variable** to Groundwater recharge and
Summary Period to annual

On the map, find and select the watershed that includes your town.
(At the upper-right corner, you can zoom in using your town's zip code.)

Answers are for the Jackson Creek-Clear Creek watershed in the Bloomington area.

Read the paragraph on the right side of the screen. Explain the difference between the two **Emissions Scenarios**. What does RCP stand for?

RCP stands for Representative Concentration Pathway. RCP is a greenhouse gas concentration trajectory. RCP 4.5 reflects a moderate greenhouse gas emission trajectory. RCP 8.5 reflects a high emission trajectory if the emissions continue to rise throughout the 21st century

Look at the plot on the lower right-hand portion of the page. What do the different sets of colors represent?

Different colors represent percent change from historical average groundwater recharge as projected by 10 different global climate models (GCMs).

Fill in the corresponding **% Change** for your watershed:

	2020s	2050s	2080s
RCP 4.5	-16.9	-10.3	-16.4
RCP 8.5	-13.6	-6.5	- 11.3

How do the different emissions scenarios impact groundwater recharge?

In the selected watershed percent change in groundwater recharge is greater under RCP 4.5 than RCP 8.5. That is to say less recharge is projected for RCP 4.5 than for RCP 8.5 for the Bloomington area. In most other watersheds in the Wabash basin, higher emission scenarios result in less groundwater recharge.

Teachers may want to use the Bloomington area data as a "teaching moment" for a few important science concepts. These data show spatial variability. Students can look at the color codes in the sub-basins in the Wabash basin in 2080s under RCP 4.5, and see an increase of groundwater recharge in northeast (blue), but severe decrease in the southwest of the basin. The climate impact on the region as whole is a sharp decrease of groundwater recharge.

Record a couple of ways that reductions in groundwater recharge would influence your everyday life.

1. Less availability of fresh drinking water from groundwater storage
2. Less availability of groundwater for irrigation purposes, which could lead to increased food prices.
3. Less availability of groundwater to recharge rivers, lakes, and streams. This could impact recreation and wildlife habitat.

B.

You have evaluated the annual data. Now, which months do you think would see the smallest and largest changes?

Using the **Ensemble Mean** from **2020s- RCP 4.5 data**, find the month with the smallest and largest percent change in Groundwater Recharge. Hint: You'll want to consider the absolute value of the numbers.

Smallest:_____February____________________

Largest:__October______________________

Fill in the corresponding months you found and fill in their data over the next 7 decades:

		2020s	2050s	2080s
Smallest	February	3.1	8.7	7.2
Largest	October	-72.6	-71.6	-77.7

How do these data compare to the annual summary period data from part **A**?

The annual values fall in between the February and October values. While the annual values are negative, they are much less negative than the October values.

Explain why the smallest and largest changes in groundwater recharge occur in the months they do.

Precipitation is projected to increase in January and February, leading to slightly increased recharge in February over baseline recharge rates. Precipitation is projected to decrease significantly in September and October, leading to decreased recharge in October compared to baseline October recharge. There are other hydrological processes that affect groundwater recharge, such as evapotranspiration. The numbers in the above table show the aggregated effects. Our mathematical model allows us to consider all these processes together.