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Review Article

Water Use in the Intermontane West

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Abstract

In the nine western states considered in this paper, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming, with the exception on Nevada, more than 70 percent of freshwater withdrawn from the hydrologic system went to irrigated agriculture. With exception of California the dominant crops irrigated were feed crops for cattle and dairy cows. California stands out among the western states in providing fruits nuts and vegetables-the source of approximately half of these products for the nation. Cattle are ubiquitous throughout these nine states and account for a large fraction of the current agricultural output and water use.

Keywords: Agricultural Products; Cattle; Groundwater; Irrigation; Surface Water; Water Use

Introduction

The history of the Intermontane West in the latter half of the 19th Century was one of boom and bust mining camps; many mining camps only lasted a decade or a few decades before collapsing. The Mormon Migration to Utah demonstrated that through diligence one could establish an agrarian based society even in a very arid western environment. The Bureau of Reclamation was created in 1902 to develop irrigation projects in the West; the idea was to foster a cadre of family farms. Finally, the Bureau turned to dams and power generation in an effort to subsidize its poorly paying projects. Even so, the Intermontane West developed a ranching agriculture. While some people think of cattle ranching as a 20th century activity, I will show that a cattle ranching is still the dominant form of agriculture in much of the Intermontane West.

Population

The Intermontane West grew in population during our period of interest; the population of the nine states considered here more than doubled since 1960 (Figure 1).

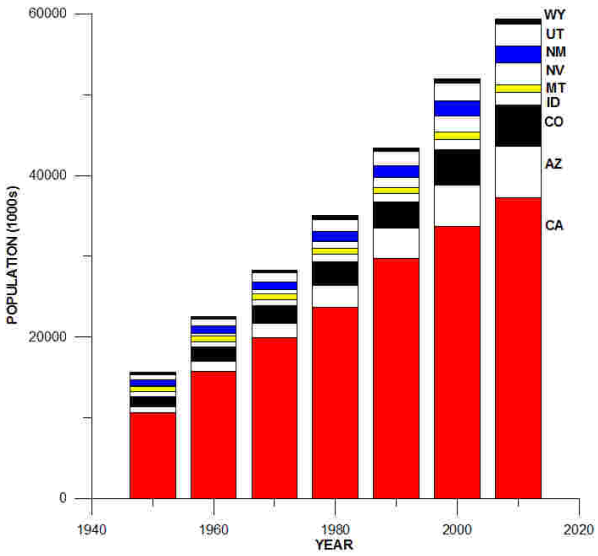

Figure 1: Population of the nine states of interest.

The largest population increases were in California, Arizona, Colorado, and Nevada; states that are urbanizing.

Water

Water is the lifeblood of the West, and has been since the Mormons demonstrated that the West would bloom if water could be brought to the land. This paper deals with water use in nine western states-states that are generally referred to as the Intermontane West, with one additional state California. California is included because its geography and much of its climate, especially in southern California, is similar to much of the adjoining states of Arizona and Nevada. The water supply of southern California is intimately tied to the Colorado River.

Every 5 years the U.S. Geological Survey (USGS) publishes a national summary of water use. Their data show the water withdrawn from the hydrologic system going back to 1960. (After collecting data, it takes the USGS another five years to analyze and publish the information-the last published information is for 2010);

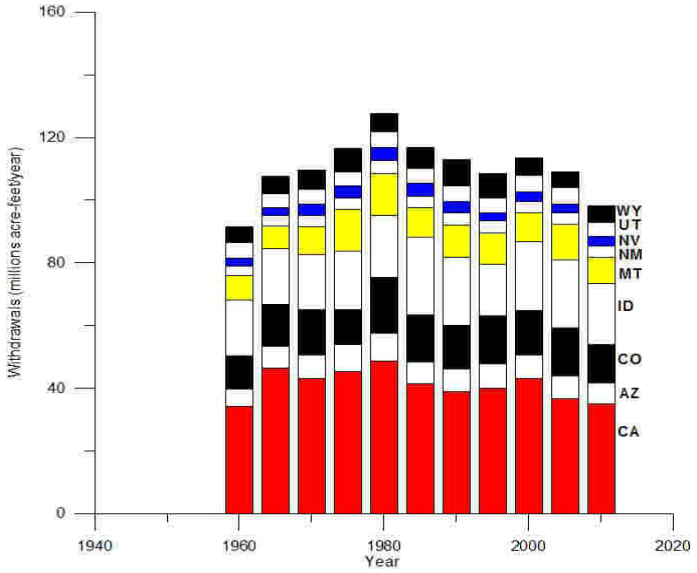

Figure 2: Total withdrawals of freshwater from 1960 through 2010 (from USGS water use data: [1-12].

Water withdrawals increased from 1960 through 1985; during this period the growth in withdrawals generally kept pace with the population growth (Figure 1). After 1985 water withdrawals declined. The decline was marked from 2005 to 2010; looking at the state data the declines after 2000 were especially large in California, Colorado, and Montana. The question is why the decline in withdrawal after 1985?

Why a Decline in Withdrawals?

The short answer is the U.S. stopped building dams. Large scale dam building started in the U.S. in the 1930s with the first project being Hoover (Boulder) dam on the Colorado River. It was followed by numerous other large dams: Bonneville on the Columbia River, numerous dams of the Tennessee River Authority, Fort Peck and other dams on the Missouri River, among others. It was a 45-year era of dam building financed by the Federal Government; only the Federal Government had the resources to build these huge projects. Dams have multiple purposes: flood control, recreation, navigation, and water supply for various purposes. The dams facilitate additional water supply by storing water during periods of high runoff for use later. In the West they store spring runoff.

The era of dam building ended in the 1980s as the country turned away from further dam building--finding other uses for scarce funds. The capacity of dams built in the U.S. during the 20th Centu

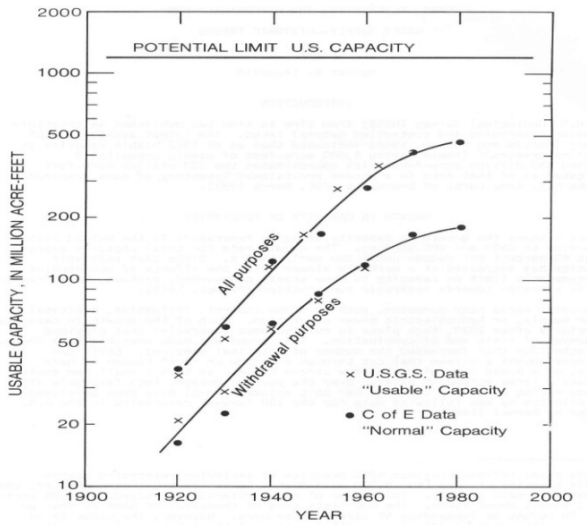

Figure 3: Capacity of dams built during the 20th Century; note the vertical log scale of capacity. [13] ("C of E" is U.S. Army Corps of Engineers; "U.S.G.S." is the U. S. Geological Survey.).

Figure 3 illustrates the country's craze for dam building in the decades of 1940s through the 1980s. The fact that major dam building ended in the 1980s meant that the water supply in the semi-arid West was fixed; it no longer grew. This is reflected in the withdrawal data (Figure 2).

Water Use

Each state manages its water resources. The Doctrine of Prior Appropriation guided development of surface water in most western states. Good water rights on the principal streams of the West date back to the 1800s. By the mid-20th Century all of the reliable surface water in the West was spoken for-someone laid claim to all of it.

A new user coming into the system must acquire his or her water from an established user because all available surface water has been previously appropriated, and those earlier water rights have seniority. The fact that all the water is currently used has led various authors to suggest that there is a crisis in water availability. Society generally allocates commodities using a market; however, there is a very limited market in water. Water is administered and allocated as a public good by a variety of federal, state, and local agencies.

A number of authors commented on water resources; among them: Postal [14], Wood [15], and Pearce [16] addressed a global water shortage. Worsted [17], Reisner [18], Hundley [19], and Glennon [20,21] focused on regional and local problems in the United States. Perhaps more than other authors, Glennon [21] thought that the current situation was in crisis; he titled his book Unquenchable: America's Water Crisis and What to Do about It.

A crisis is defined as a problem that needs immediate attention. If the fact that all the water reliably available in the West is claimed by someone constitutes a crisis, it implies that all the current water uses should continue unabated. The dominant water user is irrigation; a water crisis further suggests that the current irrigated agriculture should continue unchanged. Remaining unchanged is unrealistic as this analysis indicates.

Marc Reisner's book Cadillac Desert: the American West and its Disappearing Water, while published in 1986, is still a classic description of the water resources of the West. In 1992, Reisner published a second edition of Cadillac Desert. For this later edition Reisner wrote a lengthy afterword that expressed his view of the western water world in 1992. Reisner [18] stated: It's only recently-mainly in the years since this book first appeared [1986]-that Westerners have begun to ask where their water goes, what it costs, and what it earns. This inquiry may produce the most revolutionary results since the Reclamation Act. Unfortunately, Reisner died in 2000 at age 51-a great loss to the community. This paper is written in the spirit of Reisner's remarks.

The USGS water use data shows that all of the available reliable water was being used by the 1980s. From that point onward, the water supply could not grow to keep up with the population growth. Withdrawals actually declined after 1985. The withdrawal declined further in 2005 and 2010 in response to drought, further evidence that all the water was being used by someone.

Irrigation

The dominant use of water in all these states is irrigation; it is of interest to see how water is used in this activity.

As suggested above, all the water available was spoken for-the USGS water use data indicates this (Figure2). Meanwhile the population increased (Figure 1), especially in the southwest, and Colorado were rapidly urbanizing. It is enlightening to look at how water is used by irrigation, the dominant water use (Figure 4).

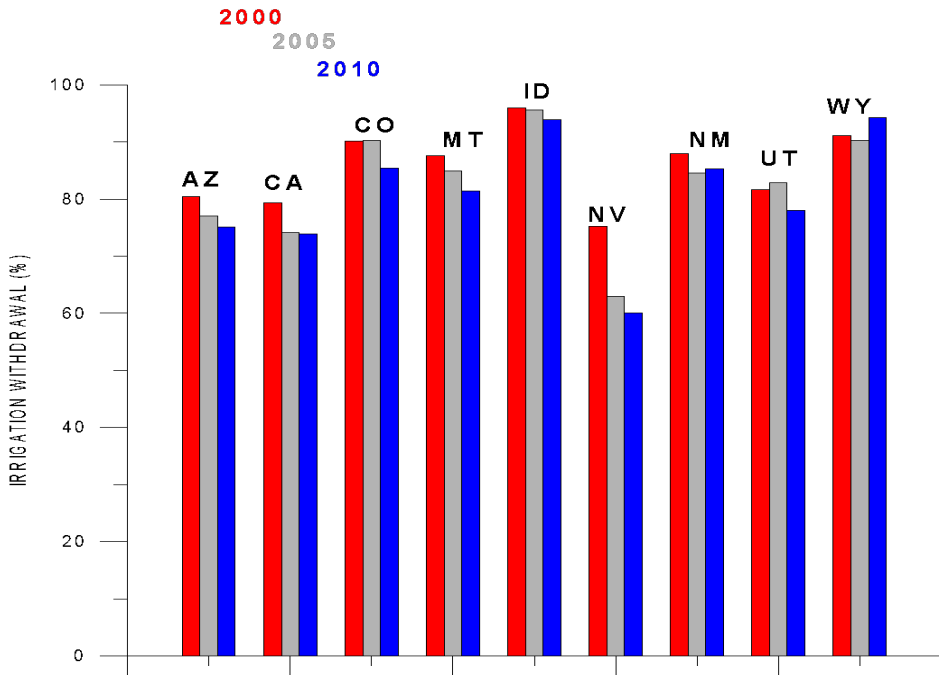

Figure 4: Percent of water withdrawn used for irrigation for the years 2000 (red), 2005 (gray), and 2010 (blue) (from the USGS water use data: [1,2,5].

Everywhere in the nine states, except Nevada, the percentage of water withdrawal going to irrigation is more than 70 percent. Nevada is skewed by withdrawals for Las Vegas, and the fact that there is limited irrigation in Nevada. In five of the nine states, the percentage of water withdrawn going to irrigation is more than 80 percent. In California, there is a constant tension over water between the environmental community and the irrigated farming community. The environmentalists argue for more water being left in the stream to support the aquatic ecosystem, especially salmon. The farmers argue for more water for irrigation to grow the country's food supply.

Both groups are ardent and vocal. Both perspectives have merit.

In some states a large part of the withdrawals is supplied by groundwater (Figure 5).

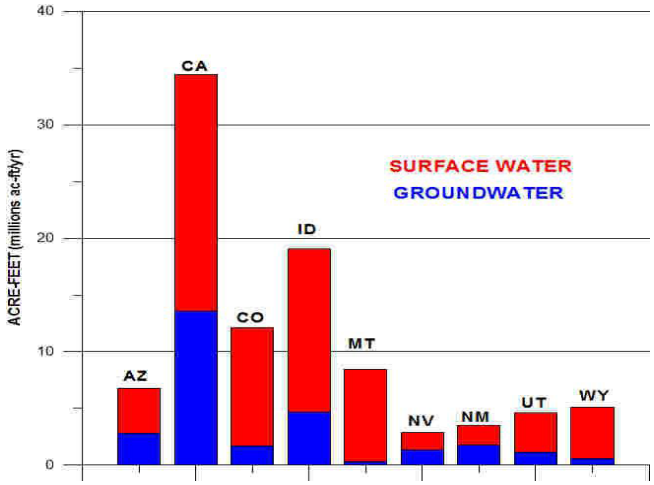

Figure 5: Source of water withdrawn in 2010 [5].

The largest groundwater withdrawals are in California (San Joaquin Valley), and in Idaho (Snake River Plain aquifer). Much of the groundwater pumped in California is from aquifers that are in overdraft; groundwater is being "mined" in California, especially in the San Joaquin Valley. The legislature of California moved in 2016 to bring groundwater pumping under State control; however, the groundwater law will not be fully implemented until 2040. Most other western states had long since moved to control groundwater development.

It is enlightening to look at what crops are irrigated. A question arises as how to make this analysis. Every 5 years the U.S. Department of Agriculture (USDA) conducts a Census of Agriculture: the last Census was 2012. The Census reports the value of agricultural products sold in the U.S. by state (Figure 6).

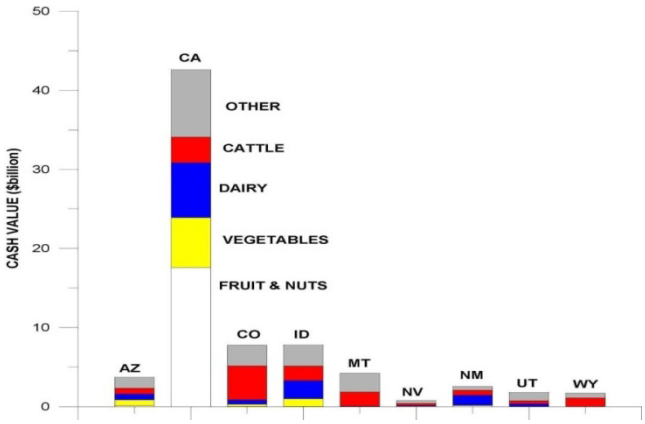

Figure 6: The value of agricultural products by various categories in 2012 in the Intermontane western states [22].

California stands out; approximately one-half of what the U.S. eats on the table is grown in California. The value of the California crops is ten percent of the total value of the nation's agriculture. The category of "other" in California includes cotton, rice, and alfalfa. The only other two states with significant vegetable products are Arizona (lettuce) and Idaho (potatoes). Table 1 shows the acreage being irrigated for selected crops.

	Total	Corn silage	Wheat	Rice	Alfalfa	Other hay	Cotton	Vegetables	Potatoes	Orchards Vineyards Nuts	Pasture
Arizona	880513	30364	65301	0	270449	47960	171902	150378	3303	24800	34897
California	7861964	353651	339188	1051274	654318	437280	274834	1499039	62101	2576801	433570
Colorado	2516785	103598	102472	0	558389	422628	0	98431	50340	2184	296345
Idaho	3365292	203110	700201	0	872207	177917	0	381716	345444	7364	277328
Montana	1903019	36522	164970	0	549849	312134	0	5306	3601	896	384184
Nevada	687790	9740	16923	0	321510	115056	0	8641	0	1203	190179
New Mexico	689318	76556	56367	0	195157	86015	30931	23973	0	45419	89871
Utah	1104257	57351	40956	0	521184	150211	0	63121	821	6347	242890
Wyoming	1435710	37329	7886	0	356859	452370	0	1090	0	1	344215

Table 1: Acreage irrigated for selected crops [23].

Of interest is that there is more than 1 million acres of rice, approximately 175,000 acres of cotton, and more than 650,000 acres alfalfa grown in California in 2013. Otherwise the pattern of irrigated acreage reflects the value of crops depicted in Figure 6.

Cattle Ranching

Referring to Figure 6, cattle are ubiquitous in all nine states, and dairies are present in all states except Montana and Wyoming. Cattle ranching is certainly still a viable agricultural enterprise. The Census of Agriculture counts the numbers of cattle (Figure 7).

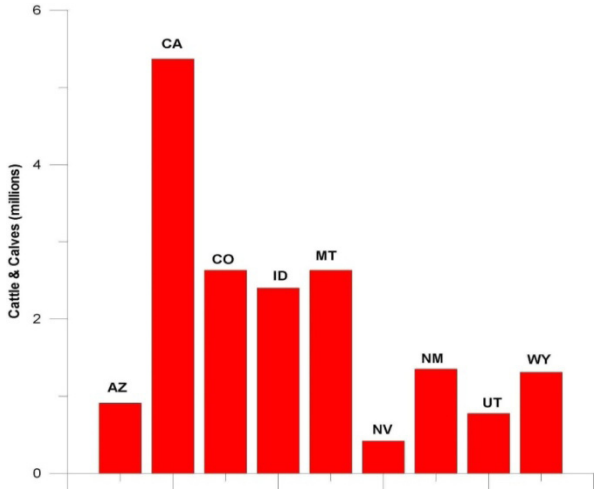

Figure 7: Population of cattle [22].

Although there are approximately 18 million beef cattle in the nine western states, this represents less than 20 percent of the total cattle population of the U.S. It is worth reminding ourselves of the value of cattle and dairy products in the nine inter-mountains states-more than $25 billion (Figure 8).

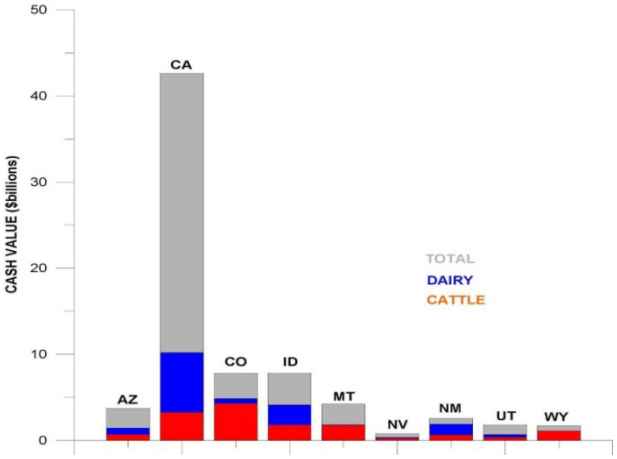

Figure 8: Cash value of cattle, and dairy products [22].

Figure 8 illustrates that cattle ranching is ubiquitous throughout the nine states. Dairies are also important in California, Idaho, and New Mexico. A large fraction of irrigated land is devoted to growing feed crops (Figure 9).

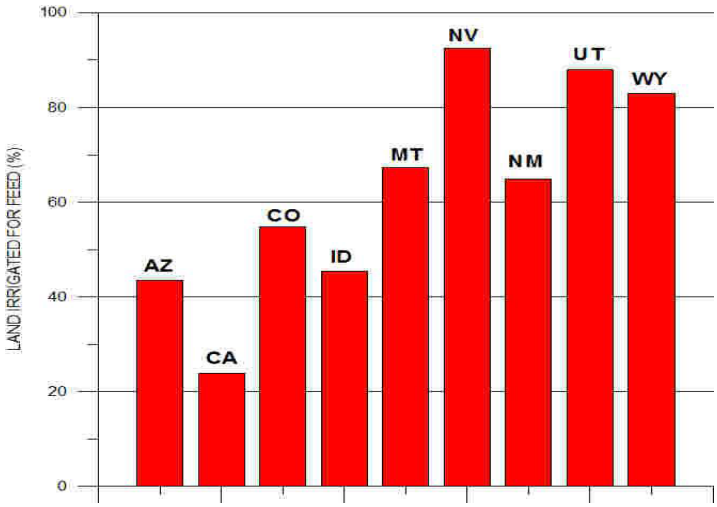

Figure 9: Percentage of irrigated land devoted to feed crops.

Six of the nine states-Colorado, Montana, Nevada, New Mexico, Utah, and Wyoming-devote more than 50 percent of the irrigated land to feed crops; in five of the states the percent going to feed is more than 60 percent. Feed is both for cattle and dairies as shown in Figure 8.

Discussion and Conclusions

One can draw a number of conclusions from the forgoing information:

1. **All of the available water is claimed (appropriated); the USGS water use data confirms this.** Some authors have suggested that there is a water crisis. Others suggest that diverting water away from agriculture will impact the nation's food supply. Only California, Idaho, and Arizona grow significant amounts of vegetables. Only California has significant fruit, nuts, and vineyard agricultural products. Ten percent of the nation's agricultural products are grown under irrigation in California. A decrease in water supply in California could impact seriously the nation's food supply.

2. **In all of the states considered, except for Nevada, more than 70 percent withdrawn goes to irrigation.** Even individuals who recognize that irrigation takes lots of water are surprised by the fraction of the total water withdrawals that go to agriculture. In five of the nine states more than 80 percent goes to irrigation. Even in California almost three

quarters of the water withdrawn goes to agriculture. Except for Montana and Wyoming, groundwater is an important part of the water supply.

3. **Cattle's ranching is a traditional agricultural activity in the West.** Ranching in the West is subsidized by cheap water from Bureau of Reclamation projects, and by grazing permits on the public land. Grazing rights are treated like property rights and are passed along from seller to buyer when ranches are sold. Cattle's ranching is deeply entrenched in the five states that devote more than 60 percent of irrigation water to feed crops (Figure 9). Approximately 20 percent of the cattle raised in the U.S are raised in these nine western states where ranching is so much of the culture. Nevertheless, cattle can be raised throughout the U.S.; they are not unique to the West where it takes lots of water to raise cows. A decrease in water for ranching probably would not greatly impact the nation's supply of beef.

4. **The drought in the West during the 21st Century has caused irrigators in the San Joaquin valley among other places to pump groundwater very aggressively. One can see the impact of the drought in the withdrawal data depicted in Figure 2; there is a marked decrease in withdrawals in California in 2005 and 2010.** Groundwater has made up in part for a lack of surface water; groundwater pumping has gone on virtually uncontrolled by the state. Whether this drought over the Southwest is a harbinger of Climate Change or the result of normal wet and dry cycles is still being debated; even so, it places further stresses the water supply.

5. **New users coming into the system obtain water either from conservation, reuse, pumping groundwater, or from a transfer from agriculture.** Parts of the Intermontane West are growing rapidly, especially Nevada, Arizona, California, and Colorado. Most investigators agree that there are structural impediments to moving water from one sector of the economy to another sector. Looking again at Figure 4, one finds that the percentage of water withdrawn devoted to irrigation declined from 2000 to 2010 in every state except Wyoming. The declines over the 10-year period ranged from 5 to 10 percent. This indicates that even in the face of impediments water is being diverted away from agriculture at a rate of between one half and one percent per year. Raising beef is the activity that will be hit hard as water is diverted away from agriculture. The diverted water goes to support urbanization. The old adage may be cynical, but it is still appropriate: Water moves uphill to money.

6. Rogers and Leal [24], while admitting there are water problems, provide a more hopeful look in which they suggest ways society can conserve and reuse, thus extending the supply.

As the West urbanizes, water will continue to be diverted from irrigation to urban use. As suggested above, the rate of the shift will be slow but inexorable. It is inevitable so long as long as urbanization continues. Over time cattle ranching seems likely to decline in importance as water is diverted away.

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