

#5. Water Systems: Abundance & Availability

Summary: In this module you will learn how access to water has shaped past and present human populations.

Goals: By the end of this module you will be able to identify how freshwater availability is changing regionally and globally, water use patterns, causes and effects of drought, and sources of water conflicts.

Required readings:

(Review notes from Module 3's assigned reading re: water cycle and global distribution of different types of water. https://cnx.org/contents/F0Hv_Zza@45.1:yeVQResF@5/Water-Cycle-and-Fresh-Water-Supply)

Distribution of Water --

<https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf>

<https://gracefo.jpl.nasa.gov/news/131/nasa-satellites-reveal-major-shifts-in-global-freshwater/>

<https://www.drought.gov/drought/tribal-engagement-nidis>

Water Use Patterns –

U.S. Water Use Summary for 2015: <https://pubs.er.usgs.gov/publication/cir1441>

Hordon, Robert. 2011. "Ancient Water Systems and Hydraulic Devices" in *AWRA Impact*. Nov, 2011. See pages 3 – 5 in this journal: <https://aquadoc.typepad.com/files/24669-awra-novimpact.pdf>

Adaptation to **climate change impacts on water** demand

[PDF] academia.edu

X Wang, J Zhang, S Shahid, E Guan, Y Wu... - ... for *Global Change*, 2016 - Springer
Research on **climate change impacts** and related adaptation to **water** demand is still very limited. A review summarising the findings related to **climate change impacts on water** demand is carried out in this article. A **water** management strategy is also proposed, which ...

Note: available via search on GoogleScholar and other sites.

Water Conflicts --

<https://www.ag.ndsu.edu/ndwaterlaw/acquiringwater/easternlaw/ripariandoctrine>

<https://www.ag.ndsu.edu/ndwaterlaw/acquiringwater/westernlaw> (all 6 sub-pages)

<https://www.ag.ndsu.edu/ndwaterlaw/international-water-issues>

<https://www.ag.ndsu.edu/ndwaterlaw/acquiringwater/interstatesolutions>

"Tribal Water Rights: The West's Last Big Bucket of Water" p. 20 in this journal:

<https://aquadoc.typepad.com/files/24669-awra-novimpact.pdf>

Supplemental Content (review in class or assign directly):

https://www.ted.com/talks/scott_gass_how_big_is_the_ocean TED Ed talk by Scott Gass (Educator) -- water distribution topic

https://www.ted.com/talks/anupam_mishra_the_ancient_ingenuity_of_water_harvesting TED talk by Anupam Mishra (Environmental Activist) – water use in dry climates

https://www.usgs.gov/mission-areas/water-resources/science/water-use-united-states?qt-science_center_objects=0#qt-science_center_objects

Review of past water conflicts around the world: <http://www.worldwater.org/conflict/list/>

Key Vocabulary: unsaturated zone, saturated zone, capillary fringe, inflow, outflow, hydraulic conductivity, flow path, hydraulic head, water budget, equilibrium, meteorological drought, agricultural drought, hydrologic drought, subsidence, gaining stream, losing stream, sole source aquifer, saltwater intrusion, acre-foot, irrigation, riparian doctrine, doctrine of prior appropriation

Assessment Tools:

Quiz: This relevant site has 2 quizzes, questionnaires, and opinion surveys, any of which can be used for assessment or class discussion <https://water.usgs.gov/edu/activity-watercontent.html>

Data Interpretation Exercises (based upon data presented in assigned reading [USGS Circular 1441](#)):

- 1) Use data in Table 1 to determine the per capita value for each state's withdrawals (in Mgd) for total groundwater and surface water withdrawals. List the states in order from lowest to highest per capita groundwater withdrawal and again for surface water withdrawal. Do you note any trends?
- 2) Next, group these same per capita data by those states where water use is determined by the riparian doctrine vs those using the doctrine of prior appropriation. For each of these 2 groups report the Min, Max and Mean per capita withdrawal of both surface water and groundwater. Is there a difference in use?
- 3) Using the population data in Table 1 and the Water Use data in Table 2A, determine the per capita freshwater use for each of 5 states in the Northeast US (NY, NJ, PA, CT, MD) and 5 states in the Southwest (CA, NV, AZ, NM, UT) for each of the 8 water use categories. Discuss trends and patterns.

Discussion Questions (can be used in classroom or for on-line discussion board):

- What are the largest “users” of water in the U.S.? and why?
- Several of the assigned readings identified measures that can be taken to avoid/minimize water shortages. Which ones do you think show promise for application in your region? Why?
- What water conflicts exist in our community? Why? What is being done to address them?
- Would the Doctrine of Prior Appropriation be an effective way to manage availability of groundwater resources? Why or why not?
- Some people argue that future wars will be fought over access to water. What do you think?

Short Essay: Write the back-story for one of the images in the TED water gallery found at <https://ideas.ted.com/edward-burtynsky-gallery/>. Include a copy of the photo with your write-up. Provide complete citations for the sources used to obtain information for your back-story.

Thought Map: Prepare a thought map on fight undertaken by the Confederated Tribes of the Yakama Nation to preserve their right to harvest fish in their accustomed waters, maintain healthy populations of fish, and adjudicate their rights to surface waters on their land. One method for preparing a thought map can be found here: <https://www2.le.ac.uk/offices/ld/all-resources/study/thought-mapping>. Use the phrase “Yakama Water Rights” for the center of your map. Add at least 3 factors that you think contributed substantially to the outcome (e.g. Winters vs U.S., Off-Res water, Fish Runs, Traditional Ways, Instream Flows, or others). The following resources might be useful for helping you understand the issues, but you do not have to limit your background research to them.

<https://www.uidaho.edu/-/media/UIDaho-Responsive/Files/law/law-review/articles/volume-48/48-3-bilodeau-katherym-a.pdf?la=en&hash=3A869A4F114777B3CAF7319D20ACE41BB61B50D9>

<https://www.ag.ndsu.edu/ndwaterlaw/acquiringwater/federal-reserved-tribal-water-rights>

<https://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/2017meetings/09202017/3acquavellaYBIPAdjudication.pdf>

Module 5 Lab Activity – Evaluating Drought Patterns in Your Community

Prepare a report that summarizes: 1) drought conditions in your community over the past year, and 2) the drought forecast for your community in the coming year. Use at least 5 separate lines of evidence to support each summary.

<https://www.drought.gov/drought/>

<https://www.usgs.gov/products/data-and-tools/real-time-data/droughts>

Alternate Module 5 Lab Activity -- Estimating Personal Water Footprint

Write down everything you eat and drink for 3 days. Calculate the daily water footprint of your diet using the calculator found at: <https://waterfootprint.org/en/> Using that same calculator, prepare a 3-day meal plan (include snacks and beverages) that would reduce the diet-portion of your water footprint by 50%. Write a 2-5 page summary of what you learned in this exercise.

Alternate Module 5 Lab Activity – Irrigation Plan for Crop Field

Pretend that you wish to raise alfalfa on an 80-acre field near your home to feed your cattle. Let's assume water availability is no problem & you have a grant to cover the cost of equipment purchase, but you need to be somewhat careful about costs of system operation since that must come out of your own pocket. Prepare an irrigation plan that covers system selection/design, planting time & cutting frequency, watering frequency, and water application rates. Use weather data from an average year to determine first and last frost dates, average daily temperatures and rainfall during the growing season, etc. Identify the soil type at your site using the NRCS websoil mapping tool (<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>). You may find it helpful to speak with an Ag Extension agent in your area to get more information about this topic. In addition, these resources may also be useful.

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_033068.pdf

<https://extensionpublications.unl.edu/assets/pdf/ec2009.pdf>

<http://www.fao.org/3/S2022E/s2022e00.htm#Contents>