**Human Impacts to the Water Cycle: The Colorado River**

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| **Grade(s):** *6,7,8* | **Topic:** Water Cycle | **Lesson #** 3 **in a series of** 3 **lessons** |
| **Brief Lesson Description**: Students will gain an appreciation of how humans can alter watersheds through a case study of the Colorado River Basin. | | |
| **Learning Outcome(s):**  Students are able to recognize human impacts to the water cycle (diversions, climate change, increasing population/consumption).  Students are able to interpret streamflow graphs and population curves. | | |
| **Background Information** | | |
| Students should have a basic appreciation of the water cycle and its stages, ideally having completed the first two lessons of this module (Water Cycle Jeopardy and Your Local Water Cycle). | | |
| **Science & Engineering Practices:**  *List up to three Science & Engineering Practices that students will engage in during this lesson.*  Developing and using models  Engaging in argument from evidence  Analyzing and interpreting data | **Disciplinary Core Ideas:**  *List up to three Disciplinary Core Ideas that are addressed in this lesson.*  (PS1) Matter and its interactions  (ESS2) Earth’s systems  (ESS3) Earth and Human Activity | **Crosscutting Concepts:**  *List up to three Crosscutting Concepts that are addressed in this lesson.*  Systems and system models  Scale, proportion, and quantity  Stability and change |
| **Possible Preconceptions/Misconceptions:** The amount of water on the planet is declining due to climate change. This statement is false. Climate change impacts the water cycle (precipitation patterns, temperature, etc.), but does not impact the amount of water on earth. | | |
| **LESSON PLAN** *This template uses the “5E” model to help with planning: Engage, Explore, Explain, Elaborate and Evaluate* | | |
| **ENGAGE**  The lesson begins with a broad warm up question: What are ways that humans can impact the flow of rivers? Students will have two minutes to think about this question, and have a brief 3-minute whole class discussion. | | |
| **EXPLORE Lesson Description**  Students will explore human impacts to the water cycle through a case study of the Colorado River.  Teachers should first introduce the Colorado River watershed to students. While projecting images onto a board (or screensharing via zoom), teachers should show the path of the Colorado River starting from its headwaters in the Rocky Mountains just northwest of Denver to its end at the Gulf of California in Mexico. Teachers should emphasize the states (Colorado, Utah, Arizona, Nevada, and California) and famous areas (e.g., Grand Canyon) the river flows through to make the activity relatable to students. Additionally, teachers should emphasize the importance of the Colorado to the entire United States, highlighting that the river is a source of water for over 40 million people.  Teachers should then organize students in pairs or groups of three to complete the worksheet-based investigation. For the investigation, students will need a worksheet and a figure packet (which contains streamflow graphs at 6 different locations along the river, and population graphs of major cities that depend on Colorado River water). While the investigation is primarily designed to be self-guided, teachers should introduce the first question to students by going over how to interpret graphs of streamflow. Emphasize that streamflow is an instantaneous measurement of how much water is moving through a river at any point in time (volume per unit time). Students will need to focus on average streamflow for the first question, so using Site 5 as an example, show students how to roughly estimate an average streamflow (for Site 5, ~8000 cfs). Students then can begin working in their small groups to estimate average streamflow for the remaining sites and begin completing questions. They should observe that the river grows in size as it flows into Arizona (Lees Ferry, Site 4), but decreases in size as it flows towards the US Mexico border (Site 6).  Teachers should monitor group progress throughout the duration of the activity. Students may need help identifying the “green areas” referred to in question 2, especially if the worksheet is printed in black and white. There’s an especially large area just south of the Salton Sea, and areas alongside the Colorado River. Teachers may want to highlight the path of the Colorado River in this image. The green areas are farmland areas in the Sonoran Desert, which are irrigated with diverted Colorado River water. Once most or all of the class has completed question 2, teachers can project a satellite image of the canal (32.705264, -115.126098) that transports Colorado River water ~80 miles west through desert to a large agricultural area south of the Salton Sea.  Once 10 minutes are remaining in the class period, teachers should bring the class together. Ask students if they expect the Colorado River to continuously flow from its headwaters all the way to the Gulf of Mexico based on what they have discovered. Mexico diverts nearly all of the remaining water in the Colorado River at the US Mexico border (canal coordinates given below). Emphasize that Mexico needs water for the exact same purposes (irrigation, drinking water, etc.) as the US but the river runs dry shortly beyond this point (coordinates given below). Teachers can project satellite images of these areas on Google Maps.  Canal coordinates: 32.706006, -114.729144  Dry riverbed coordinates: 32.555539, -114.797156  To conclude the lesson, highlight that water use is a complex issue, and that there is likely a balance to be struck. While it not good that humans divert so much water from the Colorado River that it eventually runs dry, humans also need water to grow crops and for municipal purposes (drinking water, etc.). It’s also important to highlight that the US is obligated to provide Mexico with a certain amount and quality of Colorado River water each year, and effects from climate change in the Western US (droughts) will make it more difficult for the US to satisfy their obligations to Mexico. This is a great jumping off point for a follow-up lesson (see below). | | |
| **EXPLAIN**  Drainage Basin: Any area of land where precipitation collects and drains into a common outlet  Irrigation: the supply of water to land to help with the growth of crops  Canal: a ditch constructed to transport water for irrigation  Agriculture: the practice of farming (animals or crops)  Diversion: removing water from natural flow paths or sources for commercial or private use  Cfs: cubic feet per second | | |
| **ELABORATE:**  A natural follow-up to this lesson would be a discussion on the issue of water rights (the concept of prior appropriation, allocating Colorado River water between states, international obligations to Mexico, etc.). There are some great options for lesson plans in the book: “Discover a Watershed: The Colorado” | | |
| **EVALUATE:**  **Formative Assessment:** Teachers can monitor student progress by attending to group conversations. This will help determine whether learning outcomes are being met, and also provides opportunities for teachers to clarify any points that students may be struggling with.  **Summative Assessment:** The report that the students turn in at the end of the activity will help the teacher assess whether the learning outcomes were met. | | |

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| **Materials Required for This Lesson/Activity** |
| *Insert any diagrams, handouts, pictures, or other materials that aren’t available online HERE.*  *Include any hyperlinks to online videos, maps and other resources in the “Explore” part of the lesson.*  *List any other materials, including quantity, potential supplier and price if it is significant.*  Lesson worksheet link: see word document on lesson webpage  Lesson figures link: see word document on lesson webpage  Google Maps link: [Google Maps](https://www.google.com/maps) |