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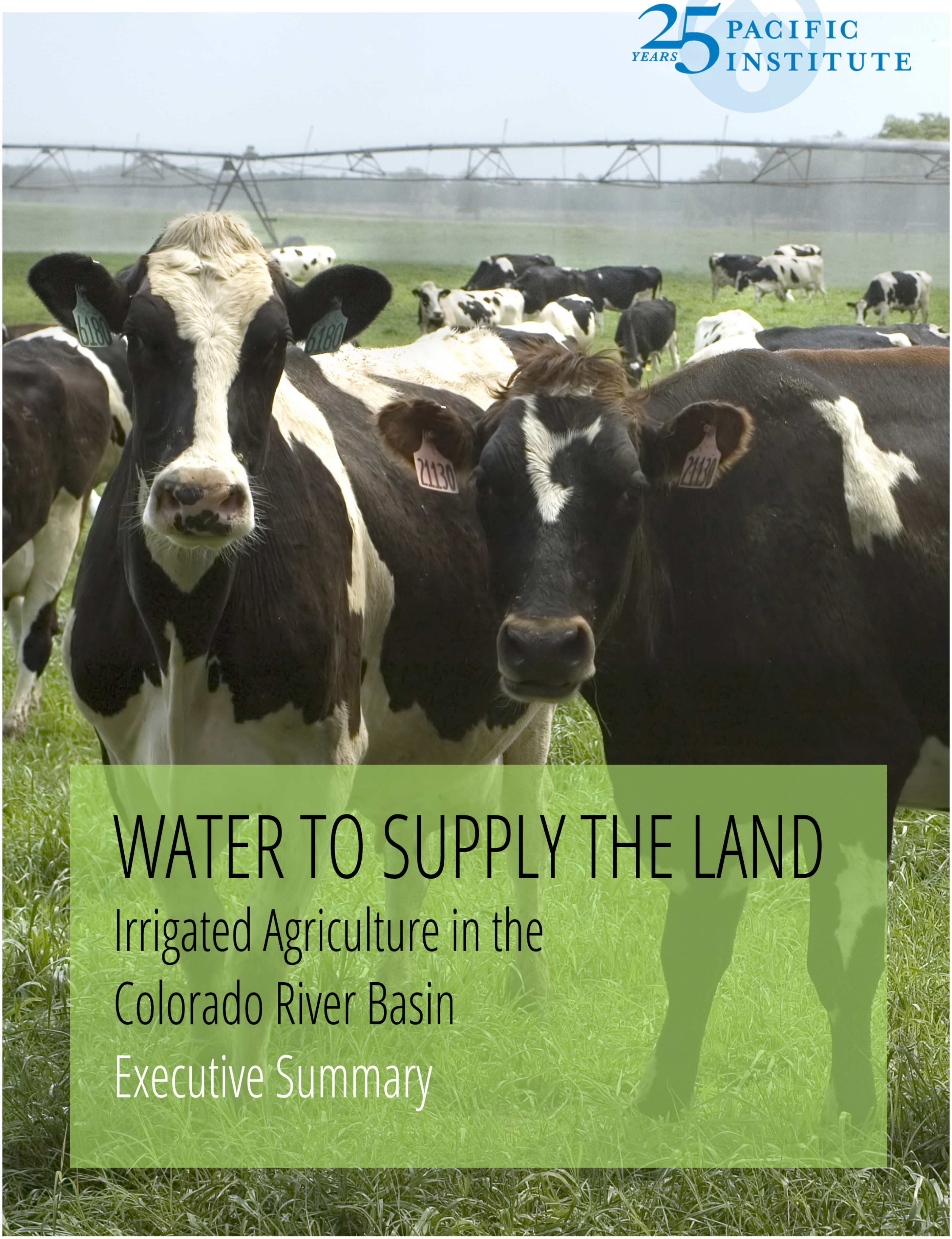

WATER TO SUPPLY THE LAND

Irrigated Agriculture in the Colorado River Basin

Executive Summary

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Executive Summary

The Colorado River basin covers 256,000 square miles in the western United States and parts of northwest Mexico (see Figure ES-1). Much of the basin is extremely arid, in some areas receiving less than three inches of precipitation per year. Irrigation and agriculture are closely linked in the Colorado River basin. More than ninety percent of pasture and cropland in the basin receives supplemental water to make the land viable for agriculture. This irrigated land extends across some 3.2 million acres within the basin, while water exported from the basin reportedly helps irrigate another 2.5 million acres in Colorado, Utah, New Mexico, and southern California. Irrigating this much land requires a lot of water, consuming roughly 70 percent of the basin's water supply (not including evaporation or exports).

As shown by the recent Colorado River Basin Water Supply & Demand Study, limited supply, climate change, and growing demand for water challenge the basin. Irrigators were among the first to divert and put water from the basin to beneficial use, securing legal rights to the use of that water. With some of the oldest and largest water rights in the basin, irrigators face increasing pressure from urban interests to sell or relinquish some of these water rights.

This report has two goals. First, improve understanding of crop acreages and water use in the basin. Second, having assessed irrigation methods and cropping patterns, develop a set of plausible scenarios in which some of the water currently devoted to irrigation could be conserved and used for other purposes without reducing the amount of land in production.

This report focuses on the last decade (2000 to 2010) and addresses land irrigated by Colorado

Figure ES- 1. The Colorado River Basin

River basin water, including water diverted from the river's mainstem, from tributary water, or pumped from groundwater in the basin. The report includes districts within the basin as well as those outside the basin that import basin water for at least a portion of their water supply and for which information was available. The data in this report come from federal and state sources, primarily the Bureau of Reclamation, the USDA/NASS Census of Agriculture, and the USGS estimate of water use. We performed no new measurements or surveys for this report.

Part I – Irrigated Acreage Inventory

About 90 percent of the pastureland and harvested cropland in the Colorado River basin is irrigated. This report highlights several important points about this irrigation:

1. More than half of the land and water use in the Colorado River basin is dedicated to feeding cattle and horses;
2. The Upper and Lower basins exhibit very different trends in the extent of irrigated acreage over the last decade and the types of crops grown;
3. Irrigation water use trends are less clear; and
4. State and federal agencies frequently report inconsistent irrigated land and water use information for areas within the Colorado River basin, obscuring key basin issues and hampering efforts to reconcile the basin's water supply and demand challenges.

Irrigated pasture and forage crops, used primarily to feed beef and dairy cattle and horses, cover about two million acres (60 percent) of the irrigated land in the Colorado River basin. We estimate that irrigated pasture and forage in the basin consume more than five million acre-feet of water each year. Alfalfa, planted extensively from Wyoming to the delta in Mexico, alone covers more than a quarter of the total irrigated acreage in the basin. Arizona, California, and Mexico have more crop diversity than the other states in the basin, with hundreds of thousands of acres in vegetables, wheat, and cotton. Nevertheless, Arizona, California, and Mexico's 750,000 acres of forage crops and pasture in the basin consume roughly three million acre-feet of water each year.

Trends in irrigated acreage reveal clear geographic differences. In Upper Basin states, the amount of irrigated acreage fell in the early part of the last decade, only to recover or surpass previous acreages by decade's end. In contrast, the amount of irrigated acreage in Mexico's portion of the basin remained relatively flat while the Lower Basin saw continued declines in irrigated acreage over the decade. The conversion and transfer of irrigation water to urban uses in all three Lower Basin states led to this reduction of total Lower Basin water use generally and reductions of irrigated land and water use for irrigation more specifically.

One of the most unexpected revelations of this study is the marked disparity in the different state and federal agencies' reported extents of irrigated acreage and volumes of irrigation water use. The agencies report different aspects of irrigation water use, complicating efforts to compare their reported values. Despite these limitations, the available information provides a revealing overview of recent land and water use in the Colorado River basin.

Part II – Conservation and Efficiency Options

Consuming more than 70 percent of the developed water supply in the Colorado River basin, irrigated agriculture is an obvious candidate for water conservation. Given available information on agricultural water use, we estimate potential water savings based on various conservation scenarios involving regulated deficit irrigation, crop shifting, and advanced irrigation technologies, without taking land out of production. We note that reductions in water use in the irrigation sector for transfer to municipal use should be contingent upon prior implementation of aggressive municipal conservation and should be on a voluntary basis only.

Table ES-1 on the next page shows the potential water savings, in both total applied water and in consumptive use, for the three general water conservation strategies explored in this report. With the exception of the conversions from flood to sprinkler irrigation, these strategies could generate large volumes of transferable conserved water at relatively low cost. This is very encouraging. We assume that other interests (such as municipal water agencies or wildlife agencies) would compensate irrigators for implementing the changes, so total costs would need to be negotiated and presumably would include some additional incentive payments to irrigators. We estimate that one of the least expensive options could reduce consumptive use by more than 800,000 AF.

We note that not all consumptive water use savings may be available for transfer, due to state legal restrictions, water rights limitations, and other challenges. We acknowledge that water rights holders are under no obligation to transfer their water to urban or instream uses: we assume that all such transfers would be voluntary and would be compensated. Furthermore, when considering crop switching or deficit irrigation, there are implications related to demands for specific crops that will affect individual producer's decisions.

Typically, only consumptive-use savings can be transferred. However, total reductions in applied water (and more broadly in total withdrawals) could offer significant benefits for general water quality, stream health, and (in the case of groundwater extraction) the sustainability of local aquifers.

Table ES- 1. Summary of Scenarios

Scenario	Description	Applied water savings (AF)[a]	Consumptive use savings (AF)	Base costs
Scenario 1a: Basin-wide RDI	Applied to alfalfa in the entire basin	>970,000	970,000	$81/AF
Scenario 1b: Lower Basin RDI	Applied to alfalfa in the Lower Basin only	>834,000	834,000	$62/AF
Scenario 2a: Decreased cotton, increased wheat	70,000 acres of cotton substituted by wheat	>90,000	90,000	$112/AF
Scenario 2b: Decreased alfalfa, increased sorghum	74,000 acres of alfalfa substituted by sorghum	>140,000	140,000	$96/AF
Scenario 2c: Decreased alfalfa, increased cotton and wheat	74,000 acres of alfalfa substituted by 37,000 acres of cotton and 37,000 acres of wheat	>250,000	250,000	$36/AF
Scenario 3a: Basin-wide improved irrigation technology	Basin wide: 25% shift from flood to sprinkler	175,000	60,000	$450-$1,500/AF[a]
Scenario 3b: Lower Basin improved irrigation technology	Counties with no return flows: 25% shift from flood to sprinkler	60,000	60,000	$470 - $1,600/AF[a]

Notes: RDI - regulated deficit irrigation.
(a) These are estimated costs per AF reduction in total applied water savings, not base costs per AF consumptive use savings.

Conclusions and Recommendations

Irrigation and agriculture are closely linked in the Colorado River basin. The total volume of water diverted from surface sources and pumped from the ground for irrigation in the Colorado River basin as a whole (including Mexico) reportedly exceeded 18.5 million acre-feet in 2005, while the total consumptive use by irrigation in the U.S. portion of the basin that year was about half as much. Yet even this massive volume of water, equivalent to more than half of the river's annual flow, was insufficient to meet the total demand for irrigation in the basin, as shown by various estimates of agricultural water shortages. As John Wesley Powell stated more than a century ago, there is not sufficient water to supply the land.

This report clearly describes the large amount of land and water in the Colorado River basin devoted to growing pasture and crops used to feed livestock. Shorter growing seasons and cooler climates, as well as limited upstream water storage and water availability, account for lower irrigation water consumption (per acre) in the Upper Basin than in the Lower. In fact, about four times more water is delivered to Lower Basin and Mexican fields than to Upper Basin fields. Excluding Mexico, in 2005 irrigated agriculture in the Lower Basin (including the Salton Sea watershed) consumed three times more water from the Colorado River basin than it did in the Upper Basin. These disparities demonstrate that irrigated acreage does not represent the volume of basin water use, and underscore the differences between Upper and Lower basin irrigation.

As noted in the *Colorado River Basin Study*, in the context of rising municipal demand, the need for healthy stream flows and climate-change's projected impact on supply over the next half-century, it is informative to consider ways to reduce irrigation water demand while maintaining a healthy agricultural sector and rural economies. The projected savings under the various scenarios evaluated in Part II of this report provide encouragement, with consumptive water use savings of almost a million acre-feet achieved by irrigating alfalfa less frequently. Other scenarios, such as shifting from water-intensive to less water-intensive crops, also yield impressive water savings at relatively low cost, without reducing the total amount of irrigated acreage in the basin. The magnitude of the potential water savings and the range of costs associated with these changes suggest considerable potential for reducing irrigation while keeping agricultural land in production.

Recommendations

The magnitude of the potential consumptive water use savings generated under this report's scenarios – especially by applying regulated deficit irrigation to alfalfa acreage in the Lower Basin and by shifting a small portion of alfalfa acreage to other, less water-intensive field crops – compels in-depth, site-specific analyses. So long as the already high demand for water in the basin and adjacent areas continues to grow and those with growing demands have already implemented aggressive water conservation measures of their own, relatively low-cost, high-yield programs such as regulated deficit irrigation and shifts to less water-intensive crops should be developed and implemented.

As we described in our companion *Municipal Deliveries* report (Cohen 2011), growing municipal demand should first be addressed by improving municipal water conservation. It makes little sense to pursue deficit irrigation of alfalfa unless municipal water agencies and their ratepayers have implemented their own aggressive water conservation measures. As cities improve their water conservation rates, regulated deficit irrigation may be implemented most appropriately as a drought response measure, keeping land in production while transferring some portion of the irrigation water requirement to cities struggling with significant shortages and to streams facing greatly diminished flows and threatened aquatic species. Crop shifting could also be implemented in the context of projected water shortages, incentivizing willing producers to plant less water-intensive crops and transfer a portion of the resultant water savings to improve supply predictability for cities or other irrigators.

Given the surprisingly disparate accounts of irrigated acreage and irrigation water use provided by the different state and federal agencies, we recommend that the relevant agencies develop and implement better and more consistent approaches to tracking and quantifying annual irrigation data. We encourage the Bureau of Reclamation to confer with other state and federal agencies and with state water agencies and irrigation districts to coordinate measurement and reporting of irrigation and cropping patterns and to clearly explain any differences that may arise in their respective reports. As noted in the recent *Colorado River Basin Water Supply & Demand Study*, rising demand and diminishing supply frame the future of the basin. The luxury of not measuring or compiling information on water use and irrigated land can no longer be afforded. Greater effort must be made to resolve these data challenges.