2004

Water Wrongs: Why Can't We Get It Right the First Time?

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Water policy has faltered throughout the ages. Our water decisions have often created more problems than they have resolved, leaving severe environmental and social disasters in their wake. In most cases, it is not that we did not know better. On the contrary, we have been making the same errors for thousands of years by replicating policies that failed societies both ancient and modern. But this destructive trend need not continue and can be reversed by integrating and accepting old knowledge and responding to new knowledge about the uncertainty and limits of water supply. It requires modesty about our ability to control nature.

The stories begin in Iraq, long predating the multiple sins of Saddam Hussein. What we know as Iraq today was once Mesopotamia, the Fertile Crescent region where civilization began. For thousands of years societies flourished in the sprawling lands where Iraq, Syria, and Turkey converge. Here originated the first written language, sophisticated commercial systems, metal tools, and art, thousands of years before Christ.¹

These scientific and cultural advances were achievable because ample food could be produced on fertile lands, allowing time for people to put their intellects to work. Today, the area is a sparse, unpopulated desert. The ancient Sumerians who lived there around 3500 BC are credited with creating irrigation systems that supported major production of wheat and barley.²

wheat production was largely phased out, a trend that resulted from
salt accumulation in the soil. Although more salt-tolerant barley continued to
be produced, overall agricultural production declined. Conquests and the
fall of Sumerian civilization followed. People emigrated and those who
remained were impoverished. Today, most scholars posit that it was
environmental degradation from intensive irrigation that led to the demise of
the region's flourishing economy, culture, and political structure.

The decline came slowly and, as there were then no textbooks on the
subject, it may be understandable and excusable that the Sumerians did not
identify and reverse the process. Those who left the area as the Sumerian
civilization dissolved moved north, transporting the same irrigation
practices. More salinity crises occurred in the new regions. Apparently, the
emigrants did not learn the lessons of Sumeria: Repeated soil irrigation
without adequate drainage in an arid climate leads to salt buildup.

What about those who developed irrigation systems on the Colorado
River in the American Southwest? The Colorado forms in the Rocky
Mountains, runs through the Grand Canyon, and ends in the Sea of Cortez in
Mexico. It is the only major river serving most of the states of the Southwest
and the Mountain West. This hot and dry climate is characterized by poor
and naturally saline land. Without irrigation, farming stood no chance of
success in much of the region. In the early part of the twentieth century,
boosters pleaded with the U.S. government to put up capital when private
investors refused.

The U.S. Bureau of Reclamation eagerly went to work on building dams
and canals to serve farmers and later to expand cities with water from the
Colorado. Dam building continued throughout the first half of the twentieth
century. The massive developments began with the Hoover Dam in the
1930s, one of the human-made wonders of the modern world. Hoover was a
success in many ways. It came in under budget and ahead of schedule, and
provides a year-round source of water to the seven Colorado River Basin
states. In addition, it was emulated not only in the U.S. system but all over
the world, and kicked off the era of big dams, a frenzy of dam building
during the first sixty years of the twentieth century.

Glen Canyon Dam was the capstone of the Colorado River projects,
approximately the same capacity and height as the Hoover Dam. No sooner

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3 Id; see also Paul Krugman, Salt of the Earth, N.Y. TIMES, Aug. 8, 2003, at A17 (urging the
Bush Administration to heed the environmental collapse of the Fertile Crescent wrought by
humans when formulating its own environmental policy).
4 See PONTING, supra note 2, at 72.
5 Id. at 73.
6 Lawrence J. MacDonnell, Managing Reclamation Facilities for Ecosystem Benefits, 67 U.
7 George W. Gorum & Cathy Murphy, Hoover Dam History: In Praise of Hoover Dam,
STRUCTURAL ENGINEER MAG., Nov. 2000, reprinted in BUREAU OF RECLAMATION, U.S. DEP'T OF
INTERIOR, HOOVER DAM: A NATIONAL HISTORIC LANDMARK, at
8 Id.
9 Scott K. Miller, Undamming Glen Canyon: Lunacy, Rationality, or Prophecy, 19 STAN.
ENVTL L.J. 121, 139, 151 (2000).
was Glen Canyon finished, and the government was filling it with water, than
the salinity in the river spiked to such a level that irrigation water diverted in
Mexico destroyed crops. This touched off an international dispute with
Mexico. Domestically, the crisis also affected farmers who were beginning
to experience declining crop yields from the increased salinity. Cities also
realized the negative and costly effects of using water with increased
salinity.

An agreement was reached with Mexico to curtail the salinity in the
water and was embodied in a document interpreting the Treaty recognizing
the right of Mexico to use a share of Colorado River water. This—coupled
with U.S. concerns with the salinity problem—necessitated an elaborate and
expensive federal salinity control program. Hundreds of millions of dollars
were spent on major engineering projects to prevent salt accumulation and
to clean up polluted water. The most expensive single investment was for
the construction of a huge desalination plant designed to take salt-laden
agricultural return flows, treat them to a pristine level, and then dump the
clean water back into the polluted river to dilute the flowing water to the
salt levels promised to Mexico.

The desalination plant has lain virtually unused since it was
completed. Thanks to high river flows that diluted the salt, coupled with
physical measures, the salinity problem in the Colorado River has been held
at bay. The enormously expensive solutions have been trial and error and, at
best, will attenuate the worst of the effects of heavy development of the
Colorado. But was all this necessary when the adverse impacts of irrigation
could have been foreseen and avoided? Perhaps we can make excuses for
the ancient Sumerians, but how forgiving should we be of those who
repeated their mistakes in the twentieth century?

Although dam builders have made engineering mistakes—resulting in
disaster and deaths from the collapse of dams—more typically the
engineers achieved what they set out to do: They built bigger, stronger dams
that harnessed great rivers and promoted economic activity. Some of these

11 Id at 303–13.
12 Id. at 302.
13 Id. at 298.
14 Agreement on the Permanent and Definitive Solution to the International Problem of the
15 See FRADKIN, supra note 10, at 312–13 (recounting the Nixon Administration’s reticent
acceptance of the proposed desalination project in the Colorado River Basin).
16 LAWRENCE J. MACDONNELL, FROM RECLAMATION TO SUSTAINABILITY: WATER, AGRICULTURE,
17 See FRADKIN, supra note 10, at 313 (comparing the costs of a desalination project to the
costs of simply buying out the Wellton-Mohawk district, the main source of the Mexican salinity
problem).
19 See DONALD WORSTER, RIVERS OF EMPIRE: WATER, ARIDITY, AND THE GROWTH OF THE
AMERICAN WEST 308 (1985) (discussing the collapse of the Teton Dam).
projects have produced great benefits for society, but even they caused environmental and social problems—and sometimes disasters. The negative consequences were typically unintended, but no less negative. Although we have improved our engineering techniques, the methods used to irrigate most farmlands in the world, including in the American West, are not much different from the methods used by the ancients. Sandra Postel writes, "[i]rrigation’s historical record spans six millennia... The overriding lesson from history is that most irrigation-based civilizations fail... the question is: Will ours be any different."20

The big dam era also made its mark on the Columbia River—and altered dramatically the great fisheries of this region,21 a story with which many Oregonians are intimately familiar. Dam construction on the Columbia-Snake River System began in the 1930s in order to provide electricity and irrigation water for the region.22 As with the dams on the Colorado, spectacular canyons and falls were necessarily flooded and the flow regime was permanently changed. The once roaring Columbia is now a series of slack water pools. This has had a devastating effect on the salmon, as the hydropower system affects every stage of salmon life.23

In some cases the government built fish ladders for returning fish, but neglected to provide a means to protect the young fish trying to pass from tributary streams down to the ocean.24 These crude efforts were not universal and allowed only the hardiest to survive.25 It is estimated that annual salmon runs have diminished from as high as 16 million to around 1 million.26 "Currently, approximately 60% of the salmon stocks in the Columbia River basin are listed as depressed, threatened, or endangered."27 Additionally, over 100 of the native stocks have already gone extinct.28

The multiple factors causing native salmon decline have been analyzed by Professor Craig Johnston. They include: 1) habitat degradation; 2) hydropower development; 3) hatchery effects; 4) over harvesting; 5) ocean

24 Richardson & Richardson, supra note 22, at 77 (citing U.S. Army Corps of Engineers, Improving Salmon Passage: The Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (Draft) at the Four Dams (1999)).
25 Id.
27 Richardson & Richardson, supra note 22, at 75.
conditions; 6) water quality; and 7) increased water temperatures caused by removal of vegetation, water withdrawals, dams, discharges from industries, irrigation return flows, and wastewater treatment facilities. Although the causes are many, hydropower is believed to account for 80% of the salmon decline.

When early explorers boasted that salmon were so numerous you could walk across the river on their backs, most of the threats discussed by Professor Johnston did not exist. But Indians in the region whose cultures and livelihoods were inextricably tied to salmon understood that the fishery was vulnerable. The "first salmon" ceremony and other Indian religious and cultural practices ensured that there would not be depletion from overfishing or contamination.

The decline of salmon grossly impacted the Northwest tribes for whom salmon have played an essential role in culture, religion, and history. The Stevens Treaties (as interpreted by the Supreme Court) reserved for tribes the right to fish. However, without fish in the river, the tribal right is useless. Even the first settlers recognized the idea that in order for salmon to survive, they need an unobstructed passage upriver. Surely the federal government knew or should have known that the type and extent of dam building it undertook would imperil salmon.

To be sure, the great dams on the Columbia provided a treasure trove of electrical energy as well as other benefits. The four Snake River dams produce approximately five percent of the Pacific Northwest's energy, 1,250 megawatts per year. Like the dams on the Columbia, the Colorado dams deliver vast amounts of electricity, bringing valuable benefits to the West. The Colorado is now distinguished as the nation's most developed river. Colorado River dams and canals deliver water across the desert to support the rapid growth of cities like Las Vegas, Los Angeles, Phoenix, San Diego, and Tucson. Dams have allowed civilization in the West to flourish.

In pursuing the impressive benefits of large dams, politicians and boosters across the West, and experts within government agencies, have ignored the consequences—consequences that were inevitable and should have been obvious. As international experts pointed out in a recent paper: "The authors are unaware of even a single large dam whose benefits and costs have been properly and systematically documented after 10-20 years of..."
Moreover, when cost-benefit analyses were made, the calculations were often distorted to justify constructing dams.

Recent technical reports have demonstrated some damning facts: 1) Dams are the predominant factor in the decline of aquatic life; 2) water development is the largest single factor in species extinction; and 3) the great masses created by large dams concentrated in parts of the world have altered the earth's rotational pattern.

In addition to environmental harm, dam building has displaced indigenous people around the world and locked them in poverty. The Garrison Dam on the Missouri River caused the flooding of the Fort Berthold Reservation, dividing families and destroying an economy. The policies of modern societies not only have repeated mistakes of the past, but also have ignored the wisdom of "primitive" peoples that incorporated a superior understanding of how nature operates. For example, modern policies disregard the knowledge embedded in the cultural practices of Northwest Tribes.

We would be well advised to observe and heed the lessons of people who have lived with the lands of particular ecosystems since time immemorial. Their permanence in apparently hostile lands has depended on observing nature and adapting to it. Jim Enote of the Zuni Pueblo shared the plain wisdom of his grandmother with me: "Listen," she told him. I did not understand this advice at first; now I think I do. Listen... to your elders, to the river, to the wind, to the earth, to the animals.

Consider the story of the Balinese. When Dutch colonialists came to Bali they found a quaint, centuries-old agricultural practice. It depended on a complex system of water temples administered by priests who released scarce water to run through canals, delivering water to crops on terraced hillsides. Insects were controlled by alternately drying and flooding fields and driving herds of ducks through at appointed times. The system was highly ritualized, with planting, harvesting, and the cyclical irrigation and other communal practices regulated according to the Balinese calendar.

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40 Elizabeth Losos et al., Taxpayer-Subsidized Resource Extraction Harms Species, 45 BIOSCIENCE 446, 448 (1995).
41 See generally Benjamin Fong Chao, Anthropogenic Impact on Global Geodynamics Due to Reservoir Water Impoundment, 22 GEOPHYSICAL RESEARCH LETTERS 3259 (1995).
46 Id.
In the 1970s, a hundred years after the Dutch arrived, the Indonesian
government of Bali was swept up in the exuberance of the Green Revolution.
Outside experts introduced modern agronomic practices, chemical
fertilizers, and pesticides and converted the crop pattern to multiple
plantings of non-native varieties of high-yield rice on Bali. Quickly, Bali went
from a modest subsistence agricultural economy to an efficient producer of
cash crops.

But then, in an event reminiscent of biblical stories, plague struck. Rice
crops were attacked by insects that were formerly controlled by the ducks
and predator insects but that had since been killed by the pesticides.
Production crashed as soil fertility was destroyed by too-frequent planting
and toxic build-up. Water shortages began to occur. Moreover, the social
structure built around cooperative irrigation rituals was destroyed. Finally,
when the past practices could no longer be ignored, traditional practices
were restored.

The point that the well-meaning experts failed to see was that the
Balinese had lived with the land for centuries and had refined an ecological
and social balance that worked for their people. Knowledge about nature is,
after all, place-based.

Besides a tendency to repudiate the lessons of the past, mistaken
approaches to water policy are characterized by a perpetual insistence on
addressing all water problems with a quest to provide more water. This
assumes that supply can expand infinitely as demand grows, and that
demand will inevitably grow. The assumptions are doubly flawed.

First, water supplies are finite and erratic. Rivers in the West range
wildly in the amount of water they produce. Indeed, there is evidence that
average supplies are becoming less reliable than in the past. Water supply
ultimately depends on nature. Nature is full of disturbances like drought,
flood, fire, and earthquake. Professor Judy Meyer has written of river
ecosystems that they are “inherently variable, patchy, and often require
disturbance to persist.”

This inherent unpredictability need not be defeating; it does instruct us
to pay attention to the realities of the natural world and to be open to
observing and adapting to nature’s vicissitudes rather than denying or trying
to control them. Farmers can tell you that there never is an average year for
water flow. Nature is not “normal”; normality is a statistical artifact.

John McPhee has chronicled some of the most heroic efforts to control
nature in the United States. Since 1950, the U.S. Army Corps of Engineers
(the Corps) has been locked in a war with the mighty Mississippi River,
attempting to protect New Orleans and Baton Rouge and countless millions

\[47\] Id.
\[48\] Id.
\[50\] Judy L. Meyer, Changing Concepts of System Management, in SUSTAINING OUR WATER
of dollars in industrial investment from flooding. The scheme depends on structures designed to contain the growing tendency of the Mississippi to shift its flow to the Atchafalaya River where floods imperil development that now lies behind fragile dikes. The Corps sought to reverse millennia of channel shifting as sediments built up and gravity forced the river to find a more direct and less resistant course to the Gulf of Mexico. Congress declared that the then-normal flow of about a third of the Mississippi to the Atchafalaya must be maintained. It charged the Corps with diverting the rest of the river away from the course beckoned by nature. Professor Oliver Houck regarded as arrogant the assumption that engineers could train the Mississippi River to go where they wanted it to go instead of where it was wont to go. Indeed, in the major floods since it was built, parts of the system have been lost and rebuilt. McPhee convinces us that it is just a matter of time before it all fails.

In the West, Americans have tried to defy nature since the first settlers arrived. The very settlement and development of the semi-arid West was conceived under the mindless belief that the “endless” lands could accommodate as many people as chose to settle there. However, John Wesley Powell knew better and espoused a vision of the West being settled in a nature-conscious pattern, with small, cooperative communities, widely dispersed over large expanses of the arid West, under counties divided by watershed boundaries. His wise counsel was disregarded.

Powell’s revolutionary ideas simply did not fit the nation’s goals of populating untamed western lands, justifying railroad investments, and fulfilling the romantic ideal of Jeffersonian yeoman farmers. So one homestead program after another offered more land for less money, and promised that water would be available according to the simple gold miner’s rule that whoever discovered the water could keep using it. But we know from subsequent history that there was not enough water to sustain this pattern in many parts of the west—just as Powell predicted. Large numbers of homesteaders quickly failed. Many of those who stayed on the Great Plains were finally driven out by the Dust Bowl.

Common sense was not only disregarded, but science was invented to overcome it. The westward movement and particularly homesteading on the Great Plains was accelerated by the boosters’ myth that “rain follows the plow.” This nonsense amounted to wishful thinking that more cultivation would reward farmers with more rainfall. “God speed the plow.... By this

52 Id. at 6–7.
53 Id. at 8.
54 Id. at 11.
55 Id.
57 See generally id.
59 STEGNER, supra note 56, at 3.
wonderful provision, which is only man's mastery over nature, the clouds are dispensing copious rains... [the plow] is the instrument which separates civilization from savagery; and converts a desert into a farm or garden. . . . To be more concise, Rain follows the plow."  

During the 1870s and early 1880s, unusually heavy rainfall made these claims sound plausible, and within ten years nearly two million people had sunk roots into the prairie soil. But when the wet years finally came to an end, the high plains again became a place where only the luckiest or most determined could survive.

There are multiple examples of water institutions being founded on ignorance of science or poor science. The frailties of the prior appropriation doctrine itself were frankly identified by a lawyer-engineer, Elwood Mead, who would become one of the great leaders in creating state water institutions. Mead, Wyoming's first State Engineer and later Director of the U.S. Bureau of Reclamation, warned in 1903 that irrigation practices sanctioned by a doctrine based on the rule of capture without a complete water code or adequate record-keeping practices lead to waste and inefficiency.

Even some of the interstate compacts that allocate the great rivers of the West among states were built on factual mistakes. And though we now know the truth, we still refuse to alter the law. An interstate compact allocating the Colorado River, concluded in 1922, was based on false assumptions about the amount of water available in the river, hypotheses that were gleaned from a period of record from 1896 to 1921. The minute time period demonstrated that there should be 16.8 million acre-feet (MAF) of available water. And then we proceeded to parcel out all of the resources. However, in the 106-year period between 1896 and 2002, the river produced, on average, much less—about 14.9 MAF. Additionally, 400 years worth of tree-ring studies indicate that historical flows averaged only 13 MAF—some 3 MAF short of modern-day commitments. However, this has not stopped people in my own state of Colorado from encouraging increased...
uses and water development so that we can get our “full entitlement” from the interstate allocation. Never mind that the water to fulfill that allocation may not exist much of the time.

Other interstate allocations are based on bad information. In his book, *High and Dry: The Texas-New Mexico Struggle for the Pecos River*, New Mexico Law School’s Emlen Hall writes about the 1948 Pecos River Compact, which allocated water between Texas and New Mexico. The drafters ignored available information about groundwater and surface water interconnections. Science revealed that the basin’s inflows and outflows were heavily influenced by erratic floods and heavy groundwater pumping. But experts looked only at river flows to determine how much water there was to divide. Hall states that had the drafters looked at all of these factors, they would have found that “the river’s water account was overdrawn. No matter how existing water rights were divided among existing claims, any solution would eventually fail . . . so long as the basin water budget did not balance.” For a time, nature was blamed for the miscalculation. The alleged villain was salt cedar trees; hence, more than 15,000 of these plants were torn out to enhance flows. A contemporary study showing that this did not work was kept secret, unpublished for 28 years.

The Pecos River Compact, though built on faulty assumptions, remained the law. The Colorado River Compact also remains the law, creating relatively immutable and inflexible demands for water deliveries and expectations of certainty. These laws, like the dams we built, were aimed at achieving certainty that we would have enough water in the future. But certainty in nature’s behavior is illusory.

Climate change exacerbates nature’s uncertainties. Various scientific models provide scenarios with different regional impacts and ranges of severity. But scientists now agree that we are clearly heading into an era of greater and more frequent fluctuations in the naturally available water supply.

Meanwhile, the West’s population grows, and with it grows demand. If we assume that demand is a steadily rising curve, or even an inflexible constant, our encounters with nature’s limits are bound to be more frequent. So what should we do?

In the face of uncertainty, it becomes more important that decisions be based on sound scientific data. This does not argue that decisions should

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69 Id. at 100.
70 Id. at 57.
71 Id. (citation omitted).
72 Id. at 72.
73 Id. at 100.
76 Lynn E. Dwyer, *Good Science in the Public Interest*, 7 HASTINGS W.-NW. J. ENVTL. L. &
await perfect information, rather it counsels a quest for and acceptance of
the best available information. Most water resource decisions have ignored
climate change, either because decision makers have just not included its
consideration in the past or because they are discouraged by the presence of
many uncertainties in the data.77 However, the American Water Works
Association (AWWA) concludes that “sufficient scientific understanding
exists of the current causes and future consequences of potential global
climatic change to begin to track this issue and evaluate current policies.”78
AWWA recommends cooperating with scientific organizations, partnering
with institutions to promote the reduction of greenhouse gases, and
evaluating the management of water in light of future climate changes.79

If we cannot avoid uncertainty, it would be rational to try to reduce our
vulnerability to uncertainty in water supply. To accomplish this we have to
integrate and accept old knowledge about the uncertainty and limits of
water supply, and respond to new knowledge concerning the limits of our
ability to control nature. Also, demand can be effectively controlled. Unlike
the natural phenomena that dominate water supply, demand is something
that humans create. Thus, humans ought to be able to manipulate demand
more readily than we can manipulate nature.

Managing demand involves water conservation measures, economic
incentives and pricing, using existing dams and other facilities more wisely,
and reallocation of rights. There is a rich and expanding literature on
conservation and the use of market mechanisms.80 The idea of reoperating
facilities—such as committing water from a reservoir for efficient modern
uses that once was used inefficiently in irrigation—is relatively new but
quite promising.81

Changes in the allocation of water from one user to another is more
difficult even than structural and operational adjustments in systems of
dams, reservoirs, and delivery systems. In the West, we are accustomed to
treating water rights as a form of property. This creates at least the illusion
of certainty. Yet only the most senior water rights holders are pretty well
insulated from the variations in river flows and weather. But last year, in a
summer of drought, irrigation ditches that pass through Boulder with
hundred-year-old priority dates were shut off early—shut off by laws that
gave what little water there was to more senior users. Water rights remained
certain for all; water deliveries were certain for only a few.

In times of shortage, we need ways to reallocate water smoothly from
unnecessary or relatively unimportant uses like growing alfalfa or Kentucky

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77 Peter Gleick, Climate Change and US Water Management, GLOBAL CHANGE: ELECTRONIC
78 Id. (quoting American Water Works Ass'n, Climate Change and Water Resources, 89 J. AM.
WATER WORKS ASS'N 107 (1997)).
79 Id.
Nonlegal Sources, 85 MICH. L. REV. 953, 1006–07 (1987) (describing some of the major players in
natural resources communities).
81 MacDonnell, supra note 6, at 202.
bluegrass to genuinely important uses like human needs or survival of a species. In fact, the recent drought in this region taught us that there are ways: Markets and pricing tempt water away from low-valued uses; regulations prevent harmful or wasteful uses. But we have found also in the drought that the market system is awkward and rusty. California set a single price for water and had more sellers than it needed. Cities trying to control outdoor watering have been afraid to increase prices for political reasons and have instead instituted clumsy rules.

Fortunately these responses can be fine-tuned. Markets and regulatory adjustments optimize the use of our prior appropriation system. Banking, transfers, and other mechanisms hold out hope for finding the flexibility in the system. The great virtue of creating property rights in water—the right to use water is itself property—is that it can be bought and sold. Therefore, the enduring and realistic social goal of adaptability reflected in prior appropriation is achieved by transferability.

When drought focuses attention on water policy, lawmakers have an opportunity to take advantage of the present system to achieve optimum use through market mechanism and to enact laws to control demand. This has rarely been their response. Instead, they have sought to secure more supplies so that we never again must suffer the agony of watching lawns and golf courses turn brown. And they have assumed that our destiny is to increase our populations, our subdivisions, and our lawns—just as we always have. In Colorado, the drought that began in 2002 focused the legislature's interest on water law, but most attention was focused on a few big supply-oriented ideas.

The state legislature passed a bill in 2002, deemed "The Big Straw," to study a project that would intercept the Colorado River before it runs to waste at the Colorado-Utah border and pump it back hundreds of miles so that it could be used in growing Front Range cities. The legislature also approved sending a ballot measure to the voters that would allow the issuance of $2 billion in bonds to build new water projects. The measure did not say where, how large, or who the beneficiaries would be. The voters saw problems, and the measure failed in 2003 by a surprisingly large margin.

Finally, the legislature debated, and ultimately favored study, of a proposal called "logging for water." This scheme proposed to cut down 25% to 40% of the forests in Colorado in order to obtain more runoff. Opponents criticized the idea as ignoring the fact that all of the water would

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82 John J. Sanko, Big Straw Study Ok'd; Bill Authorizing Water Project Funds is Sent to Governor, ROCKY MTN. NEWS, Apr. 25, 2003, at A18.
86 Id.
flush down in the spring, the land would be eroded, and silt would pollute the streams.

Interestingly, lawmakers were less enthused about proposals to conserve water or reduce demand. Several such bills were introduced but few advanced. Nevertheless, the big, supply-side approaches were all ultimately subjected to scrutiny rather than being passed without regard to their consequences.

So, what does it mean to “get it right” in addressing water problems? Doing it right requires no technological breakthroughs. It primarily requires attention to the natural world and sufficient will to exercise restraint. This may be a tall order given our past performance. However, there are four concepts that will help us avoid and correct the errors of the past. These ideas are not revolutionary, not even new. They simply are not practiced.

First, we must look at water problems primarily as demand problems, not supply problems. The truly easy solutions of controlling demand through water conservation, efficiency, and pricing have been rehearsed in multiple venues by water law experts. The methods include laser leveling to prevent wasteful runoff and pooling, and sprinkler irrigation as an alternative to flood irrigation. With low-flow systems like drip irrigation, efficiencies can reach 95%. In cities, outdoor use can be reduced. The Metropolitan Water District of Southern California estimated that reducing landscape irrigation in the region by 10% would “save an amount of water equivalent to what San Diego uses in a year.” The harder—at least politically harder—measure of controlling demand through wiser land use that concentrates developments and minimizes yard size must be high on the agenda.

Second, we must incorporate all of the values of water into the water decision-making process. This idea has been packaged in a number of ways. Engineers and other water experts speak of integrated water management. Originally, the concept was simply that water should not be developed and managed for a single purpose, like agriculture or urban use. Instead, the needs of an entire area that depend or might depend on a river or other water source were to be considered. Multi-purpose development has gone from planning a project so that it serves hydroelectric and flood control needs—and not just agricultural uses—to considering values such as fish and wildlife, recreation, wetlands, and aesthetics.

More recently, integrated water management has taken on the mantle of sustainable development. It stands for a broader consideration, not just of the multiple potential benefits of water development, but of the multiple


90 Water Situation Serious, But No Emergency: Southland’s Water Supplies Assured for Next 20 Years, METROSPETIVES, Feb. 2003 at 1, 2 (quoting Phillip Pace, Chairman of the Metropolitan Water District of Southern California) (on file with author).
potential consequences. It recognizes the links between human-made and natural capital, and integrates social, cultural, political, economic, and environmental issues.

Since the 1970s, principles and guidelines for federal water development have required that economic criteria be met as well. Although federal projects were supposed to be justified economically before being authorized, the principles and guidelines imposed more stringent requirements. The economic values attached to benefits of water projects were routinely overstated. Some project justifications were such masterpieces of "creative accounting" that they would be the envy of Enron.

Today, projects must pay their own way and must be justified by a cost-benefit analysis. Unfortunately, the analysis is only as good as the data it processes. There is still room for manipulation. If a dam costs $100 million to construct, it supposedly will be built only if it produces at least $100 million in benefits. Thus, if the project will provide only $50 million in agricultural benefits, it cannot proceed. But if we can "find" enough flood control or recreational benefits, it can be built.

Properly applied cost-benefit analyses can be a useful tool to consider affected values, and to serve as a check on the propriety of water development proposals. But even at its best, this method of integrating a fuller panoply of values to test economic justification is inadequate. First, it is difficult to reflect accurately the value of environmental harm. What is a river worth? A healthy ecosystem? Second, how do we treat scientific uncertainty about the likelihood of environmental harm? Suppose experts predict a 60% decline in the habitat of a species? Suppose scientists tell us there is a 20% chance the species will become extinct?

These problems are complex but not impossible to solve. The greatest quandary with cost-benefit analysis has been its perversion. Construction of the Tellico Dam was delayed because the Endangered Species Act (ESA) prohibited destroying what was identified as the last habitat of the snail darter (Percina tanasi). When the Supreme Court ruled against the dam's construction, the law was altered to allow a high level committee to determine whether an exception to the ESA is warranted when the benefits of the project outweighed the costs or harms. Such a committee was formed based on the new law. It considered Tellico Dam and found that the costs, including loss of farmlands as well as the snail darter, outweighed the

92 See RICHARD W. WAHL, MARKETS FOR FEDERAL WATER: SUBSIDIES, PROPERTY RIGHTS, AND THE BUREAU OF RECLAMATION 27-46 (1989) (documenting that rather than recouping the costs of reclamation projects, Bureau of Reclamation projects provide substantial, increasing subsidies to project users and concluding that "many projects have been located where benefits fail to exceed costs").
benefits of some new jobs and power outputs from the dam. Accordingly, the dam was stopped under the amended law. But in the end the dam was built. Congress passed yet another law to authorize it, notwithstanding any other law.

Consider a recent example of the tortured use of cost-benefit analysis. The Environmental Protection Agency (EPA) drafted a rule to require old power plants to build cooling towers that allowed them to reuse water. This reduced the pumping of vast quantities of cooling water from waterways that inhaled and killed millions of fish, fish eggs, larvae, and shellfish. EPA conducted several years of research and concluded that the benefits of the cooling tower rule outweighed the costs by a ratio of 3:2. However, the White House Office of Information and Regulatory Affairs decided that EPA should adopt the lowest cost rule and sent it back to EPA and the saga continued.

A third approach that will help us get water decisions right is institutionalization of the precautionary principle. This is a rather revolutionary concept in the realm of water decisions. The precautionary principle is an emerging concept that has found its way into domestic laws, mostly outside of the United States. The principle counsels that decision makers should act to prevent environmental harm before it occurs by erring on the side of caution.

The precautionary approach—minimizing irreversible impacts or irretrievable commitments of resources—is accepted widely in environmental decision making in Europe and as an international norm. "[I]t dictates that indication of harm, rather than proof of harm, should be the trigger for action—especially if the delay may cause irreparable damage."

Some international treaties and declarations that have incorporated this theory into their documents are the 1995 Agreement on Fish Stocks, the

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100 Id.
103 See generally id.
Convention on Biological Diversity,\textsuperscript{107} and the Framework Convention on Climate Change.\textsuperscript{108} But it is more common in water decisions in the American West to “skate up to the edge,” allowing water uses unless there is a showing of material harm to other water users. This laissez faire approach to water allocation and management represents both a liberal interpretation of state constitutional provisions securing “the right to appropriate water” and the notion that water rights are property.

However, things may be slowly changing. Montana’s recent decisions to freeze all new appropriations except in one basin seem to be a departure from the hands-off approach.\textsuperscript{109} The decisions may be driven primarily by a desire to protect senior water users from the pressures and complications of allowing the system to become more heavily appropriated. But they also protect flows in Montana’s spectacular fishing rivers. So they nevertheless illustrate the kind of decision a state might make in the face of uncertain data to preserve what certainty the system does provide.

The precautionary principle has courted rabid controversy in some quarters. The principle has been stated a variety of ways. Someone seizing on extreme interpretations of the idea might allege that if the precautionary principle prevailed, it would cause all progress to grind to a halt. Yet most legal embodiments of the principle are sensibly qualified. Principle 15 of the 1992 Rio Declaration on Environment and Development states, “Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”\textsuperscript{110} This iteration concedes that measures to avoid harm must also be cost-effective. Does it go far enough? Does it mean that if projected profits exceed the value of likely harms the project should proceed?

The precautionary principle is reflected in environmental statutes of several countries and explicitly in the treaty forming the European Union (EU).\textsuperscript{111} Courts have begun to apply it in some countries and it is emerging as a norm of international law.\textsuperscript{112} Twenty-two countries and the EU have explicitly adopted the precautionary principle into their legislation. Some U.S. laws reflect the ideal of the precautionary principle. The National

\begin{thebibliography}{9}
\item See MONT. CODE ANN. § 85-2-601 (2003) (legislatively passed moratorium suspending all new major permit applications in the Yellowstone Basin because they threaten Montana's water resources).
\item Treaty on European Union and Final Act, art. 130r (Feb. 7, 1992), 31 I.L.M. 247 ("Community policy on the environment ... shall be based on the precautionary principle.").
\end{thebibliography}
Environmental Protection Act (NEPA)\textsuperscript{113} recites that "uses of the environment [should be] without degradation, risk to health or safety, or other undesirable and unintended consequences."\textsuperscript{114} But those who have studied NEPA know that this is just hortatory. At most, NEPA can require an Environmental Impact Statement (EIS) on all major federal actions that significantly affect the quality of the human environment.\textsuperscript{115} However, there is no restriction against going ahead with the project even if the EIS shows substantial adverse consequences.

We do have some environmental laws that mandate action, such as provisions in the Clean Air Act\textsuperscript{116} requiring the EPA to set standards to protect public health that include an "adequate margin of safety."\textsuperscript{117} The precautionary principle can be integrated in future water decisions—decisions that affect our increasingly precious flowing waters and that affect the way water is used in the developing world. The precautionary principle should play a major role in decisions to develop water, to allocate water, or to change the way water is used. Can it be integrated into our relatively inflexible system of water law, a system where change is inhibited by the existence of property rights? We have already seen the expansion of the use of public interest factors to guide and screen water decisions.\textsuperscript{118} This exercise is far from robust in any state, but can grow. And if one looks at the far-ranging inquiries into public values affected by land-development decisions, there is a model.

The Supreme Court's takings cases teach the limits of appropriate government control. The Court will allow conditions, even exactions, of landowners who want to develop their land, so long as there is a clear relationship and some proportionality between what they must give up for the public good and the impacts that they cause.\textsuperscript{119} Subdividers can be required to pay for new schools and to grant some of their land for parks. These methods can be applied to water development and water use. For many years, Oregon has had a statute, though it is not widely used, that allows a water user to salvage water and put it to new uses if a percentage of the saved water goes to instream flows.\textsuperscript{120} Unfortunately, the precautionary principle, and to a considerable extent a fuller consideration of all of the values implicated by water use, still may not reach most of the water in the West. This is because nearly all of the resources are already allocated. The flowing streams that remain, and the ecological values supported by water

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\footnotetext{114}{Id. § 4331(b)(3).}
\footnotetext{115}{Id. § 4332(2)(C); see also Methow Valley Citizens Council v. Reg’l Forester, 833 F.2d 810, 814 (9th Cir. 1987) (explaining the purposes of an EIS).}
\footnotetext{116}{42 U.S.C. §§ 7401–7671q (2000).}
\footnotetext{117}{Id. § 7409(b)(1).}
\footnotetext{118}{See Douglas L. Grant, Public Interest Review of Water Right Allocation and Transfer in the West: Recognition of Public Values, 19 Ariz. St. L.J. 681, 681–82, 689 (1987) (discussing the use of public interest review statutes as a tool for protecting public values when allocating or transferring water rights—some states' statutes even list factors to help define public interest).}
\footnotetext{119}{Dolan v. City of Tigard, 512 U.S. 374, 391, 394–95 (1994).}
\footnotetext{120}{OR. REV. STAT. §§ 537.455–537.500 (2001).}
\end{chicago}
throughout the United States, become scarcer as populations grow and as the reality of climate change sets in. We have a gnawing, growing scarcity. And the developing world has a water crisis much worse than our own. The World Water Development Report, released by the U.N. in 2003, revealed that 1.1 billion people lack access to an improved water supply. The report highlighted the connection between the poverty of a large percentage of the world’s population and water problems, noting that “problems of poverty are . . . inextricably linked with those of water.”

We can address demand, pursue integrated water management, and institutionalize the precautionary principle to deal with future water problems and decisions. But the reality is that most water is already in use. Much of the damage, especially in a developed country like the United States, is already done or occurring.

This requires a fourth approach: restoration. Restoration efforts are afoot throughout the United States and are enormously popular. The people who move to growing metropolitan areas in semi-arid parts of this nation bring demands not just for drinking water and water to irrigate lawns, but also demand for opportunities to fish, boat, and otherwise enjoy the recreational and spiritual satisfaction that water provides. Indeed, that is the reason that many of them came to the West. It was not primarily for a green lawn that they can have elsewhere.

Communities are rebuilding streams that were despoiled or destroyed by development activities. Almost everywhere, people cherish the river that runs through their town. The city, state, groups like Trout Unlimited, and others in my hometown of Boulder have cooperated to revitalize Boulder Creek. And the demand for river recreation has heightened the value of wild rivers in wild places. Even Los Angeles is rebuilding its river namesake, long ago reduced to concrete, and is reviving it as a living river. Changing a dam’s operating regime to release more water to maintain flows can also restore ecosystems and provide water for recreation. Although these efforts can be successful, outright removal of some dams to restore natural flows appears to be the most appropriate action in many cases.

But restoration has its limits. The Independent Scientific Group recognized that “[d]espite decades of effort, the present condition of most [salmon] populations in the Columbia River Basin demonstrates the failure of technological methods to substitute for lost ecosystem functions. Normative conditions, which provide critical habitat functions in the natural-cultural landscape, must be restored, not mitigated.”

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121 See generally WORLD WATER ASSESSMENT PROGRAMME, WATER FOR PEOPLE, WATER FOR LIFE: THE UNITED NATIONS WORLD WATER DEVELOPMENT REPORT (2003) (assessing the world’s water crisis in a joint report by 23 United Nations’ agencies concerned with freshwater).
122 Id. at 504.
123 Id.
124 See generally Daniel F. Luecke, An Environmental Perspective on Large Ecosystem Restoration Processes and the Role of the Market, Litigation, and Regulation, 42 ARIZ. L. REV. 395 (2000) (describing the restoration process of large ecosystems, and discussing the role of the market, litigation, and regulation in that process).
125 INDEPENDENT SCIENTIFIC GROUP, DOC. NO. 96-6, RETURN TO THE RIVER: PREPUBLICATION
For the past twenty years, saving the salmon runs has been a huge priority in the Northwest. The National Marine Fisheries Service (NMFS) Biological Opinion (BiOp), advising against dam breaching, is the most recent and the most controversial restoration plan for the Columbia Basin. The current battle is over the adequacy of the science underlying the BiOp. In May 2001, the National Wildlife Federation (NWF) and several other environmental groups filed a suit against NMFS challenging the legality of the BiOp. NWF charged NMFS with "fail[ing] to apply the best available scientific information in assessing the status of the listed salmon." It claimed that NMFS based its conservation plan, outlined in the BiOp, on the assumption that salmon populations have declined at a constant rate, although the data confirm that salmon populations have actually declined at an accelerating rate. Instead of introducing new ideas, the BiOp relied on old technology such as fish transportation and spill and flow management.

In addition, the BiOp adopted a one-fish survival standard under which salmon would not be considered in jeopardy if even one fish returned to spawn. NWF's main premise was that NMFS underestimated the gravity of the threat to the species and did not utilize credible data in developing the plan. In May 2003, a federal district court agreed with NWF, and held the BiOp inadequate.

At this point, a major overhaul in planning and management of the Columbia River Basin is needed to recover endangered fish species. Removal of some dams appears to be the most controversial but effective way to restore the system. Four major federal dams on the Snake River are operated by the Army Corps of Engineers (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams). Although dam breaching will be costly, "failure to breach the dams would cause greater, irreparable damage." Some have suggested that dam breaching is probably the only solution to save the fish. Even the Army Corps of Engineers called the
"natural flow alternative" the "biological option if salmon and ecosystem restoration is the primary goal."

How can we avoid repeating history? How can we get it right next time?
The tools are there and relatively simple: 1) Shift the focus to controlling water demand; 2) consider all the values by using integrated water management to achieve the goal of sustainability and using cost-benefit analysis responsibly, as an analytical tool and not to justify a preconception; 3) adopt the precautionary principle in water decisions; and 4) invest in restoration.

All of this is about understanding that whatever we do with water implicates our relationship with the natural world. And all of it is subsumed in the profoundly simple wisdom of Jim Enote's grandmother: "Listen."

138 U.S. ARMY CORPS OF ENGINEERS, IMPROVING SALMON PASSAGE: THE LOWER SNAKE RIVER JUVENILE SALMON MIGRATION FEASIBILITY REPORT/ENVIRONMENTAL IMPACT STATEMENT (DRAFT), AT THE FOUR DAMS (1999) (recognizing that salmon from lower Snake River may have to pass up to eight dams before reaching Pacific Ocean).