Impacts of Declining Freshwater Resources in the Colorado River Watershed

The Colorado River Watershed is one of the most critical sources of freshwater in the Western United States. The river travels 1400 miles through 7 states in the Southwestern US and 2 states in Mexico and it provides water to nearly 40 million people in the region (*Bureau of Reclamation, Study, Forward, 2013*). See Figure 1 – The Study Area (*Bureau of Reclamation, Study, 2013*). This analysis will focus primarily on lower water levels and deteriorating water quality in the Imperial Valley. The Imperial Valley is located in southeastern California, west of the Colorado River, south of the Salton Sea and extending south to the Mexico border.

Part 1 – Issues and Trends

Stakeholders

The Imperial Valley is a critical agricultural community producing more than 100 different commodities such as alfalfa, bamboo, sugar cane, corn, and goats (*Imperial County Farm Bureau, 2013, Imperial County Agriculture*). In the winter months, the Imperial Valley provides ⅔ of the vegetables consumed in the United States and is one of California's top five producers of spinach, potatoes, broccoli and onions. (*Imperial County Farm Bureau, 2013, Agricultural Variety*) The fields and wetlands within the Imperial Valley provide habitat to over 400 bird species. In fact, there are more Burrowing Owls per square mile in the valley than anywhere else in the US. (*Imperial County Farm Bureau, 2013, Environmental Stewardship*)

Since the Imperial Valley is near the Gulf of Mexico at the river delta, it is near the end of a long line of stakeholders that have geographical and political priority such as cities and towns for drinking water, big industry farming for irrigation, utility corporations for electricity generation, big industry for water processing and discharge, State and

National Parks for recreation, Native American Communities, and at the mouth of the Colorado river, failing wetlands where the river has run dry. (*Bureau of Reclamation,2013, p9*). The stakeholders' interests and goals are further discussed in Part 2 of this analysis.

Environmental resources

The critical environmental resource in this study is the Colorado River Water. The critical properties of that resource are water levels and water quality. The water in the Colorado River is highly divided, mismanaged and misused upstream. The continued production within the Imperial Valley is completely dependent on water from the Colorado River from one canal built in 1940 named "The All-American Canal" (*Imperial Irrigation District, 2013)* diverting water from the Imperial Dam. See Figure 1 – The Study Area (*Bureau of Reclamation,2013*). Water quality and water levels are affected by the upstream users and needs to be carefully managed. Currently, existing agreements are inequitable, and that situation is likely to cause some stakeholders to see further shortages as the drought continues. See Figure 2 – Historical Supply and Use and Projected Future Colorado River Basin Water Supply and Demand. (*Bureau of Reclamation,2013*). The system map included with this analysis demonstrates connections between the environmental resources and stakeholders such as general allocation and downstream effects.

Dynamics of Change

There are four main dynamics of change in this system; Population, Pollution Biodiversity and Rainfall. First, population changes in the Colorado River Basin have a staggering effect on water levels in reservoirs. The reservoirs are man-made lakes that build up behind a series of dams built along the river shown on the map in Figure 1.

These reservoirs give the Colorado River System the ability to store nearly 4 years of average natural flow to support the water supply demand in the dry years *(Bureau of Reclamation, 2013, p9).* Second, major metropolitan cities such as Los Angeles, Phoenix and Las Vegas and Industrial Agriculture generate pollutants such as pesticides, nitrogen, phosphorus, and increased sediment into the river, decreasing the water quality downstream. (Moore et al., 1974, p138) Contaminants such as perchlorate are also discharged into the river by manufacturing plants associated with aerospace and munitions industries. (Sanchez et al., 2005, p5479) Biodiversity in wetland areas has the ability to positively affect water quality before the river enters the ocean (Kadlec et al., 2010, p1093). Varying rainfall year to year affects reservoir levels. During the most recent 11 year drought, all water needs in the Lower Basin were met (*Bureau of Reclamation, 2013, p3*) because of the high storage capacity of the entire system, but recent years of low rainfall has put pressure on the reservoirs. See Figure 2.

Direction and Causes of Changes in the System

Population in the Colorado River Basin is increasing in large metropolitan areas such as Los Angeles, Phoenix and Las Vegas. These increases require more energy to be generated, more land which takes from biodiversity, and increased farming as we need more food in the area. Pollution is increasing as a result of more industry in the region, bigger cities, more industrial farming and the reduction of wetlands due to land use changes and diminished water levels at the mouth of the Colorado River. The Colorado River has been reported to have Perchlorate concentrations of 5 to 9 ppb. Perchlorates, when ingested, interfere with the thyroid system and, as of 2011, the EPA has begun to regulate the perchlorate levels in drinking water. Sanchez et al., (2005) explores the ability of lettuce to accumulate perchlorate from irrigation water and the subsequent

human exposure through food. The reduction in biodiversity within the watershed reduces the river's natural ability to regulate and balance pollutants such as sediment loads, nitrates and phosphorus. Rainfall is a large factor in this system. The American Southwest has been in drought conditions since 1999 (*Bureau of Reclamation, Study, 2013, p3)*, and it appears that there is no sign of relief. See Figure 2 (*Bureau of Reclamation, Study, 2013, p7).* Causes of the reduction of rainfall are more difficult to isolate as global temperatures are rising due to an increase in Greenhouse Gas levels. All of these changes in the Colorado River system are tightly interrelated, difficult to isolate and in need of further study.

Part 2 – Stakeholders Analysis

Stakeholders and Governance

Within the Colorado River Watershed, there are stakeholders with varying levels of ownership, access, and influence. Key Stakeholders are defined herein as the owners of the limited water resources, primary stakeholders are defined as dependants, and secondary stakeholders have interest in oversight for the benefit of the primary stakeholders. All stakeholders play an important role in solving the issue of water shortage. (See system map). Key stakeholders are the seven southwestern states of the United States; Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming, as well as Mexico. These states have clearly defined allocations that total 7.5 million acre-feet (MAF) per year and Mexico has an additional 1.5 MAF per year. (*Bureau of Reclamation - Law of the River, 2013*). Primary stakeholders rely on the water resources and are directly affected when any change in the allocations are considered. Agriculture farming relies on water for crop irrigation, Cities, towns, parks

and Native American Communities require domestic water for drinking, Energy Generation Corporations generate electricity at several dams along the river, Industry requires water for processing chemicals and mining operations and Wetlands and Native Species rely on the ecosystem services the river provides for their survival. Finally, Secondary stakeholders include Federal agencies such as U.S. Fish and Wildlife Service, the Bureau of Reclamation, the Bureau of Land Management, and the National Park Service, just to name a few. State agencies like Colorado Wildlife Federation, Wyoming Wildlife Federation, and the Utah Water Users Association provide oversight at the state level, and Non-governmental agencies like the National Audubon Society and Environmental Defense Fund monitor and lobby for wildlife protection throughout the watershed.

Stakeholders Goals

The Key stakeholders have spent decades negotiating for the allocation of the water resources. The agreements to date have been challenged multiple times and continue to be challenged with the goal of improving allocation equity (*Bureau of Reclamation - Law of the River, 2013*). Continued population and rainfall changes will put a heavy load on the key stakeholders as they will be negotiating with smaller annual flows in the watershed. See Figure 2. Ultimately, key stakeholders may need to agree to less water being allocated to all parties.

Primary stakeholders have a big role to play in making sure that everyone gets the water they need. As the population grows, there will be less water per capita, which has an effect on domestic water prices. Energy generation corporations provide an alternative energy source for the American West that eases the reliance on fossil fuels such as coal burning power plants. The Western Area Power Administration has a total

generating capacity of 4 million kilowatts from the various dams along the river. This provides partial power for 9-12 million people. Reduction in the river flows has reduced generation by 25%-30% to date (CRWUA, River Uses, Power, 2013).

Irrigation for agricultural farming currently uses the lion share of the Colorado River water for most states. Arizona uses 80% of its share of the river water for agriculture; conversely, Nevada uses 100% of its share for domestic and industry uses. (CRWUA, River Uses, Agriculture, 2013). Therefore this stakeholder has the most to give in the way of efficiency improvements. Wetlands can add robustness to the river as they naturally filter out excess nutrients and phosphates collected in runoff from cities and agricultural areas. As water levels continue to decline, maintaining the river through these wetlands will give more value to the remaining water, critical to downstream users like the Imperial Valley and Mexico. (CRWUA, River Uses, Environment, Multipurpose Wetlands, 2013)

Secondary stakeholders such as the Department of the Interior face great challenges as lower rainfall and over-allocated water is draining reservoirs behind the dams on the river. The Lower water level means access to recreation facilities such as Lake Mead and Lake Powell are cut off. Boat launches and docks sit high and dry, waiting for the rains to refill the lakes (R.Snider 2013). The key stakeholders continue to divert their allotment in the dry years, continually drawing down the reservoirs.

Management plans going forward

As water levels show little sign of improving in the Colorado River Basin, changes to allocation between the states will occur automatically to Arizona and Nevada (*Bureau of Reclamation - Law of the River, 2013*). It is the responsibility of all stakeholders to try to

avoid drastic measures like these automatic cuts. There are opportunities for water efficiency improvements in several sectors.

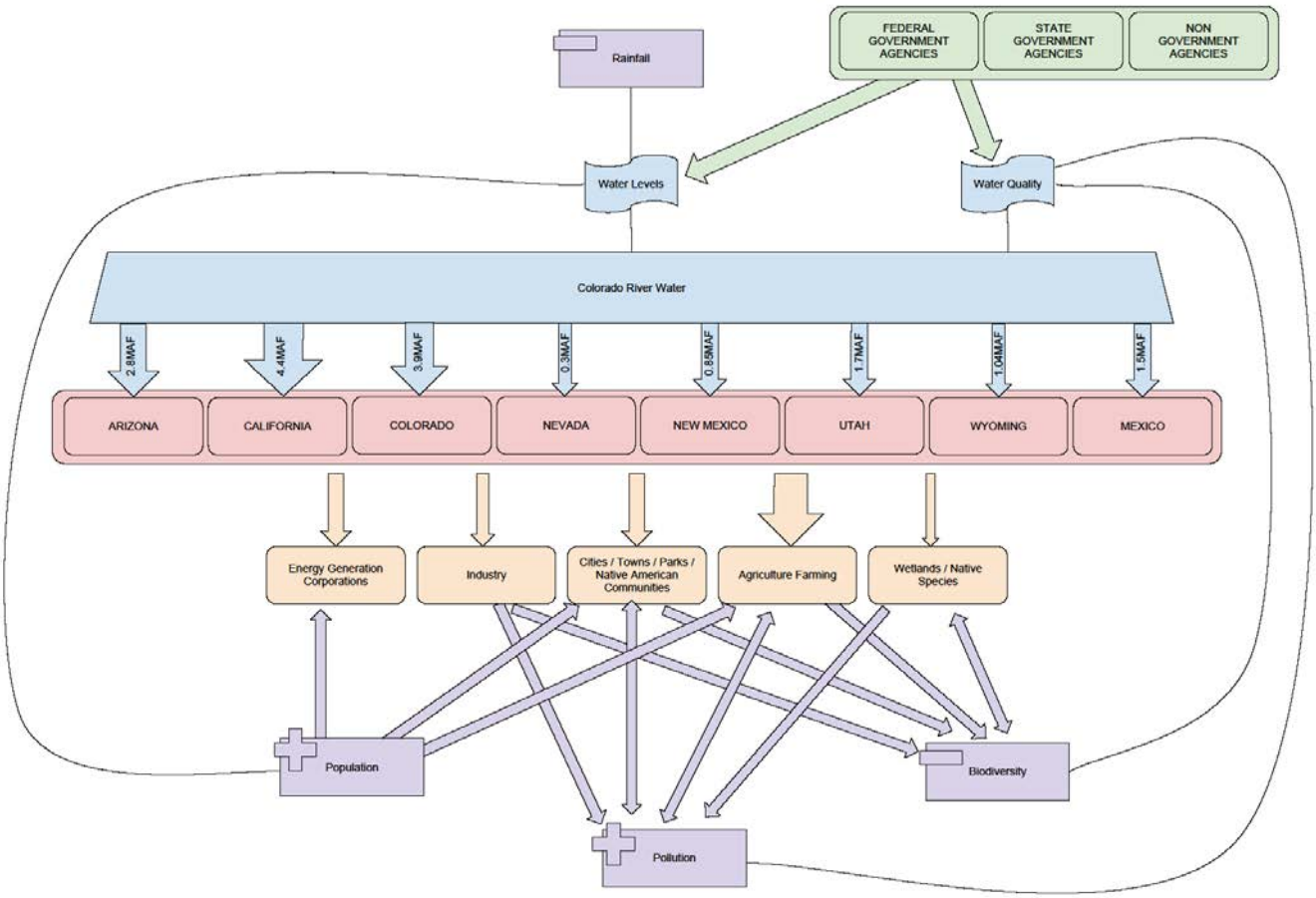
Domestic water uses are moving in the right direction with water saving appliances and fixtures. More can still be done in regards to governmental oversight and non-governmental encouragement. The US Green Building Council promotes their LEED certifications to encourage water efficiency in new and existing buildings. Cities like the City of Scottsdale are offering rebates when home owners transition their green lawns to water efficient xeriscaping. Xeriscaping has been shown to conserve water, but the tradeoff is that local temperatures can be a few degrees higher, requiring more air-conditioning inside the building.

Agriculture is the primary user of the river water, and this is where there is the biggest potential for savings. The list of irrigation districts among the seven states is impressive ((CRWUA, Member States, 2013). There is currently a combination of spray irrigation and drip irrigation in use. Spray irrigation is a very inefficient use of this limited resource, so there is great opportunity to conserve a considerable amount of water with new conservation agreements amongst the agricultural industry.

Conclusions

As we move forward with increasing population and climate change reducing the rainfall which reduces the flow in the river, all stakeholders must work together to preserve the viability of the region. Serious steps to reduce domestic water through efficient fixtures, and drip irrigation employed throughout the entire agriculture industry in the Southwest provide the opportunity to meet increasing demands with lower river levels. Further study is required to look at options in organizing new oversight in the form of a watershed wide agricultural community for water conservation.

SYSTEM MAP


FEDERAL GOVERNMENT AGENCIES
STATE GOVERNMENT AGENCIES
NON GOVERNMENT AGENCIES
Rainfall
Water Levels
Water Quality
Colorado River Water
2.8MAF
4.4MAF
3.9MAF
0.3MAF
0.85MAF
1.7MAF
1.04MAF
1.5MAF
ARIZONA
CALIFORNIA
COLORADO
NEVADA
NEW MEXICO
UTAH
WYOMING
MEXICO
Energy Generation Corporations
Industry
Cities / Towns / Parks / Native American Communities
Agriculture Farming
Wetlands / Native Species
Population
Biodiversity
Pollution

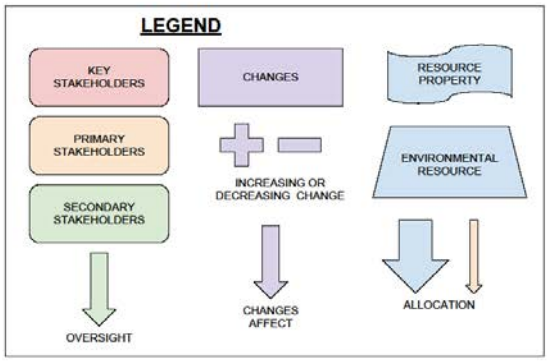

LEGEND
KEY STAKEHOLDERS
PRIMARY STAKEHOLDERS
SECONDARY STAKEHOLDERS
OVERSIGHT
CHANGES
INCREASING OR DECREASING CHANGE
CHANGES AFFECT
RESOURCE PROPERTY
ENVIRONMENTAL RESOURCE
ALLOCATION

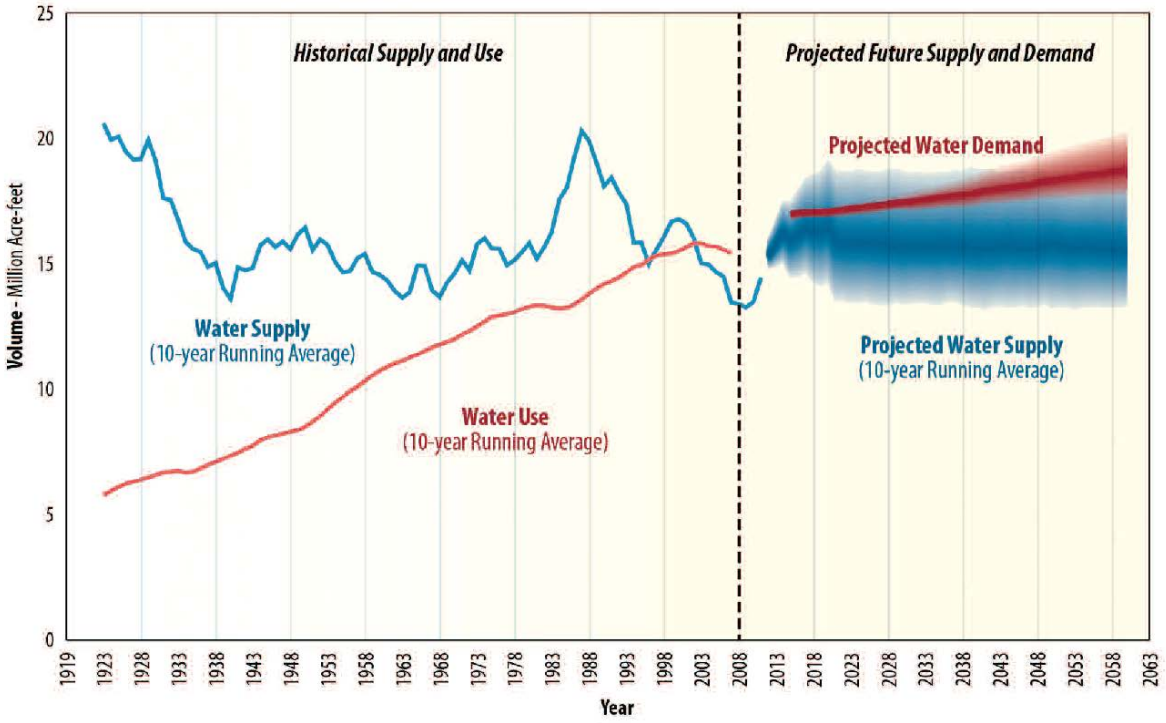
FIGURE 1

The Study Area - the hydrologic boundaries of the Basin within the United States, plus the adjacent areas of the Basin States that receive Colorado River water

Bureau of Reclamation – Colorado River Basin Water Supply and Demand Study, Fig 1.

FIGURE 2

Historical Supply and Use[1] and Projected Future Colorado River Basin Water Supply and Demand



[1] Water use and demand include Mexico's allotment and losses such as those due to reservoir evaporation, native vegetation, and operational inefficiencies.

Bureau of Reclamation – Colorado River Basin Water Supply and Demand Study, Fig 2.

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