



Version 1: 100th Anniversary of the Colorado River Compact

The Colorado River Compact, signed in 1922, is a historical document that is the foundation for legislation on the Colorado River.

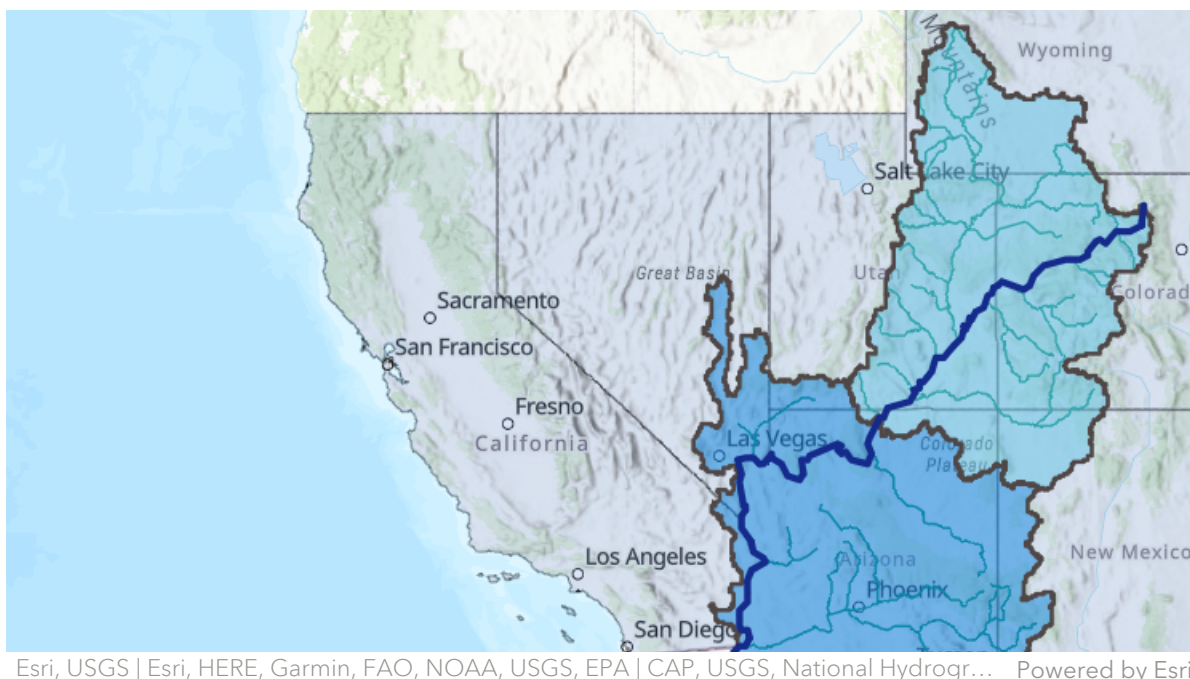
Aislin Hanscom, Camille McDonnell, Michael Morin, Finbarr O'Sullivan
May 2, 2022

The Colorado River provides water for more than 40 million people, hundreds of species of wildlife, irrigation for more than three million acres of farmland, and generates power for more than a million homes. At the heart of the management of the Colorado River lies the Colorado River Compact. This document was created in 1922 in response to industrial, agricultural, and residential development demands and conflicts over water allocation between each of the seven Colorado River Basin states. The legislation established a water allocation system, encouraged states to collaborate on water decision-making, and led to the development of reservoirs and dams. Even though the document was innovative for its time, from today's perspective, it has many shortcomings. Chief among them is

that the Colorado River Compact failed to include Native Americans in the allocations and could not foresee population growth or climate change impacts.

The Colorado River Compact established key water management strategies to guide various forms of development in the West, including dividing the river into two basins, the Upper and Lower Basins. The Compact also allocated set amounts of water to each basin, which ultimately paved the way for the construction of several dams and reservoirs to manage water in the Southwestern U.S. The division of the basins was made at Lee's Ferry, Arizona, below Glen Canyon Dam in Northern Arizona, as this was an accessible area around the middle of the river.

The Upper Basin consists of the parts of Arizona, Colorado, New Mexico, Utah, and Wyoming above Lee's Ferry where the Colorado River naturally drains, and the Lower Basin consists of the parts of Arizona, California, Nevada, New Mexico, and Utah below Lee's Ferry where the Colorado River naturally drains. Additionally, the Colorado River Compact was the turning point for the governance of the Colorado River because it led to the "Law of the River", a compilation of legislation and court cases that dictate the management of the river today.

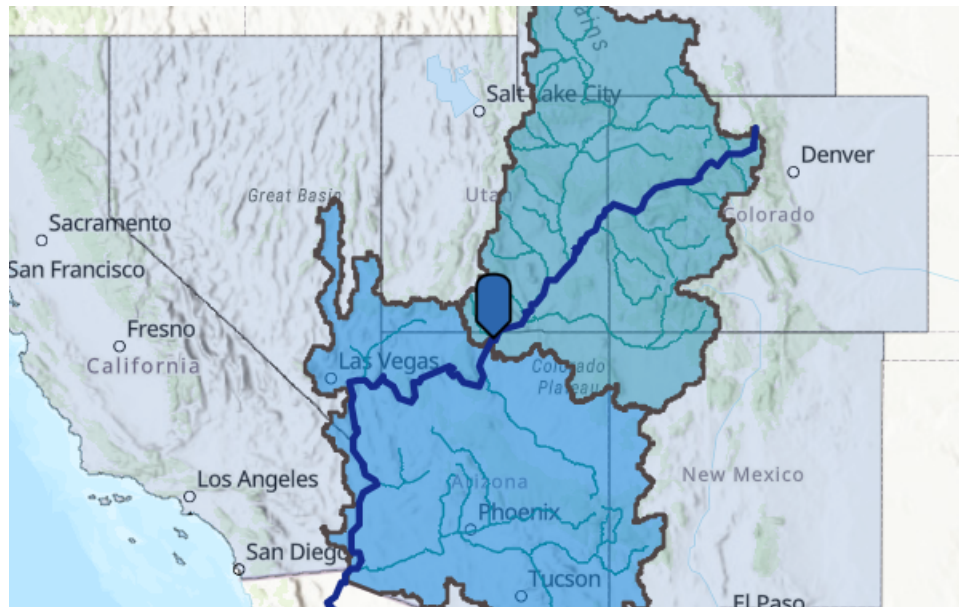


The Colorado River Basin.

Each basin is allocated 7.5 million acre-feet (maf) of water per year, with the Lower Basin granted the right to increase its maximum yearly allocation by 1maf of water for a total of 8.5maf as needed on a year-by-year basis (Colorado River Commission & Hoover, 1922). To put these numbers into perspective, one maf is “equivalent to a flow of 890 million gallons per day” or “enough water to satisfy the household needs of 6.7 million [people]” (Cooley et al., 2010).



Division between the Upper and Lower Basin.

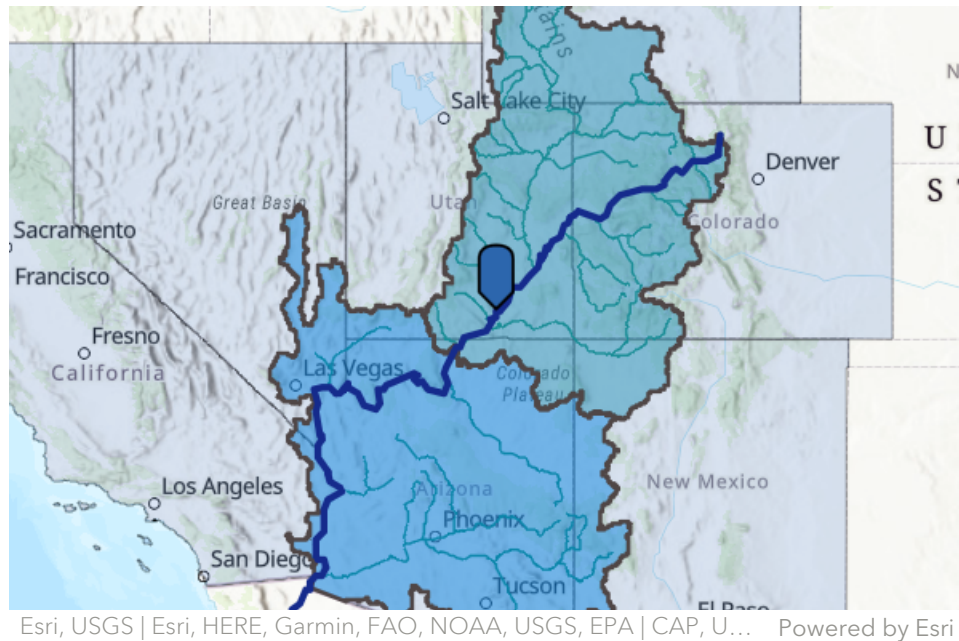


Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS, EPA | CAP, U... Powered by Esri

Lees Ferry on the Colorado River.



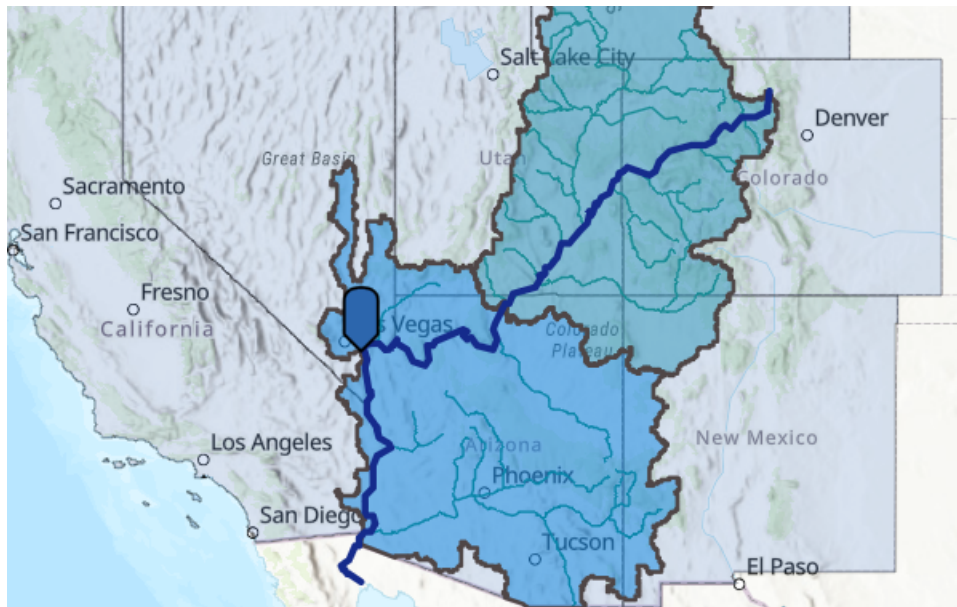
Upper Basin Reservoir.



Lake Powell on the Colorado River.



Lower Basin Reservoir.

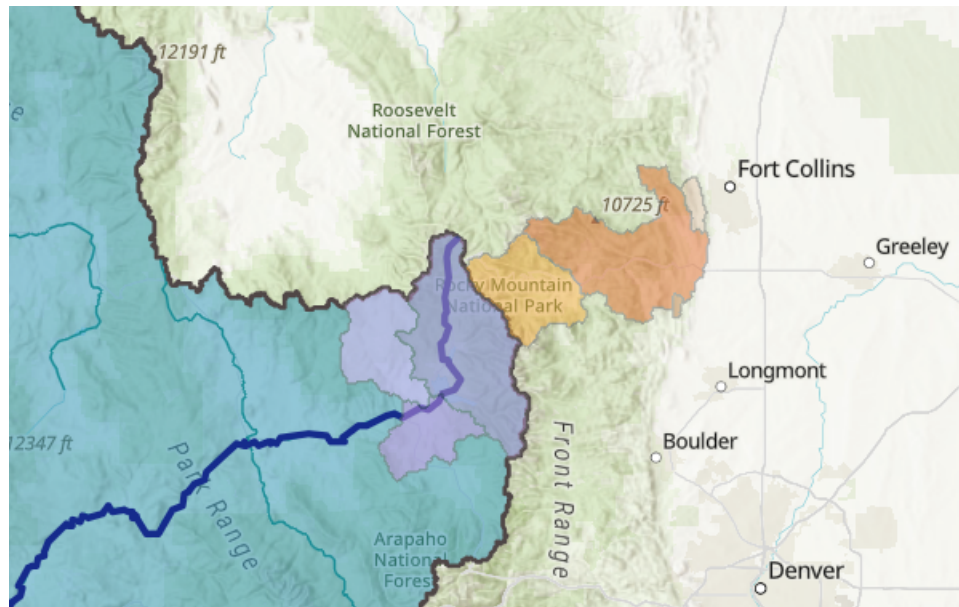


Esri, USGS | Esri, HERE, Garmin, FAO, NOAA, USGS, EPA | CAP, U... Powered by Esri

Lake Mead on the Colorado River.



Largest transmountain water diversion in Colorado.



Esri, USGS | Grand County, CO, Esri, HERE, Garmin, FAO, NOAA, ... Powered by Esri

The Big Thompson Project.



History of the Compact

By the early 1920s, there were several major stakeholder groups competing for Colorado River water. These groups included farmers in California who wanted to guarantee water to irrigate crops, the United States Bureau of Reclamation (USBR) that wanted to build dams and reservoirs to support urban development and population growth in the West, and the seven Colorado River Basin states served by the river that each wanted to protect their interests and share of the river (K. K. Smith, 2019).

ARTICLE III

e) The States of the Upper Division shall not withhold water, and the States of the Lower Division shall not require the delivery of water, which cannot reasonably be applied to domestic and agricultural uses.

An article from the Colorado River Compact.

Competition from these groups turned into concern in June 1922 when the U.S. Supreme Court ruled in the *Wyoming v. Colorado*, 259 U.S. 419 case that the water rights system established in the Prior Appropriation Doctrine applied across state lines (*Wyoming v. Colorado*, 2022). The Prior Appropriation Doctrine legally established that the first entity to use water for a “beneficial purpose” could acquire the individual rights to that water (*Prior Appropriation Doctrine*, n.d.). “Beneficial purposes” primarily include uses within the industrial, agricultural, and residential sectors as determined by the Water Court (Deans, 2021). This controversial ruling meant that larger and faster-growing states at the time, such as California, could acquire rights to large flows of water from the Colorado River at the expense of the slower-growing Colorado River Basin states, such as Utah (Gelt, 1997).

Delph E. Carpenter

Delph Carpenter, a native Coloradan, lawyer, and future delegate for Colorado in the Colorado River Commission, initiated the discussion of an interstate compact, a decision fueled by the

controversial Wyoming v. Colorado ruling (Gelt, 1997). At the time, Carpenter was wary of the federal government's involvement in state-level affairs and believed an interstate compact would save time and resources while still protecting each state's water rights (Gelt, 1997).



Delph Carpenter and the Colorado River Compact.

On November 9th, 1922, Carpenter, along with delegates from Arizona, California, Nevada, New Mexico, Utah, and Wyoming, and then U.S. Secretary of Commerce Herbert Hoover, met as the Colorado River Commission in New Mexico to discuss and negotiate the terms of what would become the largest interstate compact (Gelt, 1997). A timeline of these events related to the development of the Colorado River Compact is shown next.

“[The Colorado River Compact] was a document designed and negotiated 100 years ago, and it was made to address conditions and needs at that time, not necessarily needs and conditions that



Patricia Pettig

have evolved today.” – *Patricia Rettig,*
Head Archivist, Water Resources Archive,
Colorado State University

November 24, 1922

The Colorado River Compact is Signed.



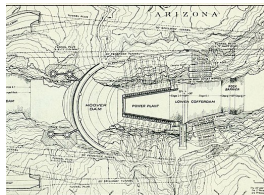
June 25, 1929

Boulder Canyon Project Act takes effect after the ratification of the Colorado River Compact by six of the seven basin states.



April 20, 1931

Hoover Dam construction begins.



May 29, 1935

Hoover Dam is finished.



September 30, 1935

Lake Mead is built.



November 1938

Big Thompson Project starts with construction of Green Mountain Dam.



June 23, 1940

Alva B. Adams Tunnel construction begins.



November 14, 1944

Mexican Water Treaty is signed in Washington D.C.



June 23, 1947

Construction of Alva B. Adams Tunnel is complete.



October 11, 1948

Upper Colorado River Basin Compact signed.



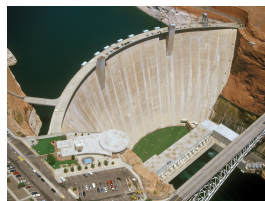
1956

Big Thompson Project is finished.



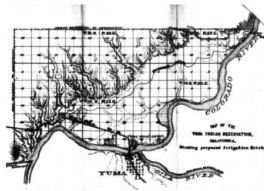
April 11, 1956

Colorado River Storage Project is passed.



June 3, 1963

The Arizona v. California U.S. Supreme Court Decision released.



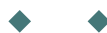
September 13, 1963

Lake Powell is built.



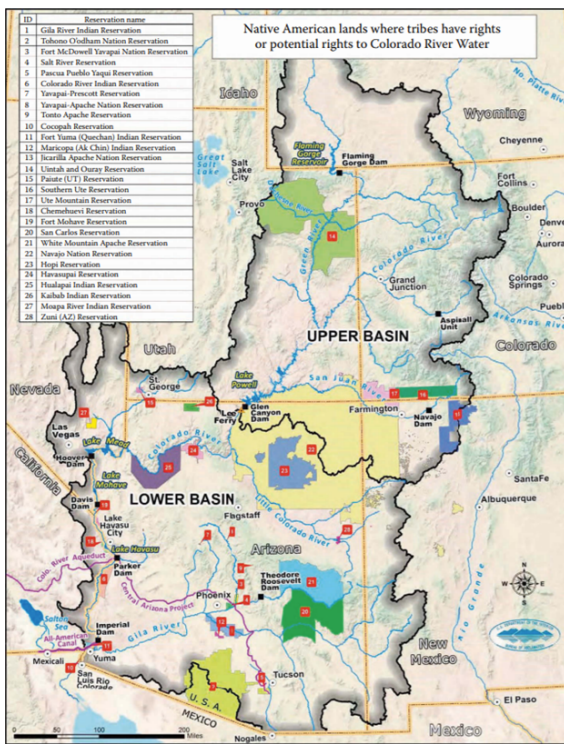
September 30, 1968

Colorado River Basin Project Act passed.



Indigenous People

The complexity of reexamining water politics means confronting colonizing and extractive policies that have excluded many groups of stakeholders, such as Indigenous Peoples. In general, there is extreme controversy concerning the rights of Indigenous Peoples and water rights. Indigenous Americans are native to the land and argue that they have implicit rights to the water from the Colorado River. According to the law and processes that excluded Indigenous



Map of Native American Reservations in the Colorado River Basins.

representation, their rights to water were not instantiated until the founding date of their reservations, which was one of the major precedents set by the Supreme Court Case *Winters v. The United States*, 1908 (Bark & Jacobs, 2009; Carter, 2008; Curley, 2021). This decision, while vital to Indigenous People's water claims, has been subjected to different interpretations.

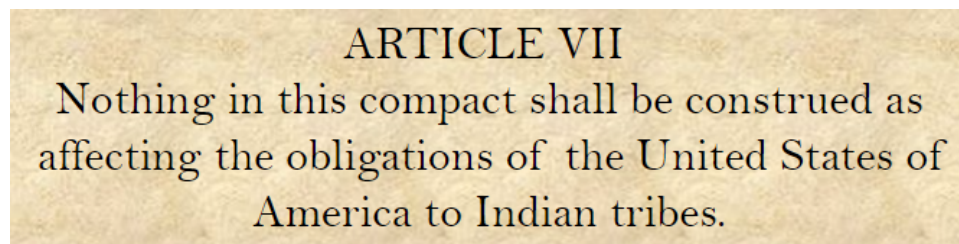
The main interpretation is that their water claim is only reserved for the original purpose of the reservation and cannot be expanded for future uses (Boelens et al., 2010; Carter, 2008; Curley, 2021; Robison, 2017; Merrill, 2013; Robison et al., 2014;

Wilson et al., 2021). A more recent perspective of the case's ruling is the viewpoint that allows "tribes to determine water rights claims on the basis of their current and future needs, which need not include water or irrigated agriculture" (Bark & Jacobs, 2009, p. 3). The controversy over the implicit water rights of Indigenous Peoples is only the tip of the iceberg on water access issues they have faced and continue to face.

Despite the Indigenous communities' implicit water rights stake, they have faced extreme difficulty in this conversion to "translating what are legal rights on paper ("paper rights") into physical water supplies that can be utilized to create viable homelands ("wet water")" (Robison, 2017, p. 307). As mentioned in several of the sources, "in many cases, tribes' land and water interests have been allocated to them through treaties, federal legislation, and court decisions" (Merrill, 2013, p. 226). The only two ways tribes can establish these rights are by negotiating with neighboring water users to form a settlement through the representation of the federal government or getting a judicial decree in the state court their

reservation resides in (Boelens et al., 2010; Hedden-Nicely, 2020; J. Robison et al., 2014; Wilson et al., 2021; York et al., 2020).

Even though Indigenous peoples' water rights are acknowledged, they face discrimination and underrepresentation in utilizing these claims and are often purposefully excluded from political meetings that could change their conditions. For example, the Colorado River Compact "made allocations to all river users except tribes, which were, of course, completely unrepresented in the negotiations. This denial was reversed forty years later" (Carter, 2008, p. 13). To compensate for the lack of representation of Indigenous people in negotiations "Article VII contains an important broadly-stated disclaimer bearing on entitlements held by these tribes in water from the Colorado River System: 'Nothing in this compact shall be construed as affecting the obligations of the United States of America to Indian tribes'" (Robison & Kenney, 2012, p. 1200). This article was included primarily because many tribal rights, as previously stated, were not quantified or formally established; therefore, the states and other participating factions did not split the river water considering Indigenous people.



ARTICLE VII
Nothing in this compact shall be construed as affecting the obligations of the United States of America to Indian tribes.

Article from the Colorado River Compact.

The final pressure point has been the increasing scarcity of water resources, specifically concerning the Colorado River. Indigenous peoples are finding their voice "as water resources become increasingly scarce, access to clean, reliable water resources is crucial. By demanding that the US government acknowledge Indigenous sovereignty, Native peoples are fighting for both autonomy and survival" especially with the consideration of their underdeveloped communities (Project MUSE - Water Is Life, n.d., p. 4). At the same time, "the decrease in the availability of water

throughout the Colorado River Basin concerns those who not only rely on the river as a source of water and food but for power as well. Most of the region, including many Native American tribes and reservation inhabitants, rely on the Colorado River Basin for at least one of the three” (Merrill, 2013, p. 239).

Merrill went further to note that the reserved water for these reservations will eventually become a source of envy from other water users as climate change and various other factors will continue to decrease the flow of the Colorado River (Merrill, 2013, p. 255). It is vital that neglected voices, such as the Indigenous People who are so often an afterthought in water politics, are brought to the table. Promoting and gathering the perspectives of neglected voices, as well as other voices, is one of the main goals of Fresh Water News, our sponsor for the project.



The Colorado River Today

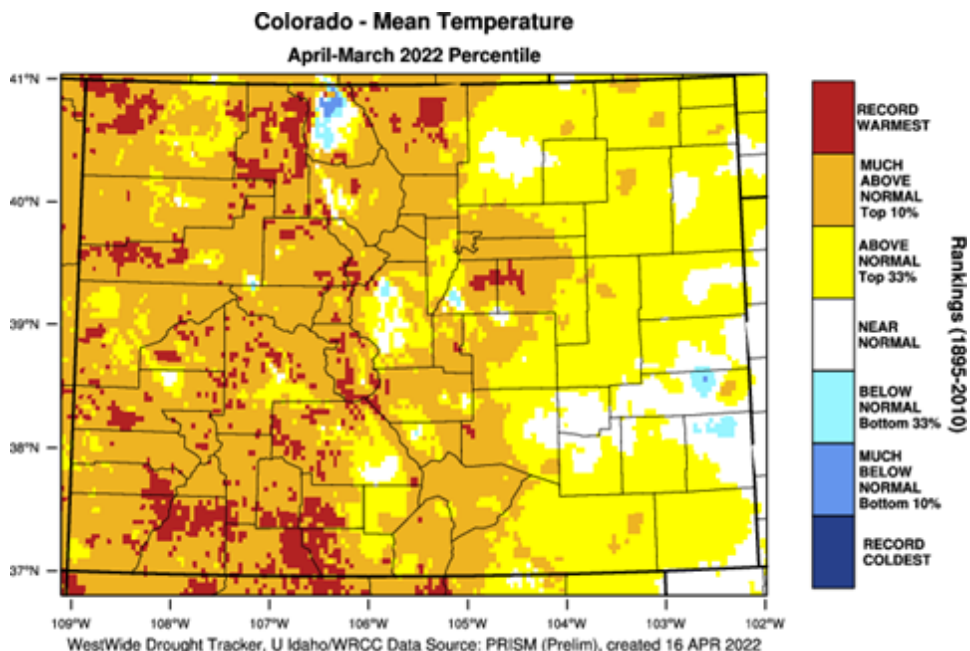
Modern factors however are straining the Colorado River and the terms of the Colorado River Compact, making it difficult for the river to effectively serve all its purposes. Climate change has caused drier soils and variable precipitation rates near the headwaters of the Colorado River, significantly decreasing the certainty and capacity of its flow. Population growth in a majority of Colorado River Basin states has been significantly above the U.S. average and the amount of people reliant on the river is increasing rapidly.

Climate Change

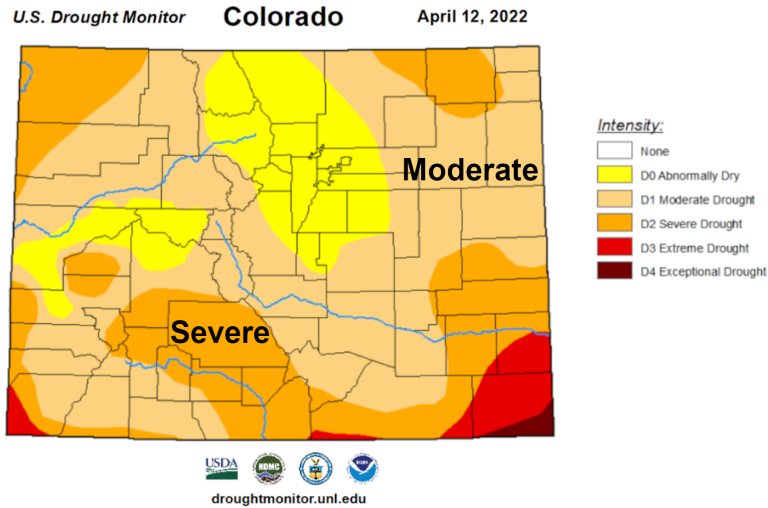
The Colorado River Compact failed to foresee and address the extent and impact of climate change on water availability, the environment and human and industrial development. According to lawyer Josh Merrill, most of the region “[relies] on the river as a source of water and food but for power as well” and as water scarcity is likely to continue due to droughts, the availability of

water will become a bigger concern (Merrill, 2013, p. 239). The climate of the Colorado River Basin is deteriorating, the most recent issue is the 20 plus year megadrought. Since the drought of 2000, there have been yearly droughts for the past 22 years in Colorado “with more than two-thirds of its terrain classified as being in extreme or exceptional drought, the worst condition” (J. Smith, 2021).

Lack of precipitation, dry soil, high temperatures, and high winds exacerbate drought conditions. According to the National Oceanic and Atmospheric Administration (NOAA), the average temperature in Colorado over the past three decades has increased by 2 degrees Fahrenheit (Ellfeldt & E&E News, 2021). The statistics for mean temperature in Colorado from April to March 2022 can be seen in the next figure which shows that most of western Colorado’s temperatures are “much above normal”. As ecologist Jennifer Gremer notes, “climate change projections indicate consistent increase in mean temperature and seasonal temperature variability for all sites” (Gremer et al., 2018). This warming has led to dryer soils that then absorb a large amount of the Colorado River water, leaving less for the people dependent on it (Gremer et al., 2018).

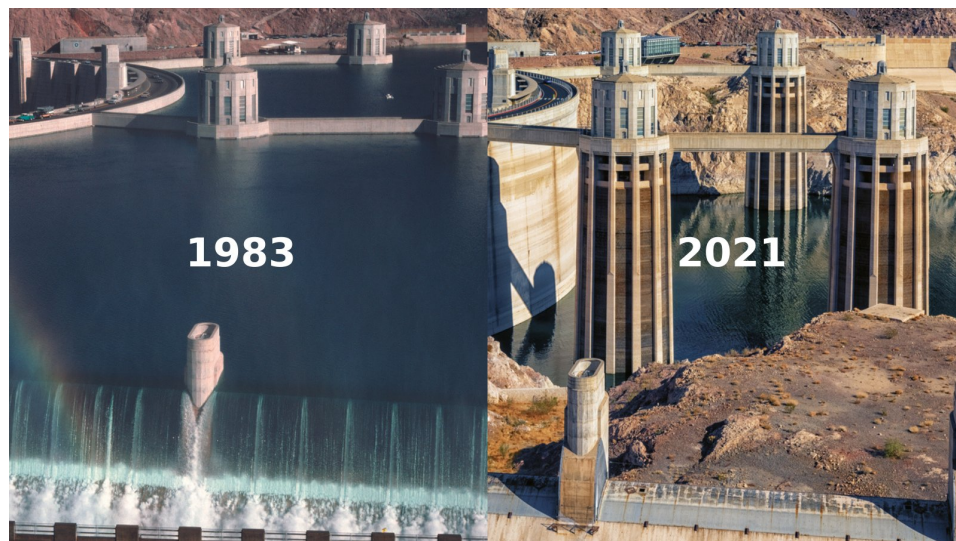


Average Temperature in Colorado.



Drought conditions in Colorado.

The pressures faced by the Colorado River have worsened because of the megadrought. The picture below indicates the current drought levels in the Colorado River Basin, which are all above “abnormally dry”. This drought has led to the Colorado River’s declining flows. For example, “since 2000, the river has delivered on average 12.3 million acre-feet a year”, much less than the 15 million anticipated by the Colorado River Compact (Loomis, 2022). Because of declining flows, it is projected that within 50 years, the mean flow through Lees Ferry, the point in the river that divides the Upper and Lower Basins, will be 9% less than 2022 levels (U.S. Department of the Interior Bureau of Reclamation, 2012). Decreasing flow rates means that the water levels of the river’s reservoirs are falling, which can be witnessed with Lake Meade and Powell. Lakes Mead and Powell, the two largest reservoirs in the United States, were at 95% capacity in 2000, but in 2021 water storage dropped to 39% capacity, the lowest levels ever recorded (*Colorado River Drought Conditions*, 2021).



Lake Mead levels in 1983 and 2021.

Specialists in Natural Resources Policy Charles Stern and Pervaze Sheikh argue that the effects of climate change prove the need for updated legislative efforts that address climate change in the Colorado River Basin because the future of the Basin does not seem to be improving (Stern & Sheikh, 2021). According to the Colorado Climate Center at Colorado State University, their research projects the precipitation rate for 2022 in Denver to be 86% of the average precipitation rate, 5.64” (*Colorado Climate Center, 2022*). This projection indicates that precipitation rates will likely continue to decrease, reiterating Stern and Sheikh’s argument for legislation that addresses current climate change in Colorado.



Peter Goble

“As the climate warms, it changes what we call the runoff ratio, which means that a higher fraction of the precipitation and snow that we get goes directly into feeding thirsty soils, and a lower fraction into filling our lake streams and reservoirs.” - Peter Goble, Climate and Drought Specialist, Colorado State University

Population Growth

Another strain on the river that was unacknowledged by the original Colorado River Compact was excessive population growth. The

Colorado River Basin States had some of the highest population growth rates out of the entire United States over the last decade. Between the 2010 and 2020 U.S. census surveys, four of the seven Colorado River Basin States experienced significantly above-average growth in residential populations: Arizona's population grew by 11.9%, Colorado's population grew by 14.8%, Nevada's population grew by 15.0%, and Utah's population grew by 18.4%, whereas the average across the entire U.S. was 7.4% (U.S. Department of Commerce & U.S. Census Bureau, 2020). Given these growth rates, the U.S. Department of the Interior and the Bureau of Reclamation forecast that the population served by the Colorado River will increase anywhere from an additional 9 million to 36 million people by 2060 (U.S. Department of the Interior Bureau of Reclamation, 2012).

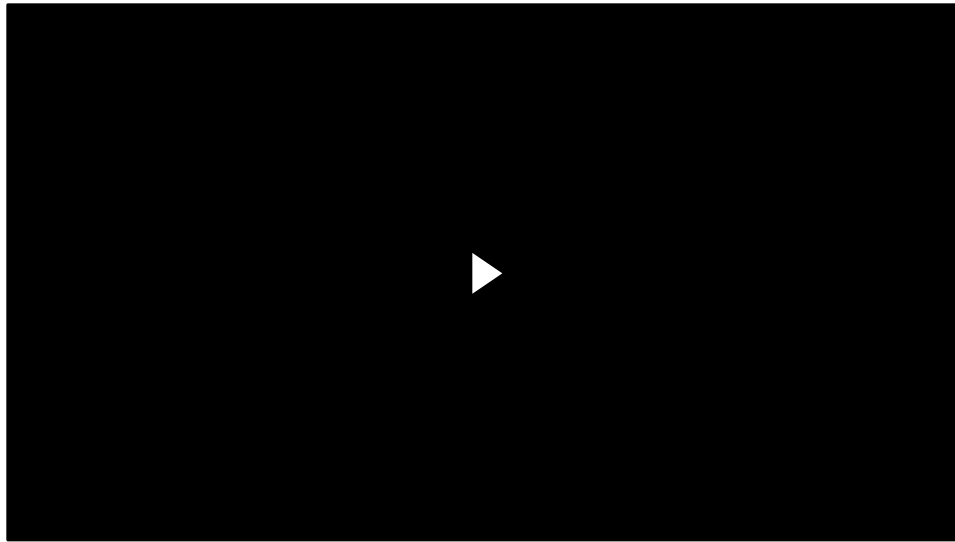
Population growth was not considered in the drafting of the Colorado River Compact, and researchers say that old legislation governing the Colorado River will likely lead to a water delivery shortage for the first time in the next few years. Policy experts say the need for new legislation for the river is crucial to address these situations (Sakas, 2021).



Uses of the Colorado River

As of 2021, the Colorado River provided water to more than 40 million people in residential areas, 29 Native American reservations, 4.5 million acres of agricultural land, and 22 National Parks, Wildlife Refuges, and Recreational areas (McCool, 2021). In addition, hydroelectric facilities on the 1450-mile river provide the Western United States with 4200 megawatts worth of electricity, enough to supply power to more than a million homes (U.S. Department of the Interior Bureau of Reclamation, 2012). The Colorado River also serves regions outside of the Colorado River Basin, with water being diverted through projects such as the Big Thompson and Central

Utah, providing essential water resources to eastern Colorado, Northern Utah, and Western California (Fradkin, 1996).



Learning to Ski in Grand Lake - Finbarr O'Sullivan, 2022.

The Colorado River and the Colorado River Compact have faced numerous challenges in the past 100 years and it is sure to face even more challenges in the next 100 years. However, through the cooperation of states and people, we will be able to overcome these challenges to help protect the future of the Colorado River.

References

Bark, R. H., & Jacobs, K. L. (2009). Indian water rights settlements and water management innovations: The role of the Arizona Water Settlements Act. *Water Resources Research*, 45(5), W05417-n/a. <https://doi.org/10.1029/2008WR007130>

Boelens, R., Getches, D., & Gil, A. G. (2010). *Out of the mainstream water rights, politics and identity*. Earthscan.

Carter, N. C. (2008). American Indian Water Rights. *Legal Reference Services Quarterly*, 27(1), 1–48. <https://doi.org/10.1300/02703190802128442>

Colorado Climate Center. (2022).

https://climate.colostate.edu/precip_proj.html

Colorado River Commission, & Hoover, H. (1922). *Colorado River Compact*.

Colorado River Drought Conditions. (2021, October 15).

<https://www.doi.gov/ocl/colorado-river-drought-conditions>

Cooley, H., Christian-Smith, J., Gleick, P. H., Cohen, M. J., & Heberger, M. (2010, September). California's Next Million Acre-Feet: Saving Water, Energy, and Money. *Pacific Institute*.

<https://pacinst.org/publication/californias-next-million-acre-feet-saving-water-energy-and-money/>

Curley, A. (2021). Unsettling Indian Water Settlements: The Little Colorado River, the San Juan River, and Colonial Enclosures. *Antipode*, 53(3), 705–723. <https://doi.org/10.1111/anti.12535>

Deans, O. (2021). *Overview of Prior Appropriation Water Rights*. 2.

Ellfeldt, A. & E&E News. (2021, December 10). *December Fires Raise Concerns over Remarkable Colorado Drought*. *Scientific American*. <https://www.scientificamerican.com/article/december-fires-raise-concerns-over-remarkable-colorado-drought/>

Fradkin, P. L. (1996). *A River No More: The Colorado River and the West*. University of California Press.

Gelt, J. (1997, August). Sharing Colorado River Water: History, Public Policy and the Colorado River Compact. *Arroyo*. <https://wrrc.arizona.edu/publications/arroyo-newsletter/sharing-colorado-river-water-history-public-policy-and-colorado-river>

Gremer, J. R., Andrews, C., Norris, J. R., Thomas, L. P., Munson, S. M., Duniway, M. C., & Bradford, J. B. (2018). Increasing temperature seasonality may overwhelm shifts in soil moisture to favor shrub

over grass dominance in Colorado Plateau drylands. *Oecologia*, 188(4), 1195–1207. <https://doi.org/10.1007/s00442-018-4282-4>

Hedden-Nicely, D. R. (2020). The Historical Evolution of the Methodology for Quantifying Federal Reserved Instream Water Rights for American Indian Tribes. *Environmental Law*, 50(1), 205–256. JSTOR.

Loomis, B. (2022, March 21). *How low can the Colorado River go? Drought forces states to face tough choices about water.* The Arizona Republic. <https://www.azcentral.com/story/news/local/arizona-environment/2022/03/21/climate-change-dries-colorado-river-force-new-rules-users/9453476002/>

McCool, D. C. (2021, November 17). *As climate change parches the Southwest, here's a better way to share water from the shrinking Colorado River.* The Conversation. <http://theconversation.com/as-climate-change-parches-the-southwest-heres-a-better-way-to-share-water-from-the-shrinking-colorado-river-168723>

Merrill, J. (2013). Climate Change and its Effect on Indigenous Peoples of the Southwest. *American Indian Law Review*, 38(1), 225–259. JSTOR.

Prior appropriation doctrine. (n.d.). LII / Legal Information Institute. Retrieved April 7, 2022, from https://www.law.cornell.edu/wex/prior_appropriation_doctrine

Project MUSE - Water Is Life: Ecologies of Writing and Indigeneity. (n.d.). Retrieved January 31, 2022, from <https://muse.jhu.edu/article/716944>

Robison, J. A. (2017). Climate Change and Allocation Institutions in the Colorado River Basin. In *Water Policy and Planning* (pp. 289–314). CRC Press. <https://doi.org/10.1201/b19534-16>

Robison, J. A., & Kenney, D. S. (2012). Equity and the Colorado River Compact. *Environmental Law*, 42(4), 1157–1209.

Robison, J., Bratrschovsky, K., Latcham, J., Morris, E., Palmer, V., & Villanueva, A. (2014). Challenge and response in the Colorado River Basin. *Water Policy*, 16(S1), 12–57. Business Premium Collection; ProQuest One Business; SciTech Premium Collection.
<https://doi.org/10.2166/wp.2014.003>

Sakas, M. E. (2021). *If the Colorado River keeps drying up, a century-old agreement to share the water could be threatened. No one is sure what happens next.* Colorado Public Radio.
<https://www.cpr.org/2021/11/19/colorado-river-water-compact-climate-change/>

Smith, J. (2021, January 27). 14 Denver-area cities to coordinate drought response. *Water Education Colorado*.
<https://www.watereducationcolorado.org/fresh-water-news/14-denver-area-cities-to-coordinate-drought-response/>

Smith, K. K. (2019). The Conservation Movement's Constitutional Legacy. In *The Conservation Constitution* (pp. 246–260). University Press of Kansas; JSTOR. <https://doi.org/10.2307/j.ctvxbpfd7.13>

Stern, C. V., & Sheikh, P. A. (2021). *Management of the Colorado River: Water Allocations, Drought, and the Federal Role*. 31.

U.S. Department of Commerce & U.S. Census Bureau. (2020). *Table E. Numeric and Percent Change in Resident Population of the 50 States, the District of Columbia, and Puerto Rico: 2020 Census and 2010 Census*. 1.

U.S. Department of the Interior Bureau of Reclamation. (2012). *Colorado River Basin Water Supply and Demand Study*. 34.

Wilson, N. J., Montoya, T., Arseneault, R., & Curley, A. (2021). Governing water insecurity: Navigating indigenous water rights and

regulatory politics in settler colonial states. *Water International*, 46(6), 783–801. <https://doi.org/10.1080/02508060.2021.1928972>

Wyoming v. Colorado, 259 U.S. 419 (1922). (2022). Justia Law. <https://supreme.justia.com/cases/federal/us/259/419/>

York, A. M., Eakin, H., Bausch, J. C., Smith-Heisters, S., Anderies, J. M., Aggarwal, R., Leonard, B., & Wright, K. (2020). Agricultural water governance in the desert: Shifting risks in central Arizona. *Water Alternatives*, 13(2), 418–445. Coronavirus Research Database; Publicly Available Content Database; SciTech Premium Collection.

About the Authors

We are a group of students from Worcester Polytechnic Institute (WPI) working with Fresh Water News on a project about the Colorado River in the context of the 100th anniversary of the Colorado River Compact. Fresh Water News is an online non-partisan news service operated by Water Education Colorado whose goal is to create clean and sustainable water for the future.

Aislin Hanscom - I am a junior at WPI majoring in Robotics Engineering with minors in Astrophysics and Mechanical Engineering.

Camille McDonnell- I am a junior at WPI majoring in Applied Physics and minoring in Chemistry.

Michael Morin - I am a junior at WPI majoring in Mechanical Engineering and minoring in Materials.

Finbarr O'Sullivan - I am junior at WPI majoring in Mechanical Engineering and minoring in Computer Science.