

# The Sustainable Use of Water in the Lower Colorado River Basin

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A Joint Report of the



PACIFIC INSTITUTE  
FOR STUDIES IN DEVELOPMENT, ENVIRONMENT, AND SECURITY

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Policy Project**

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## About the Project

An in-depth case study of the lower Colorado River basin has been chosen in an effort to make tangible what are sometimes vague notions of sustainability. The aim of the case study is to clarify key concepts and criteria for sustainable water use within a river basin or geographic region, and then, using those criteria, present patterns of water use, allocation, and management that are environmentally sound and sustainable. While some issues are unarguably specific to the Southwestern United States, it is our intent that the broader findings of the Colorado River case study will provide insight into sustainable river basin management worldwide.

This research project is particularly timely in light of new institutional developments in the realm of international water issues. Agenda 21, the “plan of action” that emerged from the 1992 Earth Summit, contains a separate chapter on water and sustainable development. In 1993, the World Bank released its new water policy paper, also making the connection between water management and sustainability. In neither case, however, is a clear vision of water and sustainability spelled out. Nor are there clear criteria or principles to guide decision making in this area. The authors believe the findings and recommendations of the Colorado River case study will significantly contribute to this emerging field of sustainable river basin management. The findings of this report express the views of the authors and not necessarily those of the United Nations Environment Programme or the Turner Foundation.

## About the Pacific Institute

The **Pacific Institute for Studies in Development, Environment, and Security** is an independent, non-profit center created in 1987 to do research and policy analysis in the areas of environment, sustainable development, and international security. Underlying all of the Institute’s work is the recognition that the pressing problems of environmental degradation, regional and global poverty, and political tension and conflict are fundamentally interrelated, and that long-term solutions must consider these problems in an interdisciplinary manner. The Institute’s mission is to conduct and distribute meaningful and usable research and policy suggestions on the interactions among these issues. The organization seeks to produce quality, impartial research and to make sure it is accessible not only to public and private-sector decision makers, but also to community groups and the public at large. The ultimate objective of the Pacific Institute’s work is to contribute to equitable and sound development, the reversal of environmental degradation, and regional and international peace and security.

## About the Global Water Policy Project

The **Global Water Policy Project**, based in Amherst, Massachusetts, was initiated in 1994 to promote the protection and sustainable use of the world’s water resources through policy-relevant research and outreach. It is motivated by the recognition that water scarcity and the growing imbalance between human demands and nature’s water supplies pose multiple threats to human societies and the ecosystems upon which they depend. The GWPP aims to demonstrate the role of new strategies — including conservation, efficiency, and innovative policy tools — in achieving more ecologically sound water use; to help shape new national and international water policies; to educate decision makers and the public about water issues; and to motivate action at the local, national, and international levels to begin moving toward more sustainable use of the planet’s finite sources of water.

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# THE SUSTAINABLE USE OF WATER IN THE LOWER COLORADO RIVER BASIN

## Executive Summary

Water is a prerequisite for life, and a key ingredient in virtually all human economic activity. In regions where demands for water approach or exceed the limits of available supplies, competition intensifies among various interests — turning water scarcity into a potential source of conflict. Scarcity often also results in unhealthy aquatic ecosystems because of alterations in the timing, quantity, and quality of freshwater flows needed to sustain their natural functions. This ecological degradation, in turn, spawns a variety of undesirable economic and social effects.

The lower basin of the Colorado River is a prime example of the consequences and challenges posed by increasing water scarcity. The aim of this study — a joint project of the Pacific Institute for Studies in Development, Environment, and Security and the Global Water Policy Project — is to clarify key concepts and criteria for sustainable water use within the Colorado basin, and then, using those criteria, to present patterns of water use, allocation, and management that can continue to support economic prosperity while maintaining ecological integrity.

We do not presume to offer a single or *best* solution to water problems in the lower Colorado basin. Rather, our goal is to define — both quantitatively and qualitatively — the unsustainable nature of current patterns of water use, and to demonstrate how technologies, policy actions, and management strategies can be combined to achieve more sustainable water use. While it is up to the region's stakeholders to reach consensus on a vision for future water use in the basin, we are convinced that the basic principles of efficiency, equity, and ecosystem integrity offer the best guidance toward reducing socio-political conflict and ecological degradation over the long term. We believe that the concepts, analytical approach, and broad findings of this case study can provide insight into sustainable river basin management worldwide.

## THE COLORADO RIVER: LIFEblood OF THE SOUTHWESTERN UNITED STATES AND NORTHWESTERN MEXICO

The Colorado River supplies water to nearly 30 million people and irrigates more than 1.5 million hectares of farmland in Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and the Republic of Mexico. Spanning 2,300 kilometers and eventually running through Mexico to the Sea of Cortez (known north of the border as the Gulf of California), the river has been the lifeblood for the arid southwestern United States and the Mexicali Valley of Mexico. As the end of the 20th century approaches, the Colorado River basin is entering a crucial juncture. Among the most critical issues is the need to integrate into water management the many values that are not explicitly recognized in the current approach — most notably fisheries protection, recreational uses, and other ecological and cultural values.

Put simply, under current laws and management regimes, there is not enough water in the system to satisfy all future human demands and to protect the river's ecological functions. However, there is now a rare opportunity for diverse groups to work together to create new approaches to achieving sustainable and secure patterns of water use. With proper foresight, solutions can be identified that will allow the river to be managed in a more equitable manner, avoid the growing potential for conflict among water users, and prevent the additional loss of biodiversity and habitat.

While the upper Colorado River basin will play an integral role in the long-term management of the river, the focus of this report is the lower basin in the United States and the Republic of Mexico. We fully recognize that optimal solutions for a sustainable basin can only be achieved by considering the river as a whole, and through cooperation among all stakeholders within the basin. However, because many of the more immediate and controversial issues are specific to the lower basin, most of this report centers on this region.

## **THE PROBLEM: CURRENT WATER MANAGEMENT AND USE IN THE BASIN ARE UNSUSTAINABLE**

In the last several years, it has become evident that traditional water policies, which permitted the region to become the agricultural and economic force it is today, are not up to the task of meeting the challenges of the 21st century. Yet water institutions and policymakers have taken only limited steps to develop new tools and approaches for addressing these new challenges. The following circumstances indicate the unsustainable nature of current management and use of Colorado River basin water resources.

### ***Projected regional water demand exceeds available supply***

Long-term planned use of Colorado River water exceeds the reliable available supply. Considerably more water has been committed to users than the river can reliably deliver — even without considering the water needs of aquatic ecosystems. The lower basin, in particular, is approaching its legally apportioned limits.

### ***Without further action, it is almost certain that a number of fish species in the Colorado River system will become extinct***

Current and past river management practices have adversely affected ecosystem health. The lower Colorado River “ecoregion” currently supports 24 federally-listed endangered and threatened species, one proposed for listing, four candidate species, and 67 species “at risk” of being listed (F&WS 1995a). The introduction of non-native fish species and dramatic physical changes brought about by major dams and water withdrawals have greatly affected native fish populations. In addition to the four native “big river fish” of the Colorado River that are now close to extinction, the totoaba, a large steel-blue fish that used to breed in large numbers in the brackish waters of the Colorado estuary, is also listed as endangered under the U.S. Endangered Species Act. Its survival is jeopardized in part by the alteration of habitat in the lower river delta-estuary system caused by the reduction in freshwater flow to the sea.

### ***Without further action, the ecological and human communities of the Colorado River delta will be destroyed***

Prior to major dam construction and water withdrawals, the delta was lush with vegetation and wildlife. Natural flows replenished the delta with silt, delivered nutrients for

fish and other life in the Sea of Cortez, and nourished the largest and most critical desert wetland in the American Southwest. Virtually the entire flow of the river is now captured and used before reaching the river's mouth — desiccating the delta, shrinking wetlands, cutting off nutrients to the sea, reducing critical habitat for Gulf fisheries, and bringing ruin to the economic, social, and cultural life of local human populations, which include the native Cocopa Indians, a 2,000-year old culture of fishers and flood-recession farmers.

Moreover, the Cienega de Santa Clara, the largest wetland bird habitat remaining in the delta, is sustained mainly by agricultural drainage water from the Wellton-Mohawk Irrigation District in Arizona — a water supply that is not secure. Should the completed, but now idle, Yuma desalting plant come on line and the Wellton-Mohawk drainage be channeled to the Colorado mainstem rather than to the Cienega, these vital wetlands could largely disappear.

### ***Long-term groundwater pumping exceeds replenishment in major portions of the lower basin***

Groundwater overdraft on an annual basis occurs in all three of the lower basin states and also in Mexico's Mexicali Valley. We estimate that average annual groundwater overpumping in the lower basin (including Mexico) totals 1.24 million acre-feet (maf), with about 80 percent of the total occurring in Arizona.

### ***The current institutional structure cannot address existing challenges***

The fact that there is no entity in the Colorado basin that is responsible for long-term planning makes it nearly impossible to develop a comprehensive plan of action for the river basin. Numerous international, federal, and state agencies each having only partial roles in the river's management has led to piecemeal attempts to plan for the river's future. The fragmented nature of the interests at play limits the ability to formulate and implement any integrated strategy for basin recovery.

### ***Water rights of Indian tribes in the basin remain unsettled***

The complicated legal nature of defining, quantifying, and integrating Indian water rights claims is one of the most complex and difficult management issues facing the Colorado River. Because these yet unsettled rights involve potentially large quantities of water (Indian claims in Arizona alone could total 3.1 maf per year, according to some estimates) and are senior to most non-Indian rights, they could substantially affect existing water uses around the basin. That these rights remain unquantified and unsettled is both a persistent inequity in the basin's water use as well as a hindrance to long-term planning.

### ***Global climatic changes may have a significant impact on the future of both water supply and demand***

Global climatic changes have the potential to significantly alter both the intensity and magnitude of climatic events in the western United States, leading to new and unanticipated climatic regimes. Colorado River basin water supply, hydroelectricity generation, reservoir levels, and salinity are all sensitive to both the kinds of changes that are expected to occur and to the policy options chosen to respond to them. However, water planners and managers have yet to take climate change into account.

## **MOVING TOWARD A SUSTAINABLE RIVER BASIN: MAJOR RECOMMENDATIONS**

The sustainable use of water resources requires maintaining the renewability of the resource as well as the integrity of the flora, fauna, and human societies that have developed around them. Rather than trying to find the additional water to meet some projection of future desires, it is time to plan for meeting present and future human and ecological needs with the water that is available, and to determine what desires can be satisfied within the limits of the resource. Sustainability criteria offered in this report provide a framework for prioritizing competing interests and for making decisions about water use, taking into account both the needs of the current population and those of future generations. We believe the goals summarized below can be achieved given a re-orientation of the way basin interests think about and manage water. More importantly, while people may argue about the details of the goals to reach, we believe the overarching principles of sustainability – such as committing some amount of water to critical ecosystems, including the delta – are vitally important.

### ***Allocate water to protect ecosystem health in the basin***

It is essential that all parties acknowledge the need to restore and protect freshwater ecosystems in the basin and to allocate the water necessary to do so. While defining and quantifying these needs are difficult, failing to do so will lead to continued degradation of the environmental health of the Colorado River basin. Long-term priorities include allocating and managing water for endangered and threatened species, restoring some basic level of water supply to the Colorado River delta, and protecting and restoring remaining delta wetlands. Although the delta cannot be restored to its pre-dam condition, valuable wetland systems and habitats remain in the delta and urgently need protection. In the short run, modified management of flood waters and agricultural drainage water in the delta region could restore a substantial area of critical wetland habitat, benefiting endangered species, waterfowl and other birds, and local human populations. In particular, it is vital to maintain agricultural drainage flows into the Cienega de Santa Clara. While the quality of the flows is poor, this supply of water is necessary for the survival of the largest remaining wetland in the region.

### ***Negotiate an environmental component to the 1944 Colorado River Treaty***

Any effort to meet basic environmental water needs, particularly in the Colorado River delta region, must involve international cooperation and agreement for two reasons. First, water users in the U.S. portion of the basin are concerned that any water reallocated for delta restoration and maintenance would never reach its intended use due to the high likelihood of diversions by agricultural interests once it crosses the border into Mexico. Second, the fact that Mexico has legal entitlements to less than 10 percent of the river's average annual flow makes it both unrealistic and inequitable to assume that Mexico have sole responsibility for delta restoration. Given the current legal framework and distribution of water entitlements in the basin, any successful ecosystem restoration program for the delta will require a cooperative binational effort, and most likely a formal international agreement such as an addendum to the 1944 treaty between the two countries.

In any such treaty negotiations, it would be necessary to determine an equitable distribution of each party's obligation to meet environmental water needs in the delta. A possible approach would be to allocate the responsibility among the basin states and Mexico in proportion to current Colorado River entitlements. Political entities within

each state would then determine a just method for distributing obligations and freeing up water for its environmental commitment.

### ***Eliminate long-term groundwater overdraft***

The massive and long-term overdraft of groundwater resources in nearly every region in the lower basin is unsustainable and reduces options available for future generations. Groundwater overpumping persists despite legislative and other efforts to bring it under control. More effective policies to eliminate this unsustainable practice, such as groundwater depletion taxes, should be implemented immediately to encourage groundwater use to come into balance with recharge.

### ***Restructure water institutions to promote planning for sustainable water use***

Given the limited ability of existing institutional structures to solve the problems of the basin, greater thought and attention should be given to integrating the planning and management efforts of the various agencies and entities in the region. In particular, more democratic participation and decision making are needed to identify long-term goals and priorities. Cooperative efforts among federal, state, international, and non-governmental interests will be required to remedy the problems of the Colorado River. Such collaborative efforts could be encouraged with a comprehensive river basin commission, with open and direct connections to the existing institutions and organizations that play a role in decision making and policy.

### ***Link land use planning to water planning***

Planning new land-use developments without considering the water implications of those developments leads to unsustainable uses of water. Integrated planning can avoid this problem. In particular, it is important that new urban developments in areas of severe overdraft be curtailed unless a long-term “assured water supply” can be demonstrated.

### ***Define, quantify, and integrate Indian tribes’ water rights***

Settling all outstanding Indian tribes water rights claims should be a top priority for federal and other stakeholders as a first step toward a comprehensive management strategy for the basin. Unless this is resolved, it will be difficult to restructure the institutions of the basin in a way that ensures long-term comprehensive management of the region’s water supplies. It is essential that Indian tribes be included early and participate continuously in such long-term planning efforts.

### ***Fill water data and information gaps in the region***

There are considerable gaps in information, data, and knowledge about the water resources of the region. These gaps hinder development of an acceptable and broad set of recommendations and solutions to current basin problems.

## **STRATEGIES AND POLICY TOOLS FOR SUSTAINABLE WATER USE**

Clearly, what can be done to move toward more sustainable patterns of water use is not necessarily what will be done. A decision to reallocate water away from human activities toward ecological systems, for example, depends on social values as well as a clear understanding of the costs — economic, social, and cultural — of such an action. In order to make sound decisions about the basin’s future, it is important that all tech-

nical and policy options for achieving more sustainable water use be clearly articulated and understood. Because of the limited opportunities for augmenting water supplies in the region, the most promising prospects for *new* water will depend on reducing and managing water demand. Conservation, increased efficiency, recycling, reuse, changes in the agricultural crop mix, and the retiring of agricultural land are among the cost-effective measures for saving water. These strategies can be combined to reach the sustainability goals described in this report and sustainable water future.

### ***Improvements in the agricultural sector can free large volumes of water for other uses***

The agricultural sector uses almost two-thirds of the water in the lower Colorado River basin and offers the greatest opportunities for savings. For example, improvements in irrigation efficiency can free significant amounts of water for environmental or other purposes. For Arizona, we estimate that upgrading half of all irrigated cotton and major vegetable and citrus crops to drip or other microirrigation techniques, and upgrading half of irrigated alfalfa, wheat, and barley to more efficient irrigation methods could save on the order of 445,000 acre-feet of water per year.

Shifts in cropping patterns and fallowing of cropland can also free substantial quantities of water. To illustrate, we show that shifting one-quarter of Arizona's cotton and alfalfa irrigated areas to higher-value citrus and vegetable crops could save some 362,000 acre-feet per year. Fallowing 15 percent of irrigated cotton and alfalfa areas in Arizona could save an additional 433,000 acre-feet. In total, we estimate that these approaches can lead to 1.24 million acre-feet of water savings — a reduction sufficient to eliminate groundwater overdraft in the state and to provide a substantial amount of water for environmental restoration efforts in areas such as the delta. Comparable savings are possible in the regions of California and Mexico that use Colorado River water.

### ***Effective urban conservation efforts can reduce anticipated future needs***

Urban conservation, once viewed as just an emergency response to drought, has been transformed over the last two decades into a sophisticated package of measures that offers one of the most cost-effective and environmentally sound ways of balancing water budgets and moving toward more sustainable patterns of water use.

Successful efforts to curb domestic water use permanently will include a combination of economic incentives, efficiency standards and regulations, voluntary retrofits, and public outreach that together promote the use of water-saving technologies and behaviors. Successful conservation programs not only yield cost-savings because of reduced or delayed capital and operation and maintenance expenditures, but can keep fresh water in rivers, streams, and aquifers.

### ***Rational pricing and other economic incentives can encourage conservation, recycling, and efficiency***

A variety of economic tools can be implemented in both the urban and agricultural sectors to promote greater efficiency in both the use and allocation of the region's water. These tools include the following:

- Properly designed pricing structures can promote water conservation and efficiency and encourage reuse and recycling.
- Low-interest loans can make it more attractive for water users to invest in conservation and more efficient technologies.

- Water depletion taxes, which raise government revenue while discouraging inefficient resource consumption, could be applied to groundwater overdraft.
- Increased assessments could be instituted on all uses of Colorado River water to help pay for “public good” uses of the river such as ecosystem restoration and maintenance.
- Voluntary water transfers can move water from “low-valued” uses to “higher-valued” uses, as well as encourage conservation and greater efficiency. Community participation in decisions to move water from a region should be a necessary condition of any transfer.
- Surcharges on all voluntary water transfers of Colorado River water can be set aside for environmental restoration.
- Water “banked” on the Colorado mainstem by a basin user could be subject to a water surcharge or monetary fee. Water or money generated through such a program could be used for environmental purposes.

### ***Regional planning can slow and then stabilize population growth***

Stabilizing or decreasing per-capita water demand and shifting some water from agricultural to urban uses will buy time for water planners and managers. However, while politically more difficult, slowing the rate of population growth in the region is also essential for achieving sustainable patterns of water use. Ultimately, reaching a sustainable equilibrium in a water-short basin such as the Colorado will require a stable population. In the interim, urban planning and growth management tools, such as urban growth boundaries and the removal of subsidies for urban sprawl, can help lessen the impacts of population growth.

## **CONCLUSIONS**

Perhaps the biggest challenge involved in moving toward sustainable water use in the lower Colorado River basin is motivating people to desire a sustainable future, and to agree on what it might look like. It is clear that deeply ingrained attitudes and vested interests in the status quo represent a formidable obstacle to changing water use and management practices in the basin. Equally clear, however, is that continuing down the current path of inefficient and highly subsidized agricultural water use, escalating urban demands, and neglect of ecosystems, Native American communities, and future generations is a recipe for conflict and ecological decline. Also obvious is that the basin is heading toward dysfunctional gridlock where all parties – urban, agricultural, environmental – are largely unsatisfied. In this situation, moving toward a sustainable river basin as a *cooperative whole*, represents a necessity, not a luxury. An inclusive planning process and improved institutional structures are urgently needed, and in order to be successful, will require that all parties begin to think about their own needs within a broader, basinwide context.

A vision of sustainable water use in the lower Colorado River basin can be described and, we believe, realized. Such a vision will include restoring and maintaining some of the unique environmental and ecological resources of the region, including the river delta and the endangered native fisheries; eliminating unsustainable use of the resource, particularly groundwater; and improving the institutional structures that must resolve these issues to the satisfaction of the many diverse interests in the basin. The answers do not lie in developing new technologies or finding new sources

of supply. Rather, they lie in reprioritizing the many competing uses for water, given the resources that are available. We believe that the sustainability principles of efficiency, equity, and ecological integrity that have guided our analysis in this report offer the best hope of alleviating social and political tension and reversing environmental decline in the region. The transition to sustainable water management will not occur overnight. It will take time to establish a dialogue, set priorities, and develop plans and actions in a democratic way. The time to begin is now.



**Figure 1**  
**Map of the Colorado River System**

