ELSEVIER Water Policy 3 (2001) 175-192

Water policy in the United States: a perspective

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Received 13 June 2000; received in revised form 22 January 2001; accepted 20 April 2001

Abstract

Lessons learned from the evolution of US water policy over two centuries of rapid population growth, economic expansion and urban development may shed light on promising approaches to issues in other areas of the world. An explanation of the major philosophical and legal underpinnings of water quantity and water quality policies that have evolved in the US federal-state system is presented. Other areas of the world may benefit from mistakes made during the evolution of US water policy in the areas of institutional reform, improved processes for conflict resolution, and increased use of modern planning and decision making procedures. © 2001 Elsevier Science Ltd. All rights reserved.

1. Introduction

Throughout human history, water resources have played a critical role in the development of advanced societies. In recent years, those involved in the development and use of water resources around the world have become increasingly concerned about the unintended effects of humanity's attempts to use these precious resources. The tough realities of competition for scarce water resources around the world have led to disagreements over goals and the degree to which goals can be achieved through proper management of water resources.

In order to provide policy makers and planners facing these exceedingly complex and difficult challenges with maximum assistance within the confines of a single document, this paper

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addresses the evolution of water resources policy analysis in the area of the world where most of the available literature on this subject is available: The United States. Hopefully, lessons learned from the evolution of US water resources policy analysis during its past two centuries of rapid population growth, economic expansion and urban development can shed light on promising approaches to address similar issues throughout the world.

2. Organization of the paper

In theory, policies are reflections of societal goals and aspirations. Once these goals and aspirations have been determined, laws, regulations and other policies are shaped to achieve them. Unfortunately, until recent years, many of the water resource policies that developed in the United States were expressions of the goals and aspirations only of those constituencies who exercised the greatest control over the law and policy process. The inevitable result of such an approach was an ad hoc "patchwork of various statutory and market incentive programs" that was driven more by conflict than consensus and more by unrealistic assumptions than by realistic assessments (Kalen, 1993). Many of the policies that emerged focused on short-term, single purpose objectives. In essence, national policy became policy by default (Getches, 1993).

This paper is organized in a manner that enables the reader to focus on the major philosophical and legal underpinnings of water policies that have evolved in the federal-state system that exists in the United States. The following section ("An ecological approach to water resources policy") focuses on the utilization of general ecological principles essential to understanding the interrelationships and interdependence that are inherent in water resources policy. Section 4 ("Dividing the commons") examines a number of water *quantity policy* issues and a number of state laws that have been enacted in response to specific policies. Section 5 ("Protecting the commons") examines a number of water *quality policy* issues and a number of state and federal laws that have been enacted in response to specific policies. Section 6 ("Lessons learned") addresses three of the most important topics in which other areas of the world can benefit from the mistakes made during the evolution of US water policy. These are: (i) institutional reform, (ii) improved processes for conflict resolution and (iii) increased use of modern planning and decision making procedures.

3. An ecological approach to water resources policy

With regard to water resources, the policy community consists of law/policy, science/ technology and beliefs/ethics. Because of the interrelationships and interdependencies that have evolved over time, changes in any one of these areas will affect the other two.

There are two fundamental ecological principles that are essential to the development of rational water resources policy. First, as in any natural community, interrelationships and interdependencies evolve over time. Second, any change in the community will affect these interrelationships and interdependencies.

There are multitudes of cases in which these fundamental principles have been ignored in the past, some of which are readily apparent. For example, although water resource policy has tended

to treat them separately, the various phases of the hydrologic cycle are intrinsically interrelated. Policies relating to surface water will affect ground water and vice versa. Policies relating to water quantity will affect water quality and vice versa.

Many examples of interrelated nature of the components embodied in water resource policy are subtler. For example, it has been argued that the primary goal of water resource policy should be sustainability, e.g. the fulfillment of contemporary and long-term needs (Longs Peak Working Group, 1994). Implicit in water resource policies focusing on sustainability is the assumption that the carrying capacity of this planet can be determined and maintained at or below capacity levels. This, in turn, presumes a stable global population. However, belief systems that oppose "artificial" means of population control may render unachievable the goal of global population stability. As a result, sustainability may also be rendered unachievable.

In order to develop the "holistic, integrated perspective" (Getches, 1993) that water resource policy analysis requires, it is essential to appreciate the interrelationships and interdependencies that have evolved over time. It also is essential to understand the consequences of alternative policies. When such an understanding is absent, the water resource policy development process becomes myopic. The result is a piecemeal approach to policy (Sherk, 1990). Such an approach is inadequate. A comprehensive, integrated approach is required.

4. Dividing the commons[1]

Historically, water resources have been considered to be common resources. In the United States, two systems of water law developed over the past century to "divide" the commons.

The prior appropriation doctrine, the basic concept adopted in the western states for the allocation and management of water resources, reflects the realities of that region. The "first-in-time, first-in-right" concept of the prior appropriation doctrine reflects the relative scarcity of water in the western states and provides certainty in times of shortage.

The riparian doctrine of the eastern states reflects the realities of a region historically blessed with abundant water resources. It does not provide a basis for the allocation and management of state water resources. Rather, it limits water use to lands adjoining or overlying the water resource, requires water to be used "reasonably" and provides for a pro rata sharing of available water supplies.

Both doctrines have been subjected to substantial criticism. Strictly construed, the prior appropriation doctrine can be exceedingly rigid, especially with regard to new water uses having junior priorities. The doctrine is not well-suited to protecting water uses, such as instream flows, that do not have easily quantifiable economic benefits.

The riparian doctrine, on the other hand, can be exceedingly vague. It does not provide a means by which certain water uses may be either protected or regulated. It neither allows water to be moved to higher valued uses nor protects environmental amenities. In addition, the riparian doctrine is predicated on the assumption that there is an abundant supply of water. Obviously, this assumption- is sometimes invalid. Because of increasing instream flow requirements, contamination of existing supplies and gradual climate changes, eastern states may not have

[1] This section is adapted from Sherk, 1991.

the abundant water resources that once were assumed to be available. Given the increasing stress being placed upon eastern water resources, strict riparian doctrine may have outlived its usefulness (Abrams, 1989).

Most of the eastern states have enacted new laws that either amend or supersede the riparian doctrine. Contrary to the expectations of numerous water law commentators, however, the eastern states have not, to date, adopted the prior appropriation doctrine of the western states. While the eastern states indeed are moving away from the riparian doctrine, the western states, conversely, have been moving away from a strict doctrine of prior appropriation. The resulting "conceptual confluence" finds the eastern states adopting some aspects of the prior appropriation doctrine while the western states temper that doctrine by adopting certain concepts that historically are riparian in origin.

A taxonomy useful in understanding the on-going evolution in water resource use policies in the US contains six issue areas: (i) programmatic scope, (ii) quantification, (iii) priorities/public interest, (iv) instream flows, (v) water conservation and (vi) transbasin diversions. Each of these issue areas is discussed briefly below. With regard to each of these issues, the water resource policies of the eastern and western states are converging.

4.1. Programmatic scope

In terms of water resource policy, should state programs be state-wide or should programs be limited to certain areas of the state? In general, western states originally adopted the prior appropriation doctrine on statewide bases. Similarly, the riparian doctrine applied statewide in eastern states because it was a part of the common law adopted in those states. As eastern states have supplemented the riparian doctrine with permit systems, the geographic orientation has shifted from statewide to site-specific.

For example, recently enacted legislation in Virginia provides for the establishment of surface water management areas. Several Great Lakes states have enacted similar laws regarding surface water uses and diversions only within the tributaries of the Great Lakes. Similar policies also may be emerging with regard to the drainage basin of the Chesapeake Bay.

At least nine eastern states have established programs regulating the uses of ground water on site-specific bases through the establishment of ground water management areas (Bowman, 1990). North Carolina, Indiana, Virginia and South Carolina, for example, provide for the establishment of capacity or restricted use areas within which the use of ground water is closely regulated.

Like their eastern colleagues, legislators in western states are establishing site-specific management programs to supplement traditional statewide concepts. At least seventeen western states have enacted legislation authorizing the establishment of ground water management areas (Bowman, 1990). Several states have created specialized types of management areas to meet specific and distinctive needs. Arizona, for example, has provided for both active management areas and irrigation nonexpansion areas. Nebraska authorized management areas, control areas and special protection areas. Kansas authorized the establishment of both ground water management districts and intensive ground water use control areas.

Recent policies such as the wellhead protection provisions of the Safe Drinking Water Act and the development of coastal zone management plans under the Coastal Zone Management Act

indicate that this trend in water resource policy is likely to continue with both statewide and site-specific programs becoming the rule in all of the states.

4.2. Quantification

The essential water resource policy questions dealing with water quantity concern whether or not the quantity of water to which the holder of a water right is entitled should be limited and, if so, how that limitation should be determined.

In western states, the basis, measure and limit of a water right under the prior appropriation doctrine is defined by beneficial use. This means western water rights are quite specific in terms of quantity, allowable use, point of diversion and timing of availability, among other things.

Under the riparian doctrine water rights are not quantified. Owners of riparian land in the eastern states were entitled under the common law doctrine to utilize adjacent or subjacent water in any reasonable way, subject only to the exercise of similar rights by other riparian landowners.

The specificity of western water rights is reflected in the administrative permitting systems that have been adopted recently in many eastern states. Such systems usually require existing riparian uses to be quantified and registered. Following registration, the state program usually provides the riparian water user with a permit which describes the water use with the same specificity ascribed to water rights existing under the prior appropriation doctrine. At least twenty eastern states have enacted legislation establishing registration or permitting requirements. Florida, for example, established a two-year period during which permits for existing consumptive uses must be obtained. Failure to obtain a permit resulted in a conclusive presumption that the use had been abandoned.

Several of the eastern states have enacted legislation requiring registration to occur during shorter periods of time or requiring registration by specific dates. North Carolina and Virginia require the registration of ground water uses in capacity use areas within six months of designation. South Carolina requires such registration within twelve months.

The movement toward quantification and registration of water uses in the eastern states as well as the issuance of permits to protect those uses has been motivated in part by the growing interest in water marketing. The eastern states are learning what the western states considered obvious: A quantification process is essential in determining the amount of water that a permit holder can transfer. Quantification of individual rights in eastern water resources is similar to "the nineteenth century tradition of dividing the commons among private claimants" (Tarlock, 1990).

Concomitant with this privatization, however, comes increasing regulation to protect the public interest. Numerous eastern and western states have recognized some form of the public trust doctrine as one means of protecting the public interest in water resources (Butler, 1990). Definitions of navigability have been expanded to include public uses and recreational values in Arkansas, Montana and Oklahoma. As discussed in detail below, a majority of the fifty states have enacted minimum water level legislation. On issues of quantification and public interest regulation of private water rights, the water resource policies of the eastern and western states are becoming more similar with each passing legislative session.

4.3. Equitable priority

When supplies are insufficient, what water resource policy should guide allocation of the resource? With regard to the operation of federal facilities, this question was addressed in part in the Flood Control Act of 1944 in which Congress provided that the use for navigation of "waters arising in States lying wholly or partly west of the ninety-eighth meridian shall be only such use as does not conflict with beneficial consumptive use" for other specific purposes, including irrigation. A similar provision has not been enacted for federal facilities lying east of the ninety-eighth meridian. This fact, combined with the fact that the specific provision of the Flood Control Act has not been enforced strictly, has led to uncertainty regarding relative priorities for the use of water stored in federal facilities.

At the state level, under the prior appropriation doctrine, the highest priority went to the most senior water use. As a general rule, all unappropriated water was subject to appropriation. In the eastern states, all riparian water users shared the resource. A limited priority was afforded domestic and agricultural water uses.

In recent years, the prior appropriation concept of temporal priority has been utilized in eastern states, but not as the sole determinant of priority in times of shortage. The emerging eastern approach has been to list a series of factors to be considered in determining whether a permit should be issued or whether a change in place or type of use should be allowed. As with the western states, one of the factors to be considered is the impact of the proposed use on existing water uses. At least a dozen eastern states require permit applicants to demonstrate that their proposed uses will not interfere with existing uses. Wisconsin, for example, allows for the revocation of a permit if the permitted water use interferes with riparian water users or public water supplies. In addition, several of the eastern states have adopted provisions favoring existing water uses in determining reasonable or unreasonable uses of surface and ground water.

New legislation in eastern states consistently includes consideration of the public interest in allocation and regulation of water rights. For example, the public interest determines how water will be allocated during a water shortage in Kentucky. In Florida and Virginia, the public interest includes consideration of environmental values and instream flow requirements.

As eastern states move toward a balance between temporal priority and the public interest, the western states, either by statute or case law, are moving in the same direction. By one means or another, virtually all of the western states require consideration of the public interest when an appropriation is initiated (Johnson & DuMars, 1989).

Eastern and western states are moving toward a concept of "equitable priority" that balances impacts on existing water users (temporal priority) with public interest considerations. This balancing is occurring throughout the regulatory process, from initiation of a water use to a change in the place or purpose of that use.

A related water resource policy question emerging in both eastern and western states is "Who decides what is in the public interest?" If a proposed change in place or purpose of use is intended to meet the needs of a water market, for example, is the public interest determined by economic benefits or by social and environmental costs? It has argued that public interest determinations are political in nature and should be resolved in more public and political regional

water processes rather than in courts or quasi judicial administrative agencies (DuMars & Tarlock, 1989). Others question whether the public interest is well served when an issue like water use is politicized. Regardless of who makes the decision, determining the public interest has emerged as a major factor in the management and allocation of water resources in the eastern and western states.

4.4. Instream flows[2]

Should water resource policies both recognize and protect instream flows? Historically, the prior appropriation doctrine required diversion of water from a watercourse before a right to the water could be established. There was little recognition or protection in appropriation doctrine states for nonconsumptive instream uses.

Except for the navigation servitude asserted by the United States, even less recognition or protection of such uses was afforded in riparian doctrine states. In England, the common law prohibited riparian water users from adversely affecting the "natural flow" of a watercourse. In the United States, the "reasonable use" doctrine replaced the "natural flow" concept in order to encourage economic development in the eastern states. In the absence of state legislation, however, "reasonable use" does not include instream uses.

The concept of "instream flows" includes the use (or nonuse) of water for a variety of purposes or to protect a variety of interests. Historically, navigation, public water supply, sanitation and fish/wildlife purposes have been recognized as requiring minimum streamflows. Recreational, aesthetic and ecological uses now are being recognized as equally important water uses.

The result is that both eastern and western states are taking steps to protect instream flows. For example, in Colorado, Idaho and Arizona (prior appropriations doctrine states), the diversion requirement has been eliminated. Legislation authorizing the reservation of water (or the withdrawal of water from appropriation) to protect instream flows has been enacted in Alaska, Oregon, Montana and Utah. In addition, instream flows have been protected by case law or statute in Washington, Wyoming, North Dakota and Nevada.

While the western states integrate protection of instream flows into the prior appropriation doctrine, at least sixteen eastern states have enacted legislation to protect such flows in the context of legislation amending (or superseding) the riparian doctrine. The preferred approach has been to authorize a branch of state government to establish minimum streamflows or water levels. Legislation enacted in Virginia illustrates the trend. In Virginia, a surface water management area may be established in order to protect instream and offstream beneficial uses. Offstream beneficial uses may be restricted if the Department of Environmental Quality determines that such uses threaten to reduce streamflows (i.e., affect instream beneficial uses adversely) in a management area. In addition, the legislation mandates the protection of instream beneficial uses and public water supplies.

Massachusetts and South Carolina have protected instream flows by restricting the amount of water available for transbasin diversions. Conversely, Wisconsin allows transbasin diversions for the purpose of maintaining streamflows or lake levels.

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[2]This section is adapted from Leone and Sherk (1993).

Protection of instream flows has been motivated in part by a growing recognition of the economic importance of such flows. In New Mexico, for example, a study by Ward (1987) examined the relative economic benefits of streamflow augmentation in the Rio Chama. When used to augment normal streamfiows for recreational purposes, releases from an upstream reservoir produced returns of between $868 and $1028 per acre-foot. When used to augment low streamflows (fifty percent of normal streamflow), the return ranged between $909 and $1040 per acre-foot. The contract price for municipal and industrial use of the water stored in the upstream reservoir, however, was only $40 per acre-foot.

At the present time, at least twenty-eight eastern and western states protect instream flows. Given the growing recognition of the value of instream flows, especially in purely economic terms, it is certain that this trend will continue.

4.5. Water conservation

Given both quantitative and qualitative limitations on water supplies, how should water resource policies encourage water conservation? Initially, it must be understood that the term "water conservation" means different things to different people. In the western states, it has meant conservation of seasonally available resources through the construction of dams and reservoirs. More often than not, in the eastern states it has meant those means by which the demand for water might be reduced.

Water conservation has been the subject of recent legislation in both regions. The doctrine of prior appropriation in practical effect discourages water conservation because protectable water rights are limited to that quantity of water that is diverted and put to beneficial use. While waste is prohibited, the owner of a water right has no incentive to reduce consumption through alternative or more efficient processes.

Several western states have moved to correct this situation. Oregon and California have given the right to use or convey conserved water to the person implementing the conservation measures. Court decisions in Utah and Colorado have reached the same result. In Texas (and in several eastern states) water conservation must be considered when granting permits for proposed water uses.

A number of eastern states also require that conservation be considered before approving transbasin diversions. In Ohio, for example, the permit applicant must demonstrate that "reasonable efforts" have been made to develop and conserve the water resources of the importing basin.

Having an approved water conservation program may exempt some water users in Virginia from the permit requirements that are imposed when a surface water management area is established. Connecticut and Vermont have established water conservation standards for plumbing fixtures. Several eastern states have authorized a branch of state government to develop water conservation plans.

While water conservation may have meant preserving supply in the western states and reducing demand in the eastern states, the trend is for it to mean both things in all states. Supply limitations and federal statutory requirements are forcing the western states to take additional steps to reduce water demands. Recent mandates in the eastern states to protect instream flows, while increasing

demands stretch available supplies, have resulted in new interest in both conservation programs and water storage projects.

4.6. Transbasin diversions [3]

Historically, cities and towns were located in close proximity to water supplies. As these municipalities have grown over time, many of them have reached (or exceeded) the supply capacity of their local water resources. In order to develop additional supplies, transbasin diversions have been proposed. In general, such diversions have been favored by areas that are seeking to augment their water supplies and have been opposed by areas of origin that fear the loss of future water supplies.

A number of state legislatures in both eastern and western states have addressed this conflict. The legislative responses have fallen into four general and nonexclusive categories: (1) prohibition of transbasin diversions, (2) imposition of general permit requirements, (3) permit conditions that require mandatory water conservation and (4) permit conditions that require some form of compensation for the area of origin.

4.6.1. Prohibitions

Under the riparian doctrine, the use of water was restricted to riparian lands located within the basin of origin. While this restriction remains in effect in many eastern states, enforcement is difficult because it requires a downstream riparian water user both to initiate litigation to prevent the diversion and to prove injury caused by the diversion.

Several of the eastern states have reinforced the traditional prohibition. South Carolina, for example, prohibits diversions in excess of 1,000,000 gallons per day or of five percent of the minimum streamfiow occurring for seven consecutive days during any ten year period of record. New Jersey prohibits the transfer of water from the Pinelands National Reserve more than ten miles from the Reserve.

While the western states have allowed transbasin diversions historically, similar prohibitions have been enacted. California prohibits diversions that would impair existing or future uses of water in the area of origin. Similar legislation has been enacted in Texas and Colorado. In Nebraska, diversions from "minor" streams are prohibited as are diversions from other streams in excess of 75% of the flow of the stream.

4.6.2. General permit requirements

States imposing general permit requirements on transbasin diversions typically have taken one of three approaches: (1) establishment of rights of recapture or priority rights for areas of origin, (2) reservation of water for areas of origin or (3) establishment of standards with which to evaluate proposed diversions.

Rights of recapture or priority rights for areas of origin have been established in three states. In Oklahoma, only excess or surplus water may be diverted. If thereafter put to beneficial use in the

[3] This section is adapted from Sherk, 1994b.

area of origin, these waters may be recaptured. Similar legislation has been enacted in California. By custom and usage, permit conditions in New York may include a right of recapture for the area of origin.

Other states have enacted legislation reserving water for areas of origin. In Connecticut, environmental impact statements for proposed transbasin diversions must include a plan to meet the needs of the donor basin for twenty-five years. In New Mexico, a "reasonable" amount of water is reserved to meet the needs of upper river basin water users.

The preferred approach has been to enact legislation establishing standards with which to evaluate proposed diversions. This approach has been taken by the legislatures of at least eighteen eastern and western states. In Georgia, for example, transbasin diversions will be allowed if the diversion is in the public interest and if the needs of the area of origin are satisfied. In Montana, only the Department of Natural Resources and Conservation may divert water out of its basin of origin. Under the Montana procedure, the state appropriates up to 50,000 acre-feet of water to be diverted. It is then leased for a maximum period of 50 yr to an entity responsible for development of the water. In Ohio, permits are required for diversions exceeding one million gallons per day from either the Lake Erie or the Ohio River drainage basins.

4.6.3. Conservation

As discussed previously, a number of eastern states have enacted legislation requiring water conservation. In general, these enactments have required the conservation and efficient utilization of existing water supplies before those supplies could be augmented by a transbasin diversion. Such legislation has been enacted in Ohio, South Carolina, Massachusetts and Illinois. In the western states, similar requirements are implicit in the definitions of beneficial use that have been enacted by the state legislatures.

4.6.4. Compensation

At least five states have enacted legislation providing some form of compensation for areas of origin. Oregon allows transbasin diversions by irrigation districts upon payment of adequate compensation. Colorado, requiring the protection of future consumptive uses in the area of origin, essentially imposes a compensatory storage requirement. In New York, payment may be required for property value diminution in an area of origin. Other forms of compensation, such as the construction of facilities to conserve or develop remaining supplies, may be required in California.

MacDonnell and Howe (1986) have proposed a three-part test to be used in evaluating proposed transbasin diversions and in protecting areas of origin. First, the proposed diversion should be the least cost source of water. Second, the benefits to the importing basin should exceed total costs (costs to the area origin plus construction, operation and maintenance costs). Third, no one should be made worse oil' as a result of the diversion. This test, which derives from a test originally proposed by the US National Water Commission in *Water Policies for the Future,* is reflected in the legislation that has been enacted in both eastern and western states.

5. Protecting the commons

Water policies in the US are set within the framework of a federal-state system in which states have those rights and responsibilities that are neither granted to the federal government nor reserved to the citizenry. Prior to the enactment of the Federal Water Pollution Control Act Amendments of 1972 (1972 Amendments), no national policy existed in the United States calling for the protection of the quality of the nation's water resources. Emphasis up to that time was focused primarily on regulating the quality of drinking water to prevent the spread of disease by waterborne carriers through contamination of publicly used waters. Pollution control was the responsibility of municipalities that constructed sewerage for the collection of sanitary wastewater and minimal treatment facilities for the purpose of eliminating public nuisances. In most large cities, sanitary and storm sewers were combined, which resulted in the discharge of untreated wastes into the receiving waters whenever it rained, during which time it was deemed that "the solution to pollution was dilution."

During the Great Depression of the 1930s, federal grants were made available to improve local pollution abatement facilities, but efforts to establish a federal role other than the protection of public health were unsuccessful. In many instances, industrial wastes were discharged into rivers or underground without treatment. Local and regional groups such as the Ohio River Basin Sanitation Commission were moderately successful in abating public nuisances. The primary responsibility of the states for controlling water pollution was recognized in the Federal Water Pollution Control Act (FWPCA) as enacted originally in 1948.

The FWPCA did, however, make federal funds available to the states for investigations and research and also authorized a program of making loans to states and municipalities for the construction of sewage treatment works. From this small beginning, the federal water pollution control program has grown to become a dominant force in the evolution of water resources policy.

The 1972 Amendments enunciated the goal of "restoration of the chemical, physical and biological integrity" of the nation's water resources, to be achieved by requiring permits for the discharge of any broadly defined pollutants into the waters of the United States and by mandating uniform technological treatment standards for municipal and industrial wastes. Objectives mandated by the 1972 Amendments included attainment of uniform application of "best practical control technology" for industrial wastes and secondary treatment for all publicly owned sewage treatment works by July 1, 1977, "best available treatment economically achievable" by July 1, 1983, and the elimination of all discharges of pollution by 1985.

Superimposed on the technological fix was a restatement of water quality goals calling for reaching, wherever attainable, a water quality that provides for the protection of and propagation of fish, shellfish and wildlife, as well as for recreation in and on the water, by 1983.

On the basis of recommendations made by the National Commission on Water Quality, legislation was enacted in 1977 that relaxed these deadlines and eliminated the zero discharge goal, calling for more recycling and reuse of resources through the use of alternative and innovative technologies for achieving the stated goals.

Today the original FWPCA, with its six major amendments in the intervening years, is popularly referred to as the Clean Water Act (CWA). Although the CWA has become a multifaceted statute during its evolution, its two most important provisions, in terms of achieving

the objectives stated above, involved the construction of local wastewater treatment plants and the creation of a major national wastewater discharge permitting system.

In the "construction grant" program, federal grants were allocated among the states for many years. Local public agencies were required to submit plans, specifications and estimates for each proposed construction project. The EPA made periodic payments for the projects as construction proceeded. During the period 1972-1990, more than $60 billion in federal grant money was invested in municipal sewage treatment works, along with more than $20 billion from state and local governments.

The 1987 amendments set 1990 as the last year that grant funds would be appropriated. Beginning in 1990, Congress shifted the method of municipal financial assistance from grants to loans provided by State revolving funds. Since that time, all 50 states have created revolving loan funds providing permanent sources of low-cost financing for water quality infrastructure projects. More that $30 billion is contained in those accounts at the present time.

In the permitting program, known as the National Pollutant Discharge Elimination System program, EPA established two methods for controlling the amount of pollution that may be discharged into surface waters: Technology-based controls and water quality-based controls.

Under the technology-based control approach, EPA develops national guidelines or performance standards for entire industrial categories according to the best pollution control technology available for such industrial categories. The guidelines are used by states to develop discharge permits issued to individual dischargers.

Where technology-based controls are not adequately protective of receiving water bodies, the water quality-based control approach is used. Under that approach, more stringent requirements are specified, based on the total amounts of point and nonpoint source discharges into particular water bodies and the uses intended for such bodies. Researchers determine a "total maximum load" for each pollutant that is exceeding the water quality standard, which is an estimate of the amount of a pollutant that can be discharged into a water body without violating water quality standards. The total amount of pollution discharged by all sources cannot exceed this quantity less a margin of safety to allow for uncertainties in the analysis.

Every two years, states reassess the quality of their surface waters and prepare statewide water reports. These reports are used to determine which water bodies within the states need imposition of the more stringent water quality-based controls to prevent major pollution problems. These state reports are used as the basis for an overall assessment of water quality in the US, providing an objective measure of the success or failure of water quality policies in the nation. According to its June 2000 report to Congress, the EPA found significant improvements in levels of water quality for designated uses throughout the country over the years that the CWA has been in place (US Environmental Protection Agency, 2000), reflecting the success that these two key programs have attained.

In addition to the CWA, Congress in 1974 passed the Safe Drinking Water Act (SDWA), establishing stringent standards for regulation of the quality of drinking water for all public water supply systems except the very smallest. Currently, more than 170,000 public water systems in the US are regulated by the SDWA (US Environmental Protection Agency, 1999).

The SDWA requires EPA to establish maximum contaminant level goals (MCLGs) for substances that are present in public water systems which may have an adverse impact on public

health. Public water systems are defined as public or private drinking water systems that have at least 15 service connections or regularly serve at least 25 individuals with water for human consumption. MCLGs are set at the level at which "no known or anticipated adverse" health effects occur.

For noncarcinogens, the MCLGs are based on "reference doses" that are based on "no-observed-adverse-effect levels" derived from studies of humans or animals. Currently, EPA uses a standard that protects a person who drinks two liters of water per day from a source every day for 70 years.

For carcinogens, the MCLG is set automatically at zero, based on a zero threshold assumption. For those contaminants that are only suspected carcinogens, the goal is calculated using reference doses with an added margin of safety to account for possible cancer effects.

Once the MCLG is set, EPA sets the drinking water standard as close as feasible to the goal. In this context, feasible means the level that may be achieved using the "best technology, treatment techniques and other means which EPA finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are available (taking cost into consideration)". Although EPA can specify such technology, it cannot mandate its use, only the result.

Unlike goals, drinking water standards are legally enforceable. In setting standards for carcinogens, EPA looks for levels that will result in additional cancer risks over human lifetimes of one out of 10,000 to one out of one million.

In addition to the establishment of drinking water goals and standards, which constitute the heart of the **SDWA,** the act also requires disinfection of drinking water by public water systems and filtration or other equally protective measures by public water systems that rely on rivers or other surface water sources. The purpose of this provision is to remove potentially infectious microorganisms from the water sources.

The SDWA also requires states to establish "wellhead protection areas" around public drinking water system wells to prevent pollution from seeping into underground formations containing water supplies; establishes a program to protect "sole source" aquifers; requires any pipe, solder or flux used to transport drinking water to be lead-free; and establishes guidelines for the regulation by states of injection of wastewater into underground formations. This last provision is aimed at the regulation of more than 400,000 underground injection wells that exist in the US.

The SDWA provides that state governments, not the federal government, have primary enforcement authority for its public water systems if the state regulations are no less stringent than federal requirements. If state governments demonstrate that their drinking water regulations are at least as stringent as the federal ones, keep records and report information in accordance with EPA requirements, provide variances and exemptions in a manner at least as stringent as required at the federal level and adopt and implement a plan for the provision of safe drinking water in times of emergency, then they are entitled to "primacy." Such status entitles the state to the full enforcement authority of the federal government. With two exceptions, all of the 57 states and territories of the US to which the SDWA applies had received primacy status at the time of this writing. The most recent amendments to the SDWA, enacted in 1996, established a multi-billion-dollar state revolving loan fund, similar to that established under the CWA, to assist states and territories with constructing water system infrastructure improvements.

The vast system of regulations that has grown up under the CWA and the SDWA has led to recent efforts to simplify the policies under which the quality of the nation's water supply is governed. At the same time that this regulatory simplification process is being undertaken, new challenges are being addressed and new approaches are being tried. For example, in the absence of any precise definition of the phrase "restoration of the chemical, physical and biological integrity" of the nation's water resources, attention is turning to ecological management of the watershed as the means to attain the desired ends of achieving sustainable development. This approach is based upon belated recognition that the regulation of specific discharges is not going to achieve the desired water quality because, in many areas, at least half of the pollutants found in the nation's waters come from nonpoint sources which have been largely ignored in the nation's water pollution control efforts.

The watershed approach has as its premise that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual water body or discharger level. In many ways, the watershed approach represents a return to the use of coordinating frameworks for water resources management that originally were established in the Water Resources Planning Act of 1965, but which were abandoned subsequently in favor of an approach that focused on specific categories of pollution. The current watershed approach focuses public and private sector efforts on addressing the highest priority problems that exist within hydrologically-defined geographic areas.

This approach allows the nation to come to grips with diffuse problems while dealing with the need for integration of land and water resource management in the watershed, inadequate or unreasonable water quality standards, difficulties in enforcing regulations and inadequate attention to ecosystem protection (Longs Peak Working Group, 1994).

6. Lessons learned

While there are many lessons from the US experience in water resource policy formulation that may be applicable in other regions of the world, three of the most important are institutional reform, improved processes for conflict resolution and increased use of modern planning and decision making procedures. In each of these areas, the evolution of US water policy can be used to improve the utilization of water resources without the need to repeat the mistakes.

6.1. Water policy institutions

With regard to institutional considerations in water resources policy development, an apparent oxymoron is true: There are both too many and too few actors. In terms of there being too many actors, the federal government is a prime example. Jurisdiction over water resources policy is fragmented among at least thirteen Congressional committees, twenty-three Congressional subcommittees, eight Cabinet level departments, six independent agencies and two White House offices. To further complicate water resource policy issues, those federal entities with authority over water resource planning are not the same entities that have jurisdiction over the funding for water-related projects.

In terms of too few actors, it has been argued that the states have been left out of the federal water resource policy process (Hatfield, 1992). It also has been argued that Indians and local communities have been left out of both the federal and state water resource policy processes (Longs Peak Working Group, 1994).

The lesson to be learned from these observations is that, while national institutions should avoid the extreme fragmentation that has characterized the US water policy-making institutions at the federal level, they should strive to incorporate the views of lower levels of government and involve such other institutions directly in the policy making process.

6.2. Conflict resolution

In addition to institutional reforms, the water resource policy development process must include a means by which conflicts concerning the management and allocation of water resources are resolved. At least four conflict management mechanisms have been applied to the resolution of major water resources conflicts in the US: (i) litigation, (ii) legislation, (iii) negotiated agreements and (iv) market mechanisms. Of course, these mechanisms neither stand alone nor exist in a vacuum. In fact, they are closely interrelated.

6.2.1. Litigation

The US Constitution provides that "In all cases ... in which a State shall be a Party, the Supreme Court shall have original jurisdiction." In litigation between two states, the jurisdiction of the Supreme Court is both original and exclusive. These constitutional and statutory provisions empower the Court to manage interstate water conflicts through application of the doctrine of equitable apportionment (Sherk, 1989; Tarlock, 1985).

In order to prevail in an equitable apportionment action, the state initiating an action must demonstrate by clear and convincing evidence that it is suffering real and substantial injury or harm. Once this requirement has been met, the burden of proof shifts to the state or states having existing diversions to prove, again by clear and convincing evidence, that the diversions should be continued. If the complaining and responding states meet their respective burdens of proof, the Court (normally using a "Special Master" appointed by the Court to hear the case and prepare a proposed decree) fashions a decree equitably apportioning the shared water resource ("balancing the equities"). Because each case will focus on a specific set of facts, each decree will be unique.

Under a different set of legal theories, conflicts concerning water resources also may be brought in US District Courts and in state courts. US District Courts have jurisdiction when a federal question is presented, such as compliance with the requirements of the National Environmental Policy Act for proposed water projects requiring a permit under the CWA. Also, states wishing to prevent a diversion of water in another state may challenge in US District Court the issuance of federal permits for the diversion. If the state proposing the diversion is allowed to intervene as a party to the action, the US District Court will lose jurisdiction and the action will have to proceed, if at all, in the Supreme Court.

States courts have jurisdiction over water management and allocation conflicts arising under state law. In addition, state courts engaged in general stream adjudications have jurisdiction to adjudicate federal and Indian claims to water.

6.2.2. Legislation

Sometimes the US Congress acts to resolve major water resource conflicts that otherwise would be resolved by the litigation procedures described above. In *Arizona vs. California,* 373 US 546 (1963), the Supreme Court concluded that Congress, when it enacted the Boulder Canyon Project Act in 1928, provided a legislative means for managing conflicts arising over the water of the lower Colorado River. Had the Congress not acted, the Court would have decided the case under the principles of equitable apportionment.

As another example, Congress enacted legislation recently that allocated the waters of the Truckee and Carson rivers and of Lake Tahoe between California and Nevada. This legislation was based on existing decrees that related to the management and allocation of the region's water resources (Muys, 1995).

It has been argued that the Federal Energy Regulatory Commission (FERC) may have adequate statutory authority under the Federal Power Act to allocate the waters of those rivers on which federally-licensed hydroelectric projects are located. This argument is based on the decisions of the Supreme Court in which the Court concluded that the national interest in the development of hydroelectric generating facilities may supersede states interests in the management and allocation of water resources. Whether the statutory directives embodied in the Federal Power Act are similar enough to the statutory directives contained in the Boulder Canyon Project Act to authorize the FERC to make water allocation determinations is likely to be the subject of future litigation.

6.2.3. Negotiated agreements

With regard to inter-state water conflicts, it was clearly the expectation of the framers of the US Constitution that states would resolve conflicts among themselves through the use of inter-state compacts (Sherk, 1994a; Muys, 1976). On this point, the Supreme Court has made its position abundantly clear: States should resolve their conflicts among themselves. Such conflicts, the Court concluded, are "more likely to be wisely solved by cooperative study and by conference and mutual concession on the part of representatives of the States ... than by proceeding in any court, however, constituted." *New York vs. New Jersey,* 256 US 296 (1921).

There is a wide variety of other types of agreements that resolve conflicts over the management and allocation of water resources. Of perhaps the greatest historical importance are the negotiated settlements of Indian water rights arising from the decision of the US Supreme Court in *Winters vs. United States,* 207 US 564 (1908).

6.2.4. Market mechanisms

In *Sporhase vs. Nebraska,* 458 US 941 (1982), the Supreme Court ruled that water was an article of commerce and that the states could not impose unreasonable burdens on the interstate transfer of water without violating the commerce clause of the Constitution. Based primarily on this decision, a decision that "will spur the removal of market barriers as beneficial use evolved toward the concept of economic efficiency" (Tarlock, 1985), it has been argued that the "invisible hand of the marketplace" should dictate the use of shared water resources. The development of "water markets" has received a great deal of attention (Anderson, 1983; Williams, 1986).

Assuming two conditions precedent, such markets could be of use in managing water conflicts. The first assumption is that existing institutions do not interfere with the operation of the market

(Rodgers, 1986). The second assumption is that water use values are amenable to quantification in economic (market) terms (Sherk, 1989). Both of these assumptions are subject to challenge. To date, water markets have not shown themselves to be an effective mechanism for the management of water conflicts, but it is possible that new approaches currently being tested could prove to be useful adjuncts to the more conventional conflict management techniques described above.

7. Conclusions

The essential purpose of water resource analysis is to develop policies that lead to the management and allocation of water resources in a manner that maximizes contributions toward societal goals and aspirations. Our species, indeed our planet, requires that the overriding goal be one of long-term sustainability.

While humanity faces unprecedented challenges resulting from unrestrained population growth, industrialization, urbanization and environmental exploitation, we also have a much greater arsenal of tools and a larger-than-ever pool of experience with which to meet these challenges. Furthermore, there are additional tools on the horizon, such as effluent trading and the use of innovative economic incentives in water resources management, that have a promising potential for further assistance.

In order to maximize our effectiveness in meeting the tremendously difficult challenges of water resource policy development, we must learn from the successes and failures of the past. The key to a sustainable future for water, the most precious of all commodities, lies in our ability to learn from our past and from each other in such a manner that will allow us to focus our collective efforts in the most effective and efficient ways possible.

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