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PROJECT TITLE:
Water in Colorado

# Water in Colorado

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The value of water is difficult to overstate. The origins of civilization itself is on the banks of rivers, and water touches every aspect of life from the lowliest tadpole to the biggest pine tree. We use and misuse it for agriculture, industry, sanitation, and recreation. To some it may seem infinite, but to those in the Colorado River Basin it is very finite. The Colorado River, like many other rivers around the world, is being bled dry from all ends. A delta was once the size of approximately 3000 square miles and is now less than 250 and is only filled by rainwater and agricultural runoff (Zielinski, 2010). The Colorado River has stopped miles short of the Gulf of California for decades (Runyon, 2019). The headwaters fare better than the delta, but they are not in great shape. With increased demand and decreased water supply, some states are starting to feel the pinch (Bureau of Reclamation, 2012). Colorado has always had a special relationship with the river, not just because they share the same name. Colorado is blessed and marred by extremes. In 1914 George J Bancroft described the situation as thus:

The mountainous and desert region of western Colorado has “a world of water and a moonscape of land, while the Eastern slope has a world of land and a moonscape of water.”

The millions that rely on it are already stretching it to its limits and with millions more projected to depend on the Colorado River, the falling supply will be stretched thinner and thinner.

## Growing Demand and Decreasing Supply

High in the Rocky Mountains is the start of the fuel for the Colorado River that runs down south fueling several other states along the way. Rain and melting snow power our river alongside ground aquifers with a supply of water annually. Once running through the rivers, the water could be used for municipal, industrial, personal, agricultural, and environmental. Approximately 14% of Colorado’s freshwater attain from groundwater. Groundwater is

responsible for almost 100% domicile use (Stanford, n.d.). More than 80 percent of the agricultural used are from groundwater and followed by about 15% multiplicities. This is a problem that can lead to feedback loops. As surface water can seep into the ground and become groundwater, which can then become surface water, i.e. springs. So, shortages or interruptions in supply of one can lead to shortages of the other. If for example, demand grows or the supply of surface water shrinks, wells may be drilled to access the more abundant groundwater. But, as the groundwater is lowered so too is the surface water. This may prove to be especially problematic for prolonged droughts, as it is estimated that 48% of the Colorado River Basin's streamflow is discharged from groundwater (Rumsey, Miller, Susong, Tillman, & Anning, 2015). While outside of the Colorado River Basin, eastern Colorado and other regions are feeling the pinch from this effect as large swatches of streams have dried up from groundwater extraction (Guiden, 2017).

The Colorado river fuels Utah, Arizona, Cailfornia, parts of Nevada, and Mexico. However, because of the drought Colorado has been experiencing over the years the Colorado river is losing its fuel the closer to the Gulf of Mexico it gets. The state's water is a limited, but essential, resource and Colorado has developed over time a comprehensive system for allocating and administering its use (Barkmann et al.,2020). The State Engineer for the State of Colorado (SEO) is what administrates and distributes the state's water.

Colorado has seen a rapid growth in population over the recent years. With this growth it may be difficult for Colorado to meet its water demands with the population continuing to increase. In the article "Colorado's Water Plan" it states that Colorado has one the fastest growing economies nationwide ("Colorado's Water Plan", 2015). It was also stated that under this high growth the change in water demands will be affect by further increase of climate

change and decreasing water conservation actions (“Colorado’s Water Plan”, 2015). Population growth is inevitable within Colorado.

### Negative Precipitation

As stated before, rain and melting snow are very important in supplying Colorado river with it is water. Over the years we have seen an increase in temperature and lower precipitation measured. The data collected throughout the years has brought the term negative precipitation into the public view. In the article “What is negative rainfall” Samurović stated this phenomenon usually occurs when temperature is unusually high, and precipitation is unusually low for the season (Samurović, 2020). The lack of rain prevents the air from pulling moisture from the ground; the cause extreme conditions to occur.

## Data and Methodology

Water demand was collected from the United States Geological Service: Water Usage Census. It collects water usage by county and sector across the U.S. every five years. Unfortunately, its records sector, such as agriculture and industry, was incomplete for Colorado and no reliable trends could be determined. However, it did provide useful water supply sources and supply methods. Most counties did not have the total number of people served by the public supply for the year 2000. A moving average of supply source from the previous years was calculated and then multiplied by the population for that year to yield values. Then after that the total number of people supplied by groundwater from domestic supply, i.e. individual wells, was added to the total number supplied from groundwater from public supply, i.e. municipal water, and divided by the population, thus yielding the percent reliant on groundwater. This was done for both individual counties and Colorado. Note that there is no data for Broomfield from 1985

until 2005. The years that are available have surface water as the only source of the water supply. However, as there are so many unavailable years, they were left blank rather than calculated via the moving average method mentioned above.

Precipitation data was collected from the Colorado Information Market. This data was provided by COCORAHS (Community Collaborative Rain, Hail & Snow Network). The COCORAHS is a non-profit, community-based network of volunteers that measure and map precipitation. This data was collected in Colorado from 1999 to 2015. The data did not require much cleansing because it had useful information throughout the spreadsheet. It recorded the precipitation along with the location were the data was measured. This data was collected through volunteers throughout the state. In the beginning of the recorded data there were not many volunteers. Unfortunately, the recorded data from the early 2000s is very low for precipitation but improves over the years as they gain more volunteers. As such total precipitation data cannot be surmised from this alone.

**Results**

Figures 1, 2, and 3 represents the percentage of the county reliant on groundwater for the years 1985, 2000, and 2015 respectively. With dark blue representing no water supplied from groundwater with a greater share from groundwater getting progressively lighter until a soft white represents half ground and half surface, then transitioning to light orange until dark orange/brown represents 100% of water is from groundwater.

*Figure 1*

Percentage of Supplied Water from Ground Water - 1985

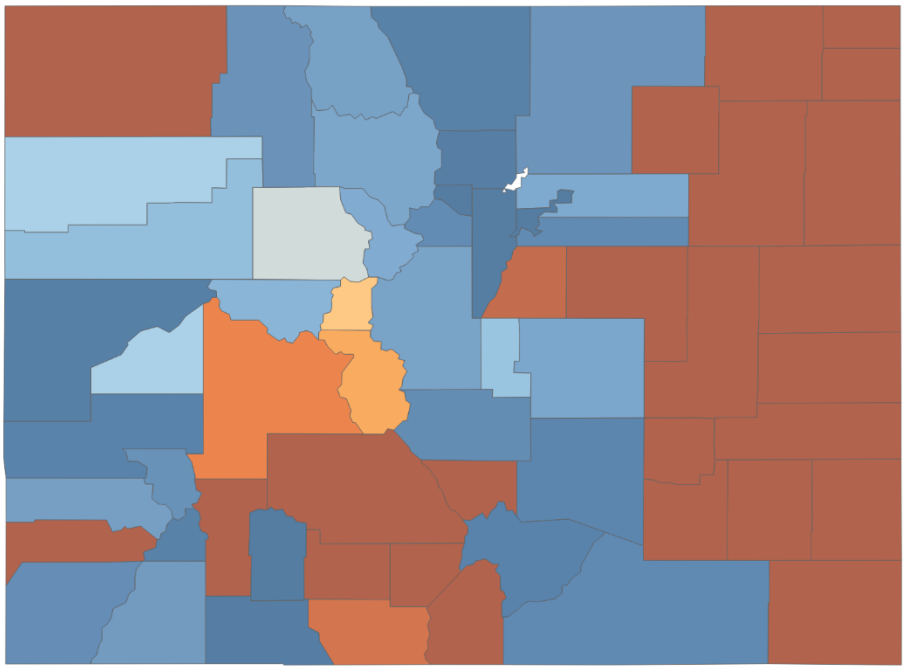


*Figure 2*

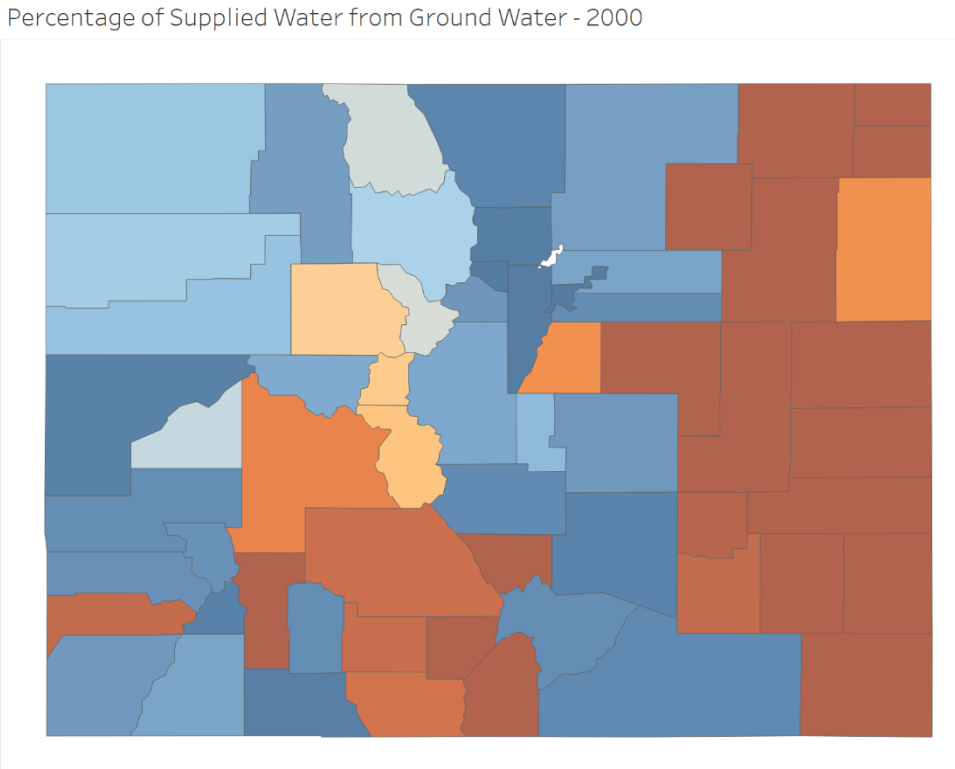
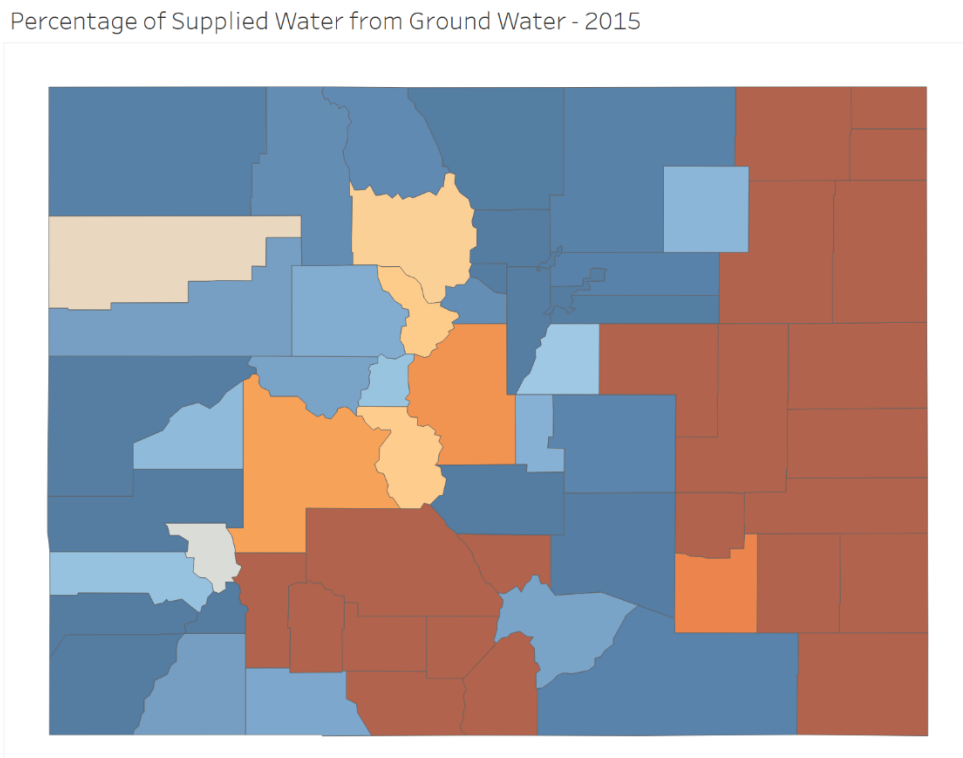



*Figure 3*



It is unsurprising to see much of far eastern Colorado supplied by groundwater as there is very little to no surface water in these counties. The primary concern arises is how much water is being extracted. As most of these counties have low populations so if they were only extracting for personal use there may not be an issue, however these are agricultural counties, so the volume is much higher. Without knowledge of the vast supply of diverted water, one would wonder where the front range is getting its water. While there is more surface water than the plains, the water provided from the eastern side of the continental divide isn't enough to supply the large cities like Denver and Colorado Springs. So, a more appropriate metric here may be whether the surface water is local or from diverted sources.

As a result of the limited and incomplete data from COCORAHS long term patterns cannot be established. However, it still provides insight into local conditions and will one day be able to provide very detailed data as more 'stations' are added and history is recorded. The precipitation data such as in the figures 4 and 5, has shown that more recently there has been an increase in negative precipitation within Colorado. The darker the blue the more precipitation has been recorded. The tanner color means there was low, or no precipitation recorded. Once an orange color appears it means the phenomenon known as negative precipitation has occurred. With the scale ranging from a low point of (negative) 2 inches of negative precipitation and high point of 6.67 inches recorded.

*Figure 4*

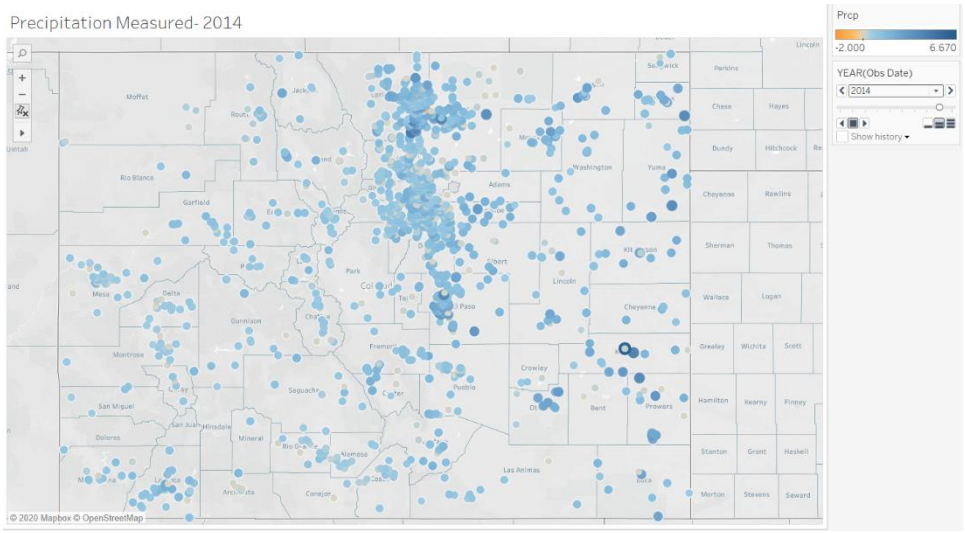



*Figure 5*

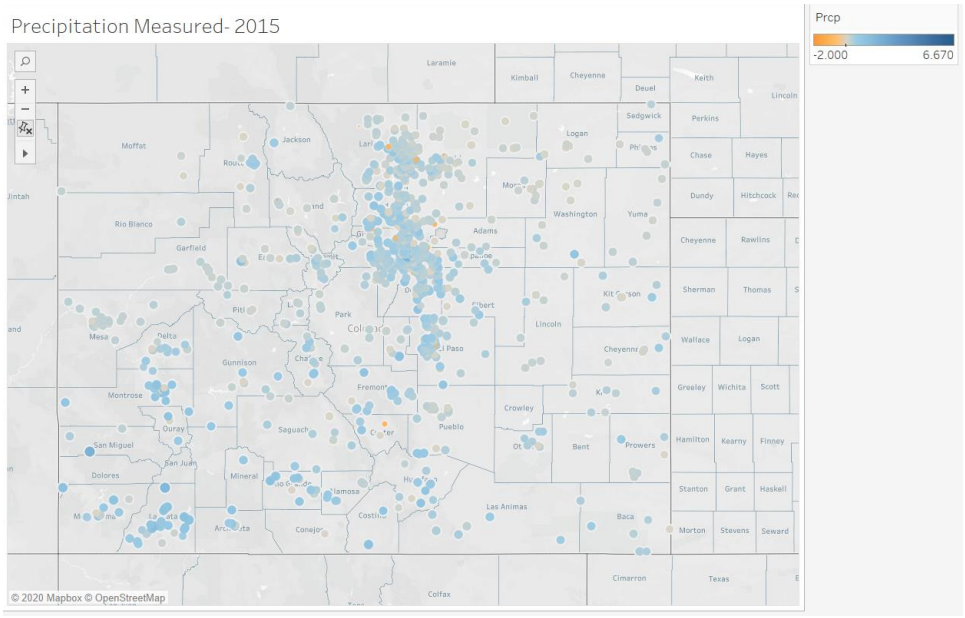
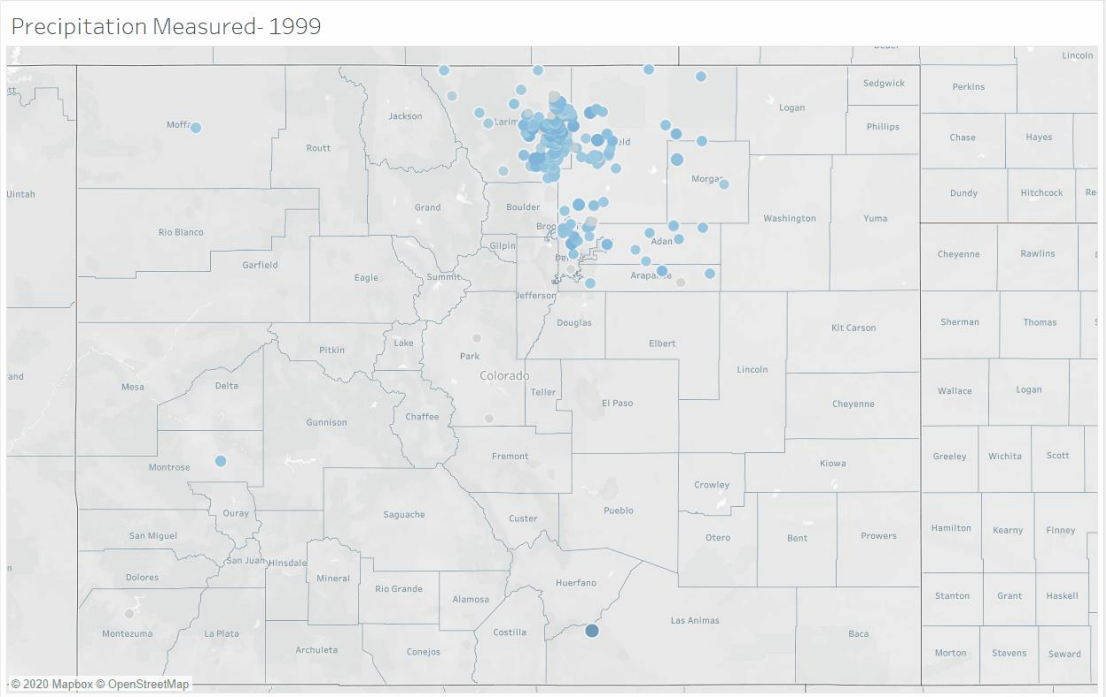



Figure 6 provides the data over time, it must be double-clicked to be viewed.

*Figure 6*




**Conclusion**

Colorado and those in the Colorado River Basin are already feeling the pinch of overuse. If trends of population growth continue to rise the existing water supply will be pushed. While the population growth might be inevitable the supply of water is only going to continue to decrease. The river basin is subject to the El Niño and La Niña system and has periods of the dry and wet season, however, the dry season is becoming more common and harsh. The utilization of the water will need to change, and the remaining question is how that change will be implemented. Wells can only be continued to be drilled so far, and as mentioned before this is not a good solution. Colorado agriculture is in need of a solution soon, the people of Colorado River Basin are in need, and the local Coloradans don't want to feel the pinch tighten.

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