

EXAMPLE PHENOMENA

(Audience: formal and non-formal educators)

The following section contains examples of phenomena and case studies for potential use in Colorado curriculum. This includes considerations for locally and culturally-relevant phenomena. While many more resources exist, we added some initial resources on where to find more water phenomena, including images, video links, data links, news article links, etc.

The goal of these examples is to provide compelling anchor phenomena that could engage students from a variety of backgrounds at the beginning of a lesson or unit of study. These Colorado-specific examples could also be used in an assessment at the end of a unit. These are examples that could spark teacher/administrator interest in identifying locally-relevant water phenomena for their students.

The identification of example phenomena was a learning process as the task force discussed the most effective way to define, brainstorm and show results from the task of identifying example phenomena. Individual task force members contributed phenomena and case studies based on their expertise and interests. In addition, these examples include input from Water Education Colorado staff. These examples should be considered a first step with more work to build out this resource with support from the Water Educator Network and water educators from around the state.

Definition of Phenomena (from Colorado Department of Education):

Local, community-related phenomena engage students and make science meaningful, preparing students for life beyond school in college, in careers, and as citizens. A good phenomenon often has no one right answer, but is a specific event or connection within the natural or designed world, ideally that students can directly experience.

Consider:

- How do our example phenomena tell a bigger story?
- Whose story are we telling?
- In what ways does local and indigenous culture interact with water that should be highlighted?
- Are we considering and elevating history?
- How and when we introduce different topics (e.g. climate change)?
 - There are students, including very young students, who are living the reality every day (water scarcity, lack of access to water, poor water quality, impacts of climate change, etc.). These can be introduced earlier, but how they are introduced is important.

Example Phenomena and Case Studies by Critical Water Concept

CWC.I. The physical and chemical properties of water are unique and constant.		
Example Phenomena and Case Studies	Example Objective (with GLE) <i>[see more objectives in Figures 7 and 8]</i>	Links or Other Resources
Ice dams breaking in spring	Use senses to explore the properties of water by investigating changes in liquid water and solid ice when water is heated, cooled, combined etc. (SC.P.1.1)	https://youtu.be/F6_LRjBHGSU https://youtu.be/P2Oq9e2ll1o
Place where water and wind went wild: Grottos, Paint Mines, Wheeler Geologic Area Local erosion (find a nearby spot with obvious water damage to soils)	Develop a model to demonstrate how water can change the shape of land. (SC.2.3.2)	  
Aerial photos and drone footage of canyons and floodplains	Construct an explanation based on evidence for water's role in how geoscience processes have changed Earth's surface at varying time and spatial scales. (SC.MS.3.6)	https://www.moxiecranmedia.com/uploads/8/9/6/5/8965616/riogrande-june-19-2.jpg https://www.nps.gov/grca/learn/photosmultimedia/b-roll_hd08.htm https://vimeo.com/356739699

Above suggestions plus Flooding - before and after shots (2013, 1965, 1933, 1864)

Construct an argument from evidence of how the properties of water and its effects on Earth materials and surface processes may alter dynamics within an ecosystem. (SC.HS.3.6)

Headwaters Magazine Summer 2014: [Flooded](#).

https://5008.sydneyplus.com/HistoryColoradoArgusNet_Final/Portal/portal.aspx?lang=en-US&p_AAEZ=tab2



https://5008.sydneyplus.com/HistoryColoradoArgusNet_Final/Portal/portal.aspx?lang=en-US&p_AAEZ=tab2



<https://www.westword.com/news/the-1965-flood-how-denvers-greatest-disaster-changed-the-city-6668119>

CWC.II. Water is essential for life, our economy, and a key component of healthy ecosystems.

Example Phenomena and Case Studies	Example Objective (with GLE) <i>[see more objectives in Figures 7 and 8]</i>	Links or Other Resources
<p>Side-by-side images of a dryland farm and flood-irrigated farm (or xeriscape and irrigated lawn) or crop circles and dry land.</p>	<p>Discuss how communities allocate water resources so that all members have access. (SS.2.2.2)</p> <p>Analyze how people use geographic factors in creating settlements and have adapted to and modified the local physical environment in order to use water resources through the development of irrigation ditches, acequias, and hard-rock mining. (SS.4.2.2)</p> <p>Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (SC.HS.3.9)</p>	<p>Northern Water's Conservation Gardens:</p>  <p>To juxtapose local images, consider using collage maker websites, e.g.: https://www.kapwing.com/explore/side-by-side-collage-maker Or photo comparison slider website, e.g.: https://codyhouse.co/gem/css-jquery-image-comparison-slider</p>
<p>Water tiger found in a stormwater outfall</p>	<p>Describe how habitats provide for the basic needs of plants and animals, including water, to grow and survive by observing a familiar living things (e.g. a classroom garden or classroom pet).</p>	<p>https://drive.google.com/file/d/1-d97oBUeALAp_alzblHFv_UcjQzpBAab/view?usp=sharing</p>

CWC.III. Water is a scarce resource, limited and variable.

Example Phenomena and Case Studies	Example Objective (with GLE) <i>[see more objectives in Figures 7 and 8]</i>	Links or Other Resources
Time series of snowpack in Colorado	Describe how the geography of Colorado and Western states differ from other regions of the United States, including the role of snowpack as the main source of water, versus the eastern region which depends on rainfall. (SS.4.2.1)	https://satelliteliaisonblog.com/wp-content/uploads/2019/03/2018_2019_modis_trend.gif
Measuring precipitation (CoCoRahs)	Construct an argument for how the quantity of water available for plants, animals, and humans varies by major river basin in Colorado and within river basins has resulted in similarities and differences seen today. (SS.3.2.2)	https://www.cocorahs.org/
Images of the Dust Bowl in Colorado	<p>Explain how communities manage and use scarce freshwater resources and certain nonrenewable groundwater sources. (SS.2.2.2)</p> <p>Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (SC.HS.3.9)</p>	 <p>Source: Headwaters Magazine, Spring 2019</p>



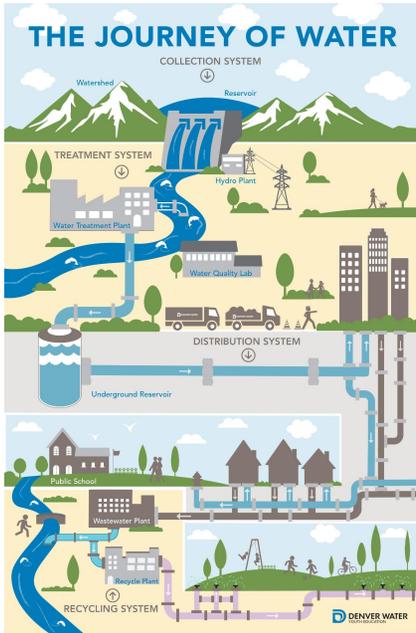
<p>Video of the Colorado River and the many demands on this scarce resource. The first half of the video describes how many people and places rely on the Colorado.</p> <p>Storymaps that investigate the Colorado River.</p>	<p>Explain scarcity by giving examples of behaviors related to water and limited water (i.e., water restrictions). (SS.2.3.1) Determine the opportunity cost of different water allocation scenarios in Colorado. (SS.4.3.2)</p> <p>Analyze how people use geographic factors in creating settlements and have adapted to and modified the local physical environment in order to use water resources through the development of irrigation ditches, acequias, and hard-rock mining. (SS.4.2.2)</p> <p>Identify, evaluate, and communicate strategies to respond to constraints placed on human systems by analyzing the scarcity and variability in available water resources in Colorado. (SS.HS.2.2)</p> <p>Explain the economic way of thinking: the condition of scarcity requires choice and choice has a cost (opportunity cost) by using Colorado's water resources as an example. (SS.HS.3.1)</p>	<p>Video: https://www.youtube.com/watch?v=mqYcC7jEe44</p> <p>Storymaps, e.g. The Hardest Working River in the West: https://storymaps.arcgis.com/stories/2efeafc8613440dba5b56cb83cd790ba?fbclid=IwAR1QxljetGs1vdLtPnOdhrEcOMFIJNjxmuntQ9sc1ljhN-hJHZnnM3M9lw</p>
<p>What happened to the people of Mesa Verde? <i>(and other regional water stories in Colorado)</i></p>	<p>Explain, through multiple perspectives, how water use in each region have shaped the settlement of the state by using examples from American Indians, Spanish explorers, trappers/traders, and settlers in the mining, trading, agriculture, and industrial industries. (SS.4.1.1)</p>	<p>Citizen's Guide to Colorado Water Heritage "Harvesting Water" <i>(and other primary and secondary sources)</i></p> <p><i>From the same Citizen's Guide see also: "Sin Agua no hay vida" and "Mingled Waters"</i></p>



<p>Where are families and communities experiencing water scarcity in Colorado and nearby?</p>	<p>Explain how communities manage and use scarce freshwater resources and certain nonrenewable groundwater sources (SS.2.2.2)</p>	<p>Roxborough Water and Sanitation District here - <i>it has enough water to supply only another 124 homes</i></p> <p>Front Range housing boom sends water prices soaring (Arvada - <i>Arvada is close to maxing out its water supplies</i>).</p> <p>Hauling water in La Plata County - <i>In a La Plata district, 25 percent of residents have had to haul water.</i></p> <p>Modern-day communal well in Ignacio: <i>Freshwater News</i> article</p> <p>Hauling water in the Navajo Nation.</p>
<p>What are some stories of water reuse that inspire hope?</p>	<p>Explain how communities manage and use scarce freshwater resources and certain nonrenewable groundwater sources. (SS.2.3.1)</p> <p>Explain how the uneven distribution of limited and variable water resources in the world can lead to conflict, competition, or cooperation among nations, regions, and cultural groups. (SS.HS.2.3)</p>	<p>WISE approach - effective way of making water go much further.</p> <p>Innovative use of water Denver developments: Use of greywater in Central Park Neighborhood</p>

CWC.IV Water cycles naturally through Colorado’s watersheds, often intercepted and manipulated through an extensive infrastructure system built by people.

Example Phenomena and Case Studies	Example Objective <i>[see more objectives in Figures 7 and 8]</i>	Links or Other Resources
<p>Historical images of different examples of humans modifying their environment in Colorado. Mesa Verde, People’s Ditch in San Luis Valley, CO-Big Thompson Project, etc.</p>	<ol style="list-style-type: none"> 1. Explain that people settle in certain areas because of the need to access freshwater. 2. Explain how access to freshwater affects a community’s ability to thrive. 3. Identify examples of how water draws people and wildlife to particular areas. (SS.2.2.2) 	<p>https://waterknowledge.colostate.edu/water-history/</p>
<p>Grand Valley Ditch, including the story of immigrant/migrant labor (Japanese and Mexican laborers) <i>Note: Grand Valley Ditch is a good hike for kids, too.</i></p>	<p>Explain how altering the environment by altering water supplies has brought prosperity to some places and created environmental dilemmas for others by examining differences between tribal nations and nontribal communities, consequences of poverty on access to clean drinking water, rural versus urban access to water, immigration/settlement and its impact on access to water resources, etc.). (SS.HS.2.2)</p> <p>Give examples of professions/jobs in the local community where individuals help plan, build and maintain water infrastructure. (SS.1.3.1)</p>	<p>https://publiclands.colostate.edu/digital_projects/dp/poudre-river/moving-storing/ditches-dams-diversions/grand-river-ditch/</p> <p>High Country News: Water Across the Divide</p>

<p>Use a pedal to pump water (“It takes work” - collaborative)</p>	<p>Design, build, and refine a device that models a watershed or municipal drinking water system to convert one form of energy into another form of energy. (SC.HS.1.9)</p> <p>Develop a model illustrating how energy (e.g. the sun and gravity) is exchanged to power the water cycle and move water from one location to another. (SC.MS.1.6)</p>	<p>https://www.denverwater.org/tap/craftsmen-pedal-journey-of-water-to-schoolkids</p>
<p>Students draw what it takes for drinking water to get to them, then see a real water system map.</p>	<p>Discuss how water contributes to the interaction of a community with their environment. (SS.2.2.2)</p> <p>Use maps to trace the paths of rivers and streams to the oceans and to identify where man made structures (cities, etc.) are located in relation to natural features. (SS.1.2.1)</p>	 <p>The infographic, titled "THE JOURNEY OF WATER", illustrates the water cycle through several stages: <ul style="list-style-type: none"> Watershed: Shows mountains, a reservoir, and a dam. COLLECTION SYSTEM: Water flows from the reservoir through a dam into a river. TREATMENT SYSTEM: Water passes through a hydro plant, a water treatment plant, and a water quality lab. DISTRIBUTION SYSTEM: Water is transported via pipes to an underground reservoir, then to a public school and a wastewater plant. RECYCLING SYSTEM: Water is recycled through a recycling plant and back into the environment. The Denver Water logo is visible in the bottom right corner of the infographic. </p> <p>Example: Denver Water Education Poster Citizen’s Guide to Where Your Water Comes From (HS-level resource)</p>

CWC.V. The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.

Example Phenomena and Case Studies	Example Objective <i>[see more objectives in Figures 7 and 8]</i>	Links or Other Resources
<p>Colorado’s variable geology, hydrology and climate have created distinct differences in water availability and crops grown. Students can investigate the maps to find trends between geologic features and how we have utilized the land and water.</p>	<p>Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (SC.HS.3.9)</p>	<ol style="list-style-type: none"> 1. Colorado water source distribution 2. Colorado Cropland Map or https://nassgeodata.gmu.edu/CropScape/ 3. https://efotg.sc.egov.usda.gov/references/public/CO/CMZPrecip_1981_2010.pdf or 4. Storymap of the Gunnison River: https://storymaps.arcgis.com/stories/196d3c8b23624530b1d7b3ff9935f258
<p>This video highlights how land cover and management (particularly fire mitigation) impact water quality and quantity. Fire causes rapid land changes and has big consequences for water users. Students can use this as a jumping off point for how natural phenomena (drought, fire, disease) impact each other and who is most vulnerable.</p>	<p>Analyze geoscience data to make the claim that one change to Earth’s surface (loss of ground vegetation from fire, flood, aridification, etc.) can create feedbacks that cause changes to other Earth systems (increase in water runoff and soil erosion). (SC.HS.3.7 and SC.HS.3.4)</p>	<p>https://vimeo.com/406250886</p>
<p>NASA Images of Change as seen from space.</p>	<p><i>See example objective above</i> (SC.HS.3.7 and SC.HS.3.4)</p>	<p>Arapaho Glacier (up to 2003) https://climate.nasa.gov/images-of-change/?id=556#556-arapaho-glacier-melt-colorado Snow drought in the Rockies (2016 vs. 2018) https://climate.nasa.gov/images-of-change/?id=640#640-snow-drought-in-the-southern-rockies San Luis Valley stream change (1987-2011) https://climate.nasa.gov/images-of-change/?id=470#470-san-luis-valley-stream-change-colorado</p>

<p>Picture/video of youth involved in a stream or wetland restoration project.</p>	<p>Discuss how water contributes to the interaction of a community with their environment. (SS.2.2.2)</p>	<p>Fountain Creek Week</p>
<p>Two Forks Dam: “For most of the 19th-century dam construction was the dominant solution to water issues in the United States. But in 1990 the Environmental Protection Agency vetoed the construction of the Two Forks dam, solidifying a decline in major dam construction that began with the enforcement of EPA and Clean Water Act standards. The Two Forks project was for a 539-foot reservoir to be built in the pristine Cheesman Canyon located at the confluence of the north and south forks of the South Platte River.”</p>	<p>Analyze how cooperation and conflict influence the division and control of Earth by using examples from the development of Colorado's extensive water infrastructure and management systems. (SS.HS.2.3)</p> <p>Identify physical water features (e.g. transbasin diversions, irrigation canals and mountain snowpack) and the positive and negative impacts on human systems in different regions. (SS.6.2.2)</p> <p>Engage in civil discourse regarding balanced water solutions by discussing how current water issues demonstrate that the sustainability of water in quality and quantity is essential for life and our economy. (SS.HS.4.1)</p>	 <p>Two Forks Retrospective (audio)</p> <p>[Other examples around the state found in Citizen's Guide to the Environmental Era, HEADWATERS Winter 2016 or other source]</p>
<p>Algal growth in a reservoir or nearby lake (cyanobacteria)</p>	<p>Design, evaluate, and refine a solution for reducing the impacts of human activities on water, the environment and biodiversity (including urbanization, building dams, and dissemination of invasive species). (SC.HS.2.6)</p>	<p>https://www.watereducationcolorado.org/fresh-water-news/in-brief-high-temperatures-toxic-algae-killing-fish-in-denver-metro-area/</p>

CWC.VI. Water is a public resource governed by water law.

Example Phenomena, Case Studies, and/or Introductory Activities	Example Objective <i>[see more objectives in Figures 7 and 8]</i>	Links or Other Resources
<p>Lake Nighthorse - the work is not yet done to fulfill tribal water rights.</p> <p>Specific environmental justice-related magazine or newspaper articles.</p>	<p>Research and interpret multiple viewpoints on issues that shape policies and programs for water resource use and explain how the management of water supplies has brought prosperity to some places and created environmental dilemmas for others by examining Colorado examples (e.g. differences between tribal nations and nontribal communities, consequences of poverty on access to clean drinking water, rural versus urban access to water, immigration/settlement and its impact on access to water resources, etc.). (SS.HS.2.2)</p>	<p>“Ute Water” (HEADWATERS)</p> <p>Animas-La Plata Project</p> <p>Article from Durango Herald</p> <p>“When Water Justice is Absent, Communities Speak Up” (HEADWATERS)</p> <p>“Plumbing Poverty” (HEADWATERS)</p>
<p>Image of “sweeping” the river - a senior water right holder may have the right to divert the <u>entire</u> flow of a stream or river at a specific location.</p>	<p><i>See example objective above</i> (SS.HS.2.2)</p>	 <p><i>Burlington Ditch sweeping the South Platte River</i></p>



<p>Miners using water (using water to make money!)</p>	<p><i>See example objective above</i> (SS.HS.2.2)</p>	<p>The story of John Hamilton Gregory. He searched the creeks, rivers, and streams of the Front Range and eventually found gold in what is now Gilpin County:</p> <p>https://www.coloradohistoricnewspapers.org/?a=d&d=STP19430211.2.106&e=-----en-20--1--img-txIN%7ctxCO%7ctxTA-----0-----</p> <p>This article talks about the sluice method of mining, which is what Gregory used: https://www.unco.edu/hewit/doing-history/pdf/essays/miners.pdf</p>
<p>Early conflict between Greeley and Fort Collins over water. Greeley (downstream) was cut off from water by a new diversion for Fort Collins (upstream). The downstream user advocated for rights that the upstream user had impaired.</p>	<p>Analyze how cooperation and conflict influence the division and control of Earth by using examples of Colorado's water administration and treaties/interstate compacts over water resources as an example. (SS.HS.2.3)</p>	<p>Water War and Law (Cache La Poudre National Heritage Area)</p>
<p>Role-play activity</p>	<p><i>See example objective above</i> (SS.HS.2.3)</p>	<p>Example: H2O Outdoors at Keystone Science School: https://www.watereducationcolorado.org/publications-and-radio/headwaters-magazine/8030-2/nextgen-collaborators/</p>



<p>What does a boat ramp have to do with having enough water for fish? The genesis of instream water rights.</p> <p>Additional introductory activity: "Pass the Jug," Project WET Curriculum and Activity Guide 2.0</p>	<p><i>See example objective above (SS.HS.2.3)</i></p>	<p>Technical resources:</p> <p>https://www.watereducationcolorado.org/fresh-water-news/bill-to-expand-colorados-innovative-instream-flow-program-advances/</p> <p>https://cwcb.colorado.gov/focus-areas/ecosystem-health/instream-flow-program</p> <p>https://www.americanrivers.org/2020/04/we-are-rivers-episode-24-understanding-colorados-instream-flow-program/</p> <p>Activity Idea: "Pass the Jug," Project WET Curriculum and Activity Guide 2.0</p>
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