6-13-2001

Using Water More Efficiently

Barton H. Thompson Jr.

Barton H. Thompson, Jr., *Using Water More Efficiently*, *in* TWO DECADES OF WATER LAW AND POLICY REFORM: A RETROSPECTIVE AND AGENDA FOR THE FUTURE (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law, 2001).

Using Water More Efficiently

Barton H. Thompson, Jr.

Robert E. Paradise Professor of Natural Resources Law & Vice-Dean
Stanford Law School

Senior Research Fellow
Institute for International Studies
Stanford University

Two Decades of Water Law and Policy Reform: A Retrospective and Agenda for the Future

June 13-15, 2001

Natural Resources Law Center Conference
University of Colorado
Boulder, Colorado

A Retrospective Review of Water Conservation

Given the breadth of the topic, this paper provides at best a cursory overview of what we currently know about water conservation in the United States. The paper does not try to deal with all issues of water efficiency. For example, this paper does not discuss the important topic of recycled water, which easily could be the subject of a lengthy paper all in itself. Instead, this paper focuses on ways of encouraging individual users of water to be more efficient in their water use, or, in every day parlance, to conserve water. In particular, the paper draws on some of the latest legal, economic, and psychological literature to discuss what we know about what forms of conservation programs (e.g., pricing, markets, voluntary conservation drives) work, the advantages and disadvantages of the various forms of programs, the degree to which governments have used the various approaches, and how successful the governments have been. In essence, this paper covers the first half of this conference's topic; it provides a "retrospective" on conservation. In my remarks at the conference, I will focus on the second half of the topic – a potential agenda for the future.

Part I of this paper provides an introduction to conservation in the western United States. It discusses the weaknesses of traditional water policy in encouraging conservation, alternative definitions of "waste," and the growing recognition that conservation is an important element of future water policy. Part II reviews the possible mechanisms for encouraging greater conservation among existing water users, including their potential effectiveness. Part III looks at what efforts states and the federal government have made to encourage water conservation either directly or through local or regional agencies.

I. Introduction

A. Traditional Water Policy Has Encouraged High Water Use

Far from promoting efficient levels of conservation, the water system that has prevailed in the western United States for the last century and a half has consciously encouraged increased water use. Water policy has started by turning the pricing system on its head, shielding water consumers from the real cost of the asset that they have consumed. Water users in the West have paid at most a nominal permit fee for the actual water that they consume. Although water suppliers have charged consumers for the conveyance, storage, treatment, and distribution of the water, even these charges often have been subsidized to varying degrees through such varied mechanisms as the federal reclamation program, tax-exempt bonds, or property tax assessments. These historical pricing policies have encouraged water users to consume more water even when the cost of the consumption has far outstripped the value to the consumer.

Courts and administrative agencies, moreover, only weakly have enforced the anti-waste restrictions inherent in the "reasonable and beneficial use" requirement. To begin with, no monitoring system was in place to bring instances of waste to the regular attention of the courts and

administrative agencies. Courts and agencies thus tended to address waste issues only in stream adjudications or the occasional case where another water user complained of wasteful upstream diversions. Under the standard case law of most states, moreover, appropriators were entitled to "make a reasonable use of the water according to the *general custom* of the locality, so long as the custom [did] not involve unnecessary waste."[1] Appropriators did not need "either to irrigate in the most scientific manner known or to divert in the most scientific manner known."[2] As a result, one can count on two hands the number of cases in which courts have found that a particular use was wasteful in either type or quantity. In most cases, courts and administrative agencies have not found water uses unreasonable except where appropriators were using extreme methods, such as flood irrigation, or were receiving no benefit from the water use, as where appropriators were letting water flow freely day and night.[3]

By awarding water rights only to those who actually put the water to a "reasonable and beneficial" use, the prior appropriation system actually has encouraged cities and other water users to use as much water as possible in order to lock up water rights before the water could be appropriated by someone else. During most of the 20th century, the wise city faced with a growing population would not encourage conservation but would use its growth to justify appropriating additional water.[4]

B. Defining and Measuring "Waste"

Although virtually everyone now agrees that these historical water policies and practices have led to some level of "waste," the exact amount of waste is an open question. Some estimates of the amount of "waste" in the United States are nothing short of spectacular. Mohamed El-Ashry, the Chief Executive Officer and Chairman of the Global Environmental Facility, estimated in the 1980s that the United States was wasting 50 percent of the water that it withdrew from its waterways and aquifers (only slightly less than the 65 to 70 percent of water that he estimated was being wasted worldwide).[5] Most estimates of "waste," including El-Ashry's, are suspect because they fail to explain how the estimates were calculated and often fail even to clearly state how "waste" is defined. But they generally suggest that there is considerable opportunity for economically valuable conservation.

---

[1] Tulare Irrigation Dist. V. Lindsay-Strathmore Irrigation Dist., 45 P.2d 972, 1009 (Cal. 1935) (emphasis added).

[2] Id. at 1010. See also A-B Cattle Co. v. United States, 589 P.2d 57, 69 (Colo. 1978); McDonald v. Montana, 722 P.2d 598, 605-07 (1986).

[3] See, e.g., State ex rel. Erickson v. McLean, 308 P.2d 983 (1957). For an excellent review of the weak historical enforcement of the "reasonable and beneficial use" requirement, see Janet C. Neuman, Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use, 28 Envtl. L. 919, 923-48 (1998).

[4] See, e.g., John R. Morris, Water Conservation Progress in Denver, Contemp. Pol'y Issues, July 1991, at 35 (discussing reasons for Denver's opposition to conservation in the mid-1970s).

[5] See Barton H. Thompson, Jr., Water Allocation and Protection: A United States Case Study, in Earth Systems: Processes and Issues 476, 483 (2000).

Part of the problem in measuring "waste" is that the term is subject to varying definitions. Courts frequently employ a relatively narrow definition of waste that encompasses only the most profligate uses of water. According to the California Supreme Court, for example, an "acceptable" definition of waste is to use water "needlessly or without valuable result; to employ prodigally or without any considerable return or effect, and to use without serving a purpose."[6] At the other end of the spectrum, waste is sometimes defined in technological terms as the difference between actual water use and the amount of water needed to achieve the same purpose given a certain level of available technology.

This paper uses an unabashedly utilitarian definition of waste to evaluate various conservation measures. For purposes of this paper, waste is any consumption or irretrievable loss of water that could be eliminated or reduced at a cost that is lower than the value of the water in alternative uses. Note three things about this definition. First, as courts have long recognized, water can be wasted either in the amount that is used or in the purpose to which the water is put. Flooding a field to exterminate rodents is wasteful if the water thereby irretrievably lost to other uses is worth more than the value of the extermination.[7] The same can be said where water that has an extremely high instream use is diverted and consumed for lower value agriculture (although courts have never so held). Second, waste is an economic question. Even if a city can save water and return it to the river, the city is not wasting water if the cost of saving the water (either in browner lawns or new water-saving technology) is greater than the added value of the instream flow.

Third, waste does not focus on the amount of water diverted from a waterway or aquifer or on the "efficiency" of use but on the total amount of water consumed or irretrievably lost. As discussed below, this distinction is quite important. A farmer, for example, might be diverting far more water than her neighbors and have a comparatively low efficiency of use, but the farmer might not be "wasting" water if virtually all of the water not consumed by the crops returns to the waterway for valuable use downstream. In a similar fashion, increases in efficiency can reduce both the amount of water that needs to be diverted (which is beneficial) and the quantity of return flow (which is detrimental). Thus both determinations of waste, and evaluations of proposed conservation efforts, must take into account existing return flows. Otherwise, policies might end up decreasing current instream flows and injuring other appropriators in the name of wise conservation.

C. Emerging Recognition of the Importance of Conservation

Whatever the current level of waste, a number of converging factors are now forcing states throughout the West to pay at least lip service to the need for increased water conservation. In many western states, most waterways are fully appropriated. Yet total demand in much of the West continues to grow, Native American nations are demanding their legal share of the water, and

---

[6] Meridian, Ltd. v. City and County of San Francisco, 90 P.2d 537 (Cal. 1939) (quoting the second edition of Webster's New International Dictionary).

[7] See Tulare Irrigation Dist. V. Lindsay-Strathmore Irrigation Dist., 45 P.2d 972, 1009 (Cal. 1935) (holding that rodent extermination is not a beneficial use of water).

environmental interests are seeking to restore water back to the stream. In light of these developments, the California legislature has found that "the people of the state have a primary interest in the development and implementation of programs, devices, and systems to conserve water so as to make more efficient use of existing water supplies" and it is thus imperative that the State "undertake all appropriate steps to encourage and develop water conservation."[8] And other state legislatures have made similar findings.

II. Mechanisms for Encouraging Conservation

A. A Typology of the Mechanisms

Governments can try to change people's behavior through a number of different types of approaches. These approaches can be broken down usefully for analytical purposes into at least four broad (and partially overlapping) categories:

- ***Appeals to Conscience:*** One of the least intrusive means of government action is to appeal for voluntary changes in people's behavior. Where a beneficial societal norm already exists, the government can call on people's conscience to comply with the governmental norm. Where a beneficial norm does not currently exist, the government can try to foster the development of such a norm. In either case, the government generally uses a combination of education, marketing, information, self-evaluation, and direct communication to try to achieve its goal.

- ***New Technological Frontiers:*** Also at the non-intrusive end of the spectrum, the government can try to make the desired goal easier to achieve by expanding the technological means by which people can pursue the goal or by reducing the cost of existing technological options. In the case of water conservation, for example, the government can aid in the development and dissemination of new water-saving technology (e.g., laser-planing of fields or low-flow plumbing fixtures) or help reduce the cost of existing water-saving technology though support for new R&D or direct subsidization. In some cases, the government can also expand the "technological frontier" by demonstrating to people how they can use existing technology effectively.

- ***Revising Price Signals:*** In most western societies, one of the most effective means of changing people's behavior is by changing the price signals that they receive. In the case of water conservation, this can be done through at least three different routes:

    - ***Raising Direct Prices:*** The government can encourage water conservation by raising the direct price that water users pay for the water that they consume. The state, for example, can begin to charge more than a nominal fee for water that is diverted from

[8] Cal. Water Code § 13956.5.

surface waterways or aquifers. Water distributors also can raise the average rate that they charge for water or can switch to a pricing structure that sends better price signals to consumers (e.g., metering water where block prices have been used, or moving to a tiered pricing system where unit prices increase with higher usage).

- ***Establishing Markets for Conservation:*** Even in the absence of direct price reform, water markets can encourage water conservation by providing water users with the opportunity to sell conserve water either to other consumers or to the government or nonprofit organizations for instream flow.

- ***Bounties and Subsidies:*** The government also can encourage water conservation by paying a direct bounty for water that is conserved or by subsidizing the costs of conservation.

- ***Governmental Mandate:*** Finally, the government can ensure conservation by mandating particular behavior or prescribing other behavior. Governments often use at least two forms of mandates in the conservation field.

  - ***Direct Regulation of Water Use:*** The government can dictate how water is used or how much is used. The government, for example, can prohibit water from being used for particular purposes or limit the amount of water that can be used for other specific purposes.

  - ***Building or Operational Standards:*** The government also can indirectly try to affect the amount of water that is used by dictating that homes and other buildings install various technologies designed to reduce water use or by requiring that water users employ various technologies or operational standards (e.g., drip irrigation) designed to do the same.

B. Appeals to Conscience

Cities and other residential water suppliers frequently have appealed for voluntary water conservation during periods of drought. A few cities also have tried to encourage longterm water conservation through mass public campaigns and appeals. Voluntary campaigns, both drought-related and longterm, have typically involved mass publicity along with educational efforts in area schools.

Cities have had varying levels of success with such voluntary appeals, and little is known about why some conservation campaigns have worked while others have not.[9] Studies to date,

[9] See Geoffrey J. Syme, Blair E. Nancarrow, & Clive Seligman, The Evaluation of Information Campaigns to Promote Voluntary Household Water Conservation, 24 Evaluation Rev. 539 (2000); Raymond K. Watson et al., An Opportunistic Field Experiment in Community Water Conservation, 20 Population & Env't 545, 546 (1999); E. Scott

however, suggest several important lessons about institutional appeals for water conservation:

- **First, people are responsive to appeals to their altruism and environmental conscience.**

  A naive economic analysis might suggest that voluntary conservation campaigns would always fail: bearing all of the cost but only part of the benefit of their own conservation efforts, each person would find it in their own economic self interest not to conserve. But studies show that many people want to do the "right thing" and will conserve even when it is not in their own individual interest to do so. Self-interest may lead to less conservation than is societally worthwhile, but self-interest does not undermine entirely people's willingness to conserve.

  Indeed, in some cases, appeals to people's social conscience may be more effective than price signals in promoting conservation. A pair of recent studies examined water use in an Australian metropolitan area facing a water shortage. The water supplier reacted to the water shortage initially by launching a major voluntary conservation campaign, involving both television advertisements and an educational program in the local schools. After two years, the water supplier also adopted a new "user-pays price structure" designed to discourage excessive water use. A year later, the water supplier discontinued the voluntary promotional campaign but retained the new price structure. The first study found that water usage dropped significantly over the three-year call for voluntary conservation.[10] According to the second study, moreover, the level of conservation declined in the three years following the termination of the voluntary appeal, even though the new price structure remained in place. Surveys of adults revealed that attitudes about conservation and behavioral intentions also declined significantly after the voluntary appeal ended.[11]

  In a more controlled experiment, households in a mid-sized Southern California community were divided into several groups. One group received mailings containing tips on how to conserve water. A second group received mailings that detailed the economics savings the households would enjoy from conserving water; included in the mailing was a worksheet by which the household could see how much it could save by taking specific conservation steps. A third group received educational materials regarding the long-term consequences and personal efficacy of conservation. A final "control group" received no mailings. The mailings emphasizing conservation-tips and the economic benefits of conservation had no impact on water conservation (although perhaps households had already factored the economic value of conservation into their water practices prior to the start of the experiment). By contrast, as explained in more detail below, the personal-efficacy mailing did

---

Geller, Jeff B. Erickson, & Brenda A. Buttram, Attempts to Promote Residential Water Conservation with Educational, Behavioral and Engineering Strategies, 6 Population & Env't 96 (1983).

[10] See Susan Moore, Margot Murphy, & Ray Watson, A Longitudinal Study of Domestic Water Conservation Behavior, 16 Population & Env't 175 (1994).

[11] See Watson et al., supra note 9, at 558.

lead to significant conservation among a subsegment of the population. According to the investigators who ran the experiment, the latter mailing worked in large part because it aroused the altruistic and other nonegoistical motives of the recipients.[12]

One should not conclude from these studies that price mechanisms are ineffective at promoting conservation. None of the studies described the exact nature of the price mechanisms that were in place, including the prices that were charged. The price structure might not have been well designed to encourage conservation, or the prices might have been too low to provide a strong incentive for conservation. As discussed below in section IIC, prices can encourage significant conservation. But the studies do show that, at least in some settings, appeals to consumers' personal conscience can engage their attention better than economics and thus lead to a higher level of conservation.

- **Second, some groups of water users are likely to respond more robustly than other groups to voluntary campaigns.**

Virtually all examples of effective voluntary campaigns, for example, have involved domestic water consumers. Agricultural and industrial water users, who must worry more about the bottom line profit than domestic consumers, are likely to be less responsive to calls for voluntary conservation. Differences also exist among groups of domestic consumers. In the study described above of water conservation in a medium-sized Southern California community, the educational materials emphasizing the long-term consequences and personal efficacy of conservation produced a significant level of conservation among lower/middle-class consumers but not among upper/middle-class consumers. Appeals to general community interests and personal efficacy seemed to resonate less as income levels rose. Because upper/middle-class consumers used two to three times as much water on average as lower/middle-class consumers, the failure of the campaign to motivate the former group limited the overall effectiveness of the conservation campaign.[13] More importantly, the failure raises a serious equity issue: even if voluntary campaigns are effective in reducing overall demand for water in a region, are they an acceptable conservation tool if they end up placing a greater burden on poorer households?

- **Third, the effectiveness of a voluntary conservation campaign depends to some degree on both the intensity of the educational efforts and the campaign's ability to make consumers feel personally engaged in the campaign.**

Campaigns that have depended largely on mass advertising or generic mailings or

[12] See Suzanne C. Thompson & Kirsten Stoutemyer, Water Use as a Commons Dilemma: The Effects of Education that Focuses on Long-Term Consequences and Individual Action, 23 Env't & Behavior 314 (1991).

[13] See id.

have made only single contacts with consumers generally have not been successful.[14] By contrast, consumers in the Southern California experiment discussed above received a number of mailings designed to personally involve the recipient in the conservation campaign. These mailings included not only education material regarding the "commons dilemma" posed by water use, but also

- a pledge sheet that the water supplier asked the consumer to sign and return, indicating the consumer's commitment to find means of saving water;

- a check list of water-saving measures that the water supplier asked the consumer to review, check which of the measures the consumer would take, and then return;

- a work sheet by which the consumer could determine how much water he or she actually was saving; and

- a bumper sticker emphasizing that it was everyone's responsibility to save water.

In the view of the researchers who designed the conservation campaign, the multiple contacts and highly individualized approach were essential to its partial success.[15]

Voluntary conservation campaigns thus are not a cheap or simple means of reducing water use. Indeed, an ideal campaign would involve door-to-door communications with consumers and "block captains" responsible for revisiting households and helping to muster neighborhood support for the campaign. Although more expensive, such campaigns are likely to be far more successful and cost-effective than the typical campaign that relies on mass media.

- **Finally, voluntary conservation campaigns may not be effective in the long run if not linked to other methods of encouraging conservation.**

The long-run viability of voluntary conservation campaigns remains an open question. Although consumers continue to conserve water for at least a short period after a campaign ends,[16] consumers over time will tend to revert back to their pre-campaign level of water use.[17] In one Australian effort to promote energy conservation, researchers were able to promote conservation among users of large amounts of electricity who had recently completed a poll saying that energy conservation is important, by sending the users a letter comparing their electricity use to that of the average consumer and noting the inconsistency

[14] See, e.g., Geller, Erickson, & Buttram, supra note 9 (no effect from a single distribution of educational material about the problems associated with wasting water and methods for implementing conservation).

[15] See Thompson & Stoutemyer, supra note 12, at 318.

[16] Id. at 328-29.

[17] See Watson et al., supra note 9, at 557.

between their energy practices and their answers in the poll. But after two months, the energy consumers returned to their former levels of energy use.

Of greater concern, active conservation campaigns may lose their impact after significant periods of time. There has been no formal study of this question. Although well-designed campaigns have high saliency in their early months, however, consumers over time appear often to bore of the campaigns and to return to former water-use practices – particularly where the consumers do not personally see any "return" from the campaign in significant rate savings or greater environmental amenities. Tucson's "Beat the Peak" campaign was very effective in reducing per capita water use when it first began in the 1970s, but over time the campaign lost its effectiveness and per capita use actually began to climb again.[18] Part of the problem was that existing consumers began to see the campaign as a "sham, intended to give water to new suburbs for more swimming pools, golf courses and lawns," and not leading to reduced bills or environmental improvement.[19]

C. New Technological Frontiers

Technological approaches to water conservation have become extremely popular. A growing number of governments and water suppliers in the West, for example, have adopted programs in which they either directly provide water-saving devices to domestic consumers or subsidize their purchase. At the agricultural level, both water districts and agricultural agencies provide various forms of technological and financial help to farmers interested in increasing their irrigation efficiency.

Domestic Programs. The popularity of such programs is not surprising. Expanding the technological frontiers of conservation is one of the most effective and sure-fire ways of reducing water use within domestic households. Studies, for example, have shown that installation of low-flow water fixtures in domestic residences result in quite stunning declines in water use. These studies show that, on average,

- each low-flow toilet decreases household water demand from 10 to 11 percent,[20]
- each low-flow showerhead decreases household water demand from 6.4 to 9.7 percent,[21] and
- the use of water-efficient irrigation technology in Southern California decreases household

---

[18] See Michael L. Nieswiadomy, Estimating Urban Residential Water Demand: Effects of Price Structure, Conservation, and Education, 28 Water Resources Research 609, 610 (1992); Molly McKassan & Dave Devine, Water Log, Tucson Weekly (available at http://www.tucsonweekly.com/tw/06-25-98/feat.htm).

[19] See McKassan & Devine, supra note 18.

[20] See Mary E. Renwick & Sandra O. Archibald, Demand Side Management Policies for Residential Water Use: Who Bears the Conservation Burden, 74 Land Econ. 343, 354-55 (1998).

[21] See id. at 356 (8%); John Whitcomb, Water Reductions for Residential Water Audits, 27 Water Resources Bull. 761 (1991) (9.7%); John Whitcomb, Water Use Reductions from Retrofitting Indoor Water Fixtures, 6 Water Resources Bull. 921 (1990) (6.4%).

water demand by at least 11 percent.[22]

Interestingly, these savings actually are somewhat less than that predicted by pure engineering studies – suggesting that water users may respond to water savings technology in part by expanding water use in other ways (e.g., taking longer showers). Having saved water in one place, at least some consumers apparently feel comfortable being profligate in others.[23] But even with these offsetting increases in water use, the net savings from the new technology have still been significant and, more importantly, certain.

Studies, moreover, show that governmental programs supporting the installation and use of new technology within domestic households are typically cost effective. The cost per unit of water saved, including the cost to both the government and the end consumer, is generally less than the cost of providing additional water to the region. Because some of the people who accept governmental support for the new technology would have installed the technology even without the support, some of the funding is theoretically unnecessary. But it is virtually impossible to distinguish which consumers would act without governmental support. And even though some of the funding is theoretically unnecessary, the programs are still cost effective.

Farming Programs. Technology programs in the farming sector present more complications. First, as new technology increases in complexity, governmental programs must both encourage the installation of the technology and ensure adequate training and use. In 1987, for example, the Arizona Department of Water Resources determined that growers who had leveled their fields were not achieving the levels of efficiency expected from such leveling, apparently because they had not made the necessary behavior changes required to maximize the water efficiency of level fields.[24]

Second, economic and operational concerns also can lead farmers to balk at participating in new technology programs with significant up-front costs. Six years after a program was begun in the Central Arizona Irrigation District to pay fifty percent of the cost of adopting level field technology, only 80,000 acres had been leveled. "Uncertainty associated with cotton prices, water costs, and crop financing," according to researchers, "dampened growers' initial enthusiasm for continued investment in an irreversible technology."[25]

Finally, increases in irrigation efficiency have not always translated into reductions in water use. When Texas first provided low-interest loans to farmers to modernize their irrigation systems, agricultural water use actually increased. According to a local water newsletter, farmers apparently found that they could "grow higher water-using crops, and increase irrigated acreage, because

---

[22] See Renwick & Archibald, supra note 20, at 356 (31% decline in low-density households and 10 percent in high-density households, for an overall average savings of 11%).

[23] See Nieswiadomy, supra note 18, at 610.

[24] See David P. Anderson, Paul N. Wilson, & Gary D. Thompson, The Adoption and Diffusion of Level Fields and Basins, 24 J. Ag. & Resource Econ. 186, 201 (1999).

[25] Id.

adoption of water-saving technologies creates a 'new' water supply."[26]

D. Direct Price Signals

As discussed at the outset, the price systems historically used to allocate water in the western United States encourage inefficiently high uses of water. Proposals to reform the price systems, however, always have invited considerable controversy. A significant part of the controversy has been political: no consumer wants to see his or her prices rise. But part of the controversy also has been legitimate questions regarding the effectiveness of price changes in promoting conservation.

Proposed price reforms typically have fallen into three general categories.

- **Where consumers are charged a flat rate for water, no matter how much they consume, reformers have pushed for the metering of water and for quantity-based water rates.**

  Metering of water can encourage conservation in at least two ways. First, even when not linked to quantity-based water rates, metering provides useful information to consumers about the level of their water use. Many consumers are not otherwise aware of their actual water use and, when they receive information from metering (particularly when also given information regarding average water use in their area), will voluntarily reduce their water use. Second, when combined with quantity-based water rates, metering provides consumers with an economic incentive to reduce their water use.

  Not surprisingly, studies show that metering can have a dramatic impact on water use. Most studies suggest that the introduction of metering and quantity-based rates has typically reduced water use by approximately a third.[27]

  The major arguments against metering (or for maintaining a significant flat rate even where some variable charge is introduced) are administrative simplicity and the need for predictability.[28] Metering obviously is more expensive than flat charges, although the cost is more than made up for in the water that is saved. Metering also introduces makes yearly revenue less certain, but this has never proven to be a significant problem for water suppliers.

- **Where quantity-based rates are already used, reformers have urged that prices be increased toward the actual marginal cost of supplying water to consumers.**

  Economic theory suggests that water should be priced at the marginal cost of supplying consumers with the last units of water. Otherwise, consumers will demand more

---

[26] Texas Water Resources, May 1999, at 2.

[27] See Morris, supra note 4, at 37 (discussing a 1977 EPA study).

[28] See Ari M. Michelsen et al., Emerging Agricultural Water Conservation Price Incentives, 24 J. Ag. & Resource Econ. 222, 229 (1999).

water than is justified by its value to the consumers. By moving prices toward marginal cost, water suppliers therefore will promote an efficient level of conservation.

Without disagreeing with this theory, many water interests have opposed or questioned price changes on several grounds. Most typically, opponents have argued that the demand for water is inelastic and that price changes will therefore hurt consumers without decreasing water use. The difficulty of measuring actual price effects has made it difficult to respond conclusively to this argument. Recent studies, however, have indicated that domestic water demand in the western United States is significantly elastic, although the elasticity is considerably less than one. One study of 1984 national water data concluded that average price elasticity in the West is approximately -0.45 (meaning that water use will decline 4.5% for every 10 percent increase in average price).[29] This estimated elasticity is actually somewhat smaller than the elasticities estimated for western water use in earlier studies, including an elasticity of -0.54 based on 1970 data and even -1.02 based on 1955 data. The most recent study of price effects on conservation concluded that the elasticity of water demand in the Santa Barbara region of California was -0.33 in the short run and -0.39 in the long run.[30] Demonstrating the potential influence of prices, price increases in the late 1980s and early 1990s in Santa Barbara and neighboring Goleta caused water use to decline by 9.3 percent and 26.2 percent, respectively.[31]

Opponents also have raised equity concerns to price increases. Farmers, for example, sometimes have argued that it would be unfair to significantly increase rates because the farmers have made significant longterm investments based on the existing price structure. Farmers, moreover, may not have the financial resources needed to make the conservation investments needed to avoid the higher water charges. Some opponents also have objected that price increases are likely to have a regressive effect. Price increases will have a higher percentage cost impact on the poor, according to opponents; the rich, moreover, will generally be able to absorb the higher prices, leaving the poor to pick up the brunt of the conservation. The Santa Barbara study just discussed provides some support for this concern. Water use statistics in the region suggested that for every 10 percent increase in prices, low income households reduced their use by 5.3 percent, middle income households by 2.2 percent, and high income households by 1.1 percent. As the researchers concluded, a pricing approach to conservation "distributed the conservation burden to lower income households."[32]

- **Where unit rates are the same no matter how much water is used, reformers also have proposed the adoption of tiered pricing in which unit prices rise as the total quantity used increases.**

---

[29] See Nieswiadomy, supra note 18, at 613.
[30] See Renwick & Archibald, supra note 20, at 354.
[31] Id.
[32] Id. at 354-355.

Rather than simply raising the price of all water, rate reformers often have proposed moving to a tiered pricing system in which the unit price of water increases for higher volume uses. In theory, such a tiered pricing system can provide the advantages of a rate increase without raising the same equity concerns. The highest rates can be set at marginal cost, sending the correct economic signal to large water users, without requiring a rate increase for smaller water users who might not be able to afford to pay a higher rate. Because a tiered pricing system gives large water users the greatest incentive to conserve, a tiered pricing system also provides for a more progressive allocation of the conservation burden.

E. Water Markets

Water markets are the principal subject of a separate paper, by Professor Bonnie Colby, on "Strategies to Facilitate Changes in Water Use." The discussion here therefore will be brief.

Water markets are another means of giving consumers an economic incentive to conserve. Prices encourage conservation by forcing people to ask whether they fully value all of the water that they are using and whether there are cost-effective means of reducing their water use; to the degree that water users reduce their water consumption, they pay less in water bills. Markets encourage conservation by giving people the option to sell water that they conserve; to the degree that water users reduce their water consumption, they may be able to increase their revenue.

Although conceptually similar, markets and pricing schemes vary in a number of important ways. Markets have a number of potential advantages compared to pricing approaches:

- **Markets encourage conservation through a " positive incentive" (the opportunity to sell conserved water) rather than a "penalty" (increased prices).** As a result, markets do not raise the same equity concerns as price increases. Markets, for example, do not threaten farmers who have made investments based on existing water rates. More importantly, markets therefore may be easier to sell politically than price increases. In reality, of course, markets still threaten a number of interests and thus have faced significant opposition in many parts of the West.

- **Markets provide both an incentive and the funding often needed to implement conservation.** Although pricing can provide an incentive to conserve, water users often do not have the funding needed to pay for more expensive conservation measures. Where there is a market for conserved water, the current water user often can use the market to provide the funding needed to pay for the conservation.

- **Markets adjust automatically to changes in the value of the water to other consumptive uses.** As the value of water in other consumptive uses rises, the incentive for conservation should also rise to reflect the increased "opportunity cost" of the water. Under a pure pricing approach to conservation, water suppliers must continually monitor changes in water value

and adjust prices accordingly. Markets, by contrast, adjust automatically because the price for which a water user can sell conserved water will depend on its value to others.

- **Markets have proven more effective at returning water to rivers and streams than price changes.** In theory, marginal water prices should be set at a level that reflects the value of the water both for other consumptive uses and as instream flow. Prices set at this level might well result in some water being returned to the stream. In practice, however, prices have been used to free up water for other overall growth in consumptive use; water suppliers seldom give up water that their consumers conserve.

  By contrast, water markets have resulted in water being returned to rivers and streams. Governments and non-profit organizations are increasingly purchasing water on the market in order to return the water to the waterway. Since 1994, annual acquisitions for instream flow in the western United States have exceeded 500,000 acre feet of water (with the exception of 1998 when acquisitions temporarily dipped to about 350,000 acre feet), involving purchases in eight different states.[33] Given political and free rider problems, the funding available for such environmental purposes has not reflected fully the environmental value of instream flows.[34] But such market purchases nonetheless have added significantly to the available instream flows.

  Governments also can try to benefit the environment by linking the sale of conserved water with environmental goals. Oregon, for example, requires that appropriators who plan to conserve water for sale or other use must allocate a portion (usually 25 percent) of the conserved water to the state for instream flow maintenance.[35] Such an "environmental tax," however, reduces the value of the conservation to the appropriator and thus decreases the likelihood that water will be conserved at all. For multiple reasons, no water was conserved under Oregon's statute for ten years after the statute was passed in 1987.[36]

Water markets, however, are far from a panacea. Effective water markets confront a number of obstacles and problems, including the following:

- **Water markets face significant political opposition.** As discussed in a variety of previous articles, water districts and local communities frequently oppose market transfers for both good and bad reasons.

- **Water markets most benefit large water users who have been profligate in the past.** Because the state does not charge for appropriative rights, some people have objected that

---

[33] See Barton H. Thompson, Jr., Markets for Nature, 25 Wm. & Mary Envtl. L. & Pol'y Rev. 261, 267-293 (2000).

[34] Id. at 276-280 & 292.

[35] See Or. Rev. Stat. § 537.470(3).

[36] See Janet C. Newman, Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Law, 28 Envtl. L. 919, 957 (1998).

water markets permit water users to profit from a public resource. Of greater concern, water users who have been particularly wasteful in the past will often find it easiest to make a profit from conservation.

- **Markets work only where there is a market.** As noted above, the market for water does not reflect the full societal value of water for environmental and other public purposes. Indeed, in some areas where there is no unmet offstream demand for water, the value of water on the market is zero – even though the water could serve valuable instream purposes. In these areas, markets do not provide an effective incentive for conservation.

- **Markets do not always work as economists would predict.** Water users with an opportunity to conserve water, for example, sometimes "hoard" their water even where they could sell the water for far more than the cost of conservation. The reasons are not clear. Water users may fear that they will be able to purchase water if they need it in the future; the value of the water to the current user may include a significant "endowment effect"; water users may fear that the government will change rules midstream to their detriment. Similar "hoarding," however, arises in other environmental market and undermines the effectiveness of the market.

F. Bounties and Subsidies

Although water suppliers and governments have helped subsidize the installation of water-saving technology such as low-flow toilets (see subsection C above), they have not tended to subsidize conservation directly by, for example, paying water consumers who are able to reduce their water use by a specified percentage. Such subsidies, however, are simply the flip side of price increases. If political opposition prevents raising prices by a sufficient margin to encourage significant conservation, water suppliers and governments can achieve the same end by paying consumers to conserve. Consumer opposition to increasing electricity prices during California's current energy "crisis" has led a number of cities, such as Palo Alto, to initiate programs to pay large electricity users to reduce their electricity use during the summer.

Although such subsidy programs often are politically more feasible than price increases, they pose a number of disadvantages:

- **Someone must fund the subsidies.** Often the source of the funding is general tax revenue or a general surcharge on water use, including water use by smaller, low-income users.

- **As with markets, subsidies can appear to benefit large water users, especially those who have been prodigal in their past water use.**

- **If subsidies are based on reductions in historic water use, water suppliers must have accurate baseline data on water use.**

- **Some of the payments under subsidy programs are "wasted" on people who would have conserved even without the subsidy.**

- **Subsidies can undermine altruistic motives for conserving.** In related areas, studies often have shown that, when people are paid to engage in a particular activity, they become less inclined to engage in the activity for purely altruistic reasons. Subsidy programs, in short, can "crowd out" altruistic conservation.

G. Regulation of Water Use

Governments and water suppliers also can achieve conservation by mandating it. Governments and water suppliers can require consumers to reduce water use by a particular amount (a "performance standard"), to install or use particular technology (a "technological standard"), or to engage in particular practices such as not using water to remove leaves from the driveway (an "operational standard"). Because homeowners often do not make decisions on what plumbing equipment is used in their houses, governments also frequently establish water-related building standards designed to conserve water.

When enforced, such regulations can generate significant water savings. In the late 1980s, for example, the Southern California community of Goleta reduced water use by almost 30 percent by assigning maximum water allotments to households based on a percentage of historic use.[37] The neighboring community of Santa Barbara reduced water use by over 15 percent by banning virtually all forms of landscape irrigation except for hand watering and drip irrigation.[38] In most cases, moreover, regulations tend to spread the burden of conservation more evenly among water consumers than pricing schemes or voluntary conservation campaigns.[39]

Consumers, however, generally dislike such regulations and tend to strongly oppose them except in periods of drought or other emergency. Domestic consumers complain of "water cops," while agricultural and industrial consumers complain of governmental "micro-management" of their businesses.[40] Governments considering the direct regulation of water use, moreover, must address several critical questions:

- **How well can the government enforce the regulation?**

  The few studies of compliance with water regulations suggest that there is a relatively high rate of compliance (although, not surprisingly, still incomplete compliance). A relatively recent study of Florida's management of irrigation water use, for example, found that only

---

[37] See Renwick & Archibald, supra note 20, at 355.

[38] Id.

[39] See id. (finding that the Goleta and Santa Barbara regulations generated the most conservation among low density households).

[40] See Gary D. Lynne et al., Conservation Technology Adoption Decisions and the Theory of Planned Behavior, 16 J. Econ. Psych. 581 (1995).

14 percent of the farmers failed to adopt technology needed to meet required efficiency goals, although many others put in only minimal effort.[41] According to the same study, compliance increases where water users are initially ordered to make only moderate changes in their water practices, permitting gradual buy-in to the regulatory scheme.[42]

- **Will the regulation undermine voluntary regulation, becoming both a floor and a ceiling on conservation?**

Regulations, like subsidies, can "crowd out" voluntary conservation. Studies in related settings suggest that people behave less altruistically when the government regulates an activity. Indeed, people actually may try to use more of a resource if use is regulated than if it is not. If the regulation is imperfectly enforced, the result therefore can be increased rather than decreased use.

III. A Brief Survey of State and Federal Conservation Efforts

A. Direct State and Federal Conservation Measures

Although most conservation measures over the last several decades have been local, some states, as well as the federal governmetn, have taken direct measures to promote water conservation. These steps have included:

- **More Forceful Enforcement of the Traditional "Reasonable and Beneficial Use" Requirement**

The "reasonable and beneficial use" requirement remains an underutilized and, in most states, totally unutilized means of encouraging conservation. Most water uses still go unreviewed except in contested stream adjudications. And when water practices are reviewed, most courts and administrative agencies still permit water users substantial latitude.

Some change, however, has occurred. A few states have tried to tighten up slightly on the standards used to evaluate "reasonable and beneficial use." In 1980, for example, California amended its water code to provide that "conformity of a ... method of diversion of water with local custom shall not be solely determinative of its reasonableness, but shall be considered as one factor to be weighed."[43]

New judicial or administrative decisions occasionally give hope that courts and administrative agencies are taking a new interest in water use. In 1993, for example, the

[41] Id. at 596.
[42] Id.
[43] Cal. Water Code § 100.5.

Washington State Supreme Court affirmed a lower court decision limiting an irrigation right, noting the need for reasonable efficiency and holding that customary practices "do not justify waste of water."[44] There is no evidence at the moment, however, of a sustained change in scrutiny. Decisions holding a particular use to be unreasonable remain few and far between, and an equal number of recent cases can be cited that were generous to farmers or other water users.[45] A close examination of the decisions that so hold, moreover, suggest that courts and administrative agencies remain cautious about intervening to police water use:

- Most of the decisions involved unique circumstances where one water user was willing to lodge a complaint about the practices of another water user. In the California Water Resources Control Board's 1984 decision involving alleged waste by the Imperial Irrigation District, for example, a member of the district sued after his land was flooded by a Salton Sea expanded by irrigation return flow.[46] Outside these situations, courts and administrative agencies appear reticent to scrutinize water use.

- In each decision, the court or administrative agency was reticent to order the water user to change its traditional practices, even though these practices were found wasteful. In most cases, the court or administrative agency ordered a reduction in water use only where other water users were willing to pay for the cost of the necessary conservation.[47]

- **Direct Regulation of Water Use**

For years, a handful of states have set specific water duties that cap the amount of water that farmers and others can use. In most cases, the legislature directly sets the water duty.[48] In Oklahoma, the Water Board determines how much water may be applied by each applicant.[49] Such water duties, however, historically have done little to reign in waste. Water duties suffer from considerable "regulatory lag," particularly where they are set (and seldom revisited) by legislatures. Even when the water duties are first set, political considerations ensure that the duties are set at relatively generous levels.

---

[44] Washington Dept. of Ecology v. Grimes, 852 P.2d 1044 (Wash. 1993).

[45] See, e.g., United States v. Alpine Land & Reservoir Co., 503 F. Supp. 877, modified, 697 F.2d 851 (9th Cir.), cert denied, 464 U.S. 863 (1983).

[46] Imperial Irrigation District: Alleged Waste and Unreasonable Use of Water, Water Rights Decision No. 1600 (Cal. Water Resources Control Bd. 1984).

[47] See, e.g., Erickson v. Queen Valley Ranch Co., 99 Cal. Rptr. 446 (1971).

[48] See, e.g., Neb. Rev. Stat. § 46-231 (an "allotment from the natural flow of streams for irrigation shall not exceed one cubic foot per second of time for each seventy acres of land and shall not exceed three acre-feet in the aggregate during one calendar year for each acre of land for which such appropriation has been made, and an allotment shall not exceed the least amount of water that experience may indicate is necessary, in the exercise of good husbandry, for the production of crops"); S.D. Codified Laws § 46-5-6 (setting a duty of two acre-feet per year that can be raised to up to three acre-feet by the Water Management Board).

[49] 82 Okl. Stat. § 105.12.

Under its 1980 Groundwater Management Act, however, Arizona has gone a step further and mandated relatively rigorous performance standards of water users withdrawing groundwater from the state's active management areas. Municipal users must make "reasonable reductions" in per capita water use; industrial users must meet water duties based on the "latest commercially available conservation technology consistent with reasonable economic return"; irrigators must comply with water duties based on the "maximum conservation consistent with prudent long-term management practices."[50] Under the irrigation standard, the Arizona Department of Water Resources has set a target efficiency of 85 percent, effectively requiring the use of level basin irrigation.[51] An open question, however, is the degree to which farmers actually have met this standard.[52]

Florida also sets specific water standards for irrigators. In some cases, the standards take the form of irrigation efficiency standards. In other cases, the state requires irrigators to use particular technology. Florida tries to enforce its standards by holding out the prospect that water permits will not be granted where the water standards are not met.[53]

- **Establishment of Technological Water Standards**

The federal government and a number of states have tried to set standards for construction and product design that will minimize water use. The National Energy Policy Act of 1992, for example, requires that all new toilets, faucets, and showerheads manufactured for residential use in the United States meet national efficiency standards. States such as Washington have adopted water-saving plumbing codes for new construction.

- **Reduction of Water Subsidies**

The federal government has reduced the size of the subsidy being provided to some water districts through both the Reclamation Reform Act of 1982 and the Central Valley Project Improvement Act of 1992. In both cases, however, the changes were incremental, and significant subsidies remain.

- **Promoting Water Markets for Conserved Water**

A number of states have tried to foster water markets for conserved water. Professor Colby's paper discusses water market legislation generally. The marketing of conserved water, however, raises particular obstacles because of several prior cases suggesting that

---

[50] See Ariz. Rev. Stat. §§ 45-411 et seq.

[51] For useful discussions of the conservation provisions of the Arizona Groundwater Management Act, see Neuman, supra note 3, at 950-53; Anderson, , Wilson, & Thompson, supra note 24, at 189.

[52] See Anderson, Wilson, & Thompson, supra note 24, at 201.

[53] Fla. Stat., ch. 373; see also Lynne, supra note 40.

conserved water might not belong to the water user and thus not be available for sale.[54] A handful of states have responded by providing statutory assurances that conserved water can be sold.

- California, for example, provides that water conservation "shall be deemed equivalent to a reasonable beneficial use of water," that conserved water cannot be lost by forfeiture, and that conserved water can be "sold, leased, exchanged, or otherwise transferred pursuant to any provision of law relating to the transfer of water or water rights." The statute defines "water conservation" broadly to encompass "the use of less water to accomplish the same purpose or purposes of use allowed under the existing appropriative right," including temporary land fallowing or crop rotation.[55] The State of Washington has adopted a similar approach.[56]

- In Oregon, as discussed earlier, irrigators interested in conserving water must file a conservation plan and obtain the approval of the Water Resources Commission. Once the plan is approved, the irrigator can sell or lease the conserved water or use the water itself on other lands, provided that a portion of the water (generally 25%) is dedicated to the state for instream uses.[57]

- **State-wide Conservation Planning**

As part of an effort in 1997 to convince the National Marine Fisheries Service not to list Oregon coastal salmon species under the Endangered Species Act, Oregon developed the "Oregon Plan for Salmon and Watersheds." As one part of this plan, the Oregon Water Resources Department promised to develop "regional efficiency standards" to reduce consumptive uses and thus hopefully increase instream flows. The Department planned to work with interdisciplinary working groups in basins with stream flow problems to develop basin-specific efficiency standards by June 1999. As Professor Janet Neuman has written, the original goal proved hard to achieve.[58] The 1998 annual report summary for the Plan noted that the "Water Resources Department has not made significant progress developing regional efficiency standards. This concept is controversial and divisive. It is unlikely that agreement on appropriate goals can be achieved in the time frame contemplated under the Oregon Plan." By the 1999 annual report, the original concept seemed to have been entirely abandoned. Instead, the report noted that Department staff members were working with local watershed councils on "'efficiency projects' to identify water conservation goals."[59]

---

[54] See, e.g., Salt River Valley Water Users' Ass'n v. Kovacovich, 411 P.2d 201 (Ariz. 1966); Southeastern Colorado Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321 (Colo. 1974); Bassinger v. Taylor, 211 P. 1085 (Idaho 1922).

[55] Cal. Water Code § 1011.

[56] See Wash. Rev. Code § 90.42.030.

[57] See Or. Rev. Stat. §§ 537.455-50, 540.510(2)-(3).

[58] Neuman, supra note 3, at 953-56.

[59] Copies of the various reports can be found at www.oregon-plan.org.

- **Subsidization of Conservation**

  Both the federal and a number of state governments have provided funding or technical support for conservation measures. In the Yakima River Basin Water Enhancement Project Act, for example, Congress authorized public funding for improvements in on-farm irrigation efficiency in the Yakima River Basin; water saved through such conservation is to be used to increase water for both instream flows and irrigation.[60]

B. State and Federal Efforts to Encourage Local Conservation Measures

Local water suppliers and governments have taken varied steps to promote conservation over the past several decades. As discussed in Part II, these measures have included voluntary and mandatory conservation programs, conservation incentives, and price changes. Many local agencies and governments, however, are reticent to act on their own. Because conservation can require changes in lifestyles, significant conservation measures are often politically unpopular. Many water suppliers, moreover, fear that conservation will reduce the buffer that they can use to make it through droughts. Pressure therefore can be very useful in getting local water suppliers to act.[61]

Both the federal government and a number of state governments have taken steps to encourage local agencies and governments to take conservation measures. These steps vary considerably among jurisdictions, but a brief overview can provide the general tenor of the provisions.

- **Conservation Planning**

  Both the federal government and states have tried to encourage local conservation measures by requiring water suppliers to develop conservation plans. Both the federal Reclamation Reform Act and the Central Valley Project Improvement Act, for example, require irrigation districts receiving federal reclamation water to prepare conservation plans.[62] Under the Department of the Interior's 1996 policy document, conservation plans should address four "fundamental" areas: water measurement and accounting systems, water pricing, information and education programs, and assignment of responsibility for conservation activities. Typical of state provisions is California law, which requires municipal water suppliers to prepare urban water management plans that describe and evaluate the practical and efficient use of the agency's supplies, including conservation.[63]

  Most of the laws requiring conservation planning are both vacuous and toothless. Most of the laws, for example, leave the actual conservation goals entirely up to the local

---

[60] Pub. L. No. 103-434, § 1201; see also Ray Huffaker & Norman Whittlesey, The Allocative Efficiency and Conservation Potential of Water Laws Encouraging Investments in On-Farm Irrigation Technology, 24 Ag. Econ. 47, 48 (2000).

[61] See Morris, supra note 4, at 37 (discussing Denver's opposition to conservation measures in the mid-1970s).

[62] For a discussion of the provisions of these acts, see Michelsen, supra note 28.

[63] Cal. Water Code §§ 10620 et seq.

water supplier. Few of the laws, moreover, attach any penalty to the failure to develop a conservation plan. Under the Reclamation Reform Act, for example, districts must submit conservation plans to the Bureau of Reclamation for review, but the Bureau does not approve the plans and cannot penalize districts that do not comply. Perhaps for this reason, less than half of all irrigation districts had complied ten years after the conservation plans were originally due; in California, less than 28 percent of the districts had complied.[64] The Central Valley Project Improvement Act is an exception to the normal approach and imposes pricing penalties on districts that do not develop adequate conservation plans.

Not surprisingly, laws requiring conservation planning do not appear to have had a significant impact on the actual practices of most water suppliers. In 1986, virtually no irrigation districts in the nation used an inclining tiered pricing structure. Almost half used fixed assessments only; slightly less than 40 percent used combinations of fixed and quantity-based charges (but the quantity-based charges were either uniform or declining block); 14 percent used only quantity-based charges (and 96 percent of these were uniform).[65] Despite the passage of various federal and state laws encouraging conservation planning, things had not changed much ten years later. By 1997, only 16 districts had made significant changes in their rate structures.[66]

- **Imposition of Particular Pricing Systems**

Both the federal government and a handful of states have also mandated that local water suppliers use various forms of pricing structures. Some states, for example, now require metering of at least new water users. The Central Valley Project Improvement Act also requires irrigation districts receiving Central Valley Project water to use tiered pricing.[67]

Here again, the federal and state laws have been less than successful. Consider, for example, laws requiring districts to use tiered pricing. Most districts that have adopted tiered pricing set the lowest block so high that it covers virtually all crop water needs. Most districts set the block structure so as only to "penalize" irrigators using water in a particularly "wasteful" fashion; the block structure is not used as an economic incentive for the vast majority of irrigators.[68]

- **Reduction of Local Subsidies**

A few states also have encouraged local water suppliers to reduce or eliminate traditional sources of subsidy. California, for example, has mandated that local water agencies reduce their use of property taxes to subsidize water rates.

---

[64] Michelsen, supra note 28, at 223.
[65] Id. at 226-28.
[66] Id. at 229-31.
[67] CVPIA § 3405(3)(d).
[68] See Michelsen, supra note 28, at 232-34.