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Pre-Conference Statement for the Session on: "Lessons in Water Allocation: Roles for Government and Markets"

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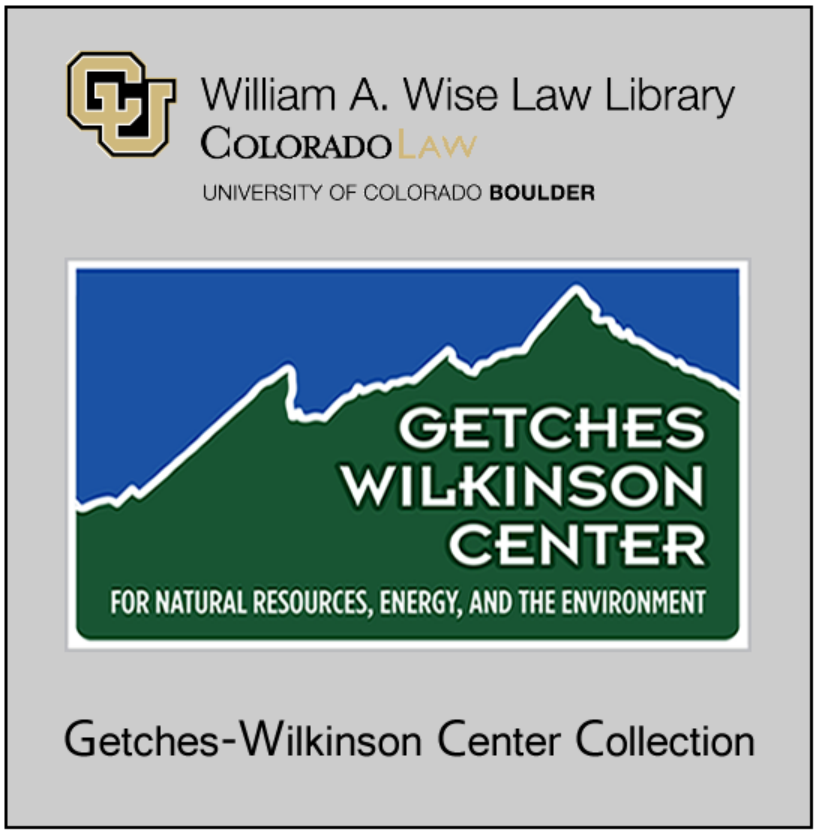

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Pre-Conference Statement for the Session on:

"Lessons in Water Allocation: Roles for Government and Markets"

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"Allocating and Managing Water for a Sustainable Future: Lessons from Around the World"

Natural Resources Law Center
University of Colorado School of Law

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Editor's Note: The following document is a draft and incomplete chapter, prepared by the Session Coordinators in order to help steer and organize the initial thinking of the panelists, and to serve as a reference for conference attendees. Upon completion of the conference, this material will be revised and integrated with material from the panelists and will reflect ideas raised at the conference. Ultimately, it will comprise a chapter in a book based on the conference. Given that this is a working document, the authors should not be directly quoted, and the draft nature of the document should be noted in any use of, and references to, this work.

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1. Introduction

For most of the world, the question is not government or markets, per se, but is what is the proper ratio, mixture, and application of each? (In this context, "government" must be interpreted broadly to include agencies at different levels, special districts and water-related laws and regulations.). This is certainly the question surrounding water reallocation as shown by Ingram's work on Arizona water farms (Oggins and Ingram, 1989) and Howe's work on Arkansas Valley transfers (Howe, 1990) and dozens of other studies. Stated differently, to what extent can water markets and market-like processes be beneficially utilized within the necessary politically determined institutional framework?

Water markets take many forms, from informal rural water sales in developing countries to highly organized market arrangements in semi-arid parts of the developed world. In most of these settings-especially in developed nations –water markets are nested within some sort of legal sidebars, administrative systems, or rule sets. Prominent examples include "capacity sharing" arrangements on the Murray-Darling system in Australia, similar arrangements on the Snake River in Idaho, informally arranged sales of water rights under the appropriations doctrine of the western United States, and formally organized arrangements like the California water bank that was established under severe drought conditions in 1991. Even relatively "pure" water markets such as that found in the Northern Colorado Water Conservancy District are based on well-defined property rights, while being constrained by certain rules about "beneficial" water use. While it is possible to find examples of water allocation mechanisms that don't use markets at all (e.g., interstate compact allocations in the western United States), there are no market processes that aren't nested within some structure established through a political/legal process.

These are questions that nations everywhere are dealing with. Some opt for systems that emphasize markets; some opt for systems that emphasize strict policies and major roles for public agencies; most utilize a mixture. Rules within basins may be different than those between basins, and still different than those between political regions. Surplus waters may be subject to market allocations, while subsistence levels may be governed by political allocations. Crisis situations may merit yet another set of rules, e.g., emergency water banks, expropriation of water for priority uses, and endangered species protection. Specific contextual factors including the number and variety of values and actors concerned with water may result in different kinds of organizational arrangements that defy simple market/government dichotomies.

2. Dimensions of the Allocation Process

Water supplies are allocated, formally or informally, over space, over time and among different classes of users. The pervasive attribute of water today is *scarcity*, measured by the marginal social value of water in its various uses. This scarcity may or may not be reflected in the terms of access by users (i.e. in prices or rationing schemes) but in very few settings is the scarcity value really zero (in temporary flood situations or in a few tropical basins). Scarcity is reflected in the high economic and environmental costs of developing new, reliable supplies. Combined with growing demands for water, these high costs imply that the *reallocation* of existing supplies is of increasing importance. The question then, again, is what mechanisms should be used to effect reallocations of existing supplies?

A. Allocation of Water among Sectors

We will consider three broad categories of water use: agriculture and related activities; municipal and industrial uses (M&I), including residential, commercial and public uses; and environmental uses that include bio-diversity, water quality, the aesthetics of streams and certain types of water-based recreation. Competition among these growing uses in the face of nearly fixed supplies is becoming more intense over time. Further, it is becoming clear that water involves a number of noncommensurable meanings and values that greatly complicates water allocation.

In semi-arid and arid regions, irrigated agriculture is the predominant diverter and consumer of water. In the western United States, irrigated agriculture accounts for about 80% of all surface water and groundwater diversions and about 90% of all consumptive use (USGS ref). According to Peter Gleick (ref), similar proportions are found in many regions. This suggests agriculture as a major source of water for the other sectors. Naturally, not all of the water being used in irrigated agriculture is suitable for or available to other uses for reasons of distance, cost or quality. Nonetheless, increased efficiency in irrigation application and crop selections can free up large quantities of water, sometimes with little decrease in agricultural output. Reductions in irrigated acreage and the re-location of agriculture to more appropriate regions will take place in the future. Inappropriate location of agriculture, inefficient irrigation techniques and wasteful cropping patterns result from policies of water and crop subsidies that fail to confront the water using region and the individual user with the correct scarcity value (or "opportunity cost") of the water and the real social value of the crops being produced.

Transfers of water within the agricultural sector and between agriculture and other uses have a long history in regions where the "appropriations doctrine" of water law obtains. In Colorado, water rights have been traded as personal property for more than 100 years through contacts between individual buyers and sellers. In Idaho on the Snake River, individuals having storage space in Bureau of Reclamation reservoirs have leased

their water to others since the 1920's (check ref). In the Northern Colorado Water Conservancy District, permanent sales and temporary rentals of water started soon after completion of the project in 1957 and have shifted heavily in favor of M&I users. This market is informally organized through the provision of a bulletin board on which offers to buy and sell can be posted, although various brokers act to identify potential participants. While this market is usually considered to be highly effective, some of the legal conditions are not commonly found. What we might call *market-like arrangements* for ag to M&I uses are found in Southern California where the Metropolitan Water District and San Diego County have contracted to improve the irrigation system of the Imperial Irrigation District with resultant water savings diverted to the District and County. Other market-like arrangements include *drought year lease-outs* that have been arranged between the Metropolitan Water District and the Palo Verde and Desert Irrigation Districts.

Municipal and industrial water users usually have a greater ability to pay (higher prices) for water than the agricultural sector. M&I users also require high quality and reliable water supplies (refs on reliability and WTP). M&I supplies are typically metered to individual users so that volumetric pricing can be applied. It is well known that M&I demands are responsive to price (significant price elasticities, various refs), but this responsiveness decreases with increases in the incomes (or production values) of users (significant cross elasticity, various refs). Outdoor uses account for nearly 50% of M&I withdrawals (ref). Changes in landscaping practices (xeriscaping) would significantly reduce total consumption and would help avoid summer peak demands. In spite of increasing use of increasing block rate (price) structures, M&I water is typically under-priced , largely because public water agencies, while accounting for infrastructure costs, fail to recognize the scarcity value of the raw water itself. The Boulder, Colorado water utility uses a steeply increasing block rate structure to reflect the high costs of new supplies but attributes no cost to existing water supplies that may have a market value of $ 200 or more per thousand cubic meters.

The newest water demand in the high income countries is that for environmental purposes. Increasing incomes and educational levels lead to demands for higher quality environments and to concern with issues like bio-diversity. The provision of these water-based environmental amenities is mostly dependent on public agencies because the benefits are widespread and cannot be individually rationed or priced (such services are called "public goods").

For the same reason, significant new instream demands are collectively manifested in laws and regulations like the U.S. Endangered Species Act and the Clean Water Act that have required the reallocation of stream flows from traditional uses to instream flows. Some cities and even agricultural interests have dedicated some of their water rights to instream flow protection, including Boulder, Colorado that dedicated water rights having a market value of $ 12 million to late season instream flow. These values, along with community and cultural values tied to water, emphasize the need to

broaden the concept of "beneficial use" that is required to establish water rights in most systems and to broaden the "no injury" rules that are constrain water transfers.

Water has other meanings that are undergoing cutting edge changes the consequences of which are as yet are not entirely clear for issues of water allocation. Water has become a kind of "lifestyle" product for some people as exhibited in the high price paid by consumers for bottled water, often supplied in convenient to carry bottles with prestige labels. Bottled water from specific places, like Rocky Mountain springs and streams or Lake Constance, takes on value and meaning only loosely related to economic values. Moreover, the growth in popularity of theme parks, where virtual nature becomes an attraction, has introduced "environmental" and recreational uses only remotely connected to reality or outdoor sports. (Blatter and Ingram, 1992)

B. Allocation Among Regions

The river basin is the natural physical unit for water management. Naturally, interbasin transfers of water are widely used (e.g. out of the Colorado Basin to eastern Colorado, from the San Juan to the Rio Grande), but the physical connectedness of the river basin still makes it the natural management entity. Major problems are likely to arise, however, when the political subdivisions that have policy-making powers over water resources fail to correspond to the boundaries of the basin. For example, the Colorado River is divided into Upper and Lower Basin jurisdictions that stem from the Colorado River Compact that was agreed upon by the seven riparian states in 1922. The compact requires the Upper Basin to deliver 7.5 million acre-feet (___ cubic meters) annually for use by the Lower Basin States. Upper Basin users have no motivation to recognize the high value that additional deliveries would have for the Lower Basin. Similarly, the distribution of available water among the 4 states of the Upper Basin and, in turn, the 3 states of the Lower Basin are determined by compact and court orders, so that no state has motivation to recognize the value of additional water to downstream states. This disjunction of basin and political boundaries results in "jurisdictional externalities", i.e. losses of basin-wide benefits through failure to recognize losses to other political jurisdictions.

In the United States, the federal government has ceded much of the regulatory power over water resources to the individual states. Each of the western states has its own system of administering property rights over water (although most states abide by the "appropriations doctrine" under which water rights are considered personal property subject to sale within some kind of oversight system). One of the implications is that, to date, water markets have been confined to the individual states, i.e. there are no interstate water markets even though some of the greatest inefficiencies in allocation occur between states. In 1994, California proposed an interstate marketing arrangement for temporary (annual) exchanges of water among states with the state water authorities acting as marketing organizers (ref). The idea was quickly shot down by Colorado, as was the State

Engineer who had the temerity of endorsing the concept without clearing with the Governor. Other well-conceived schemes for interstate leasing of foregone agricultural consumptive uses (like the Resource Conservation Group scheme of 1990: ref in NRJ) have received no serious political consideration.

As water scarcity increases, the appropriateness of locating water intensive agriculture in dry regions where irrigation is required will be seriously raised both by the market and by the legislative process. The westward shift of U.S. agriculture that followed the Reclamation Act (Howe and Easter, 1971) will be partially reversed. New enforcement of air and water standards (TMDL) will force some relocation (Denver Post, April 14th, 2002).

The complexity of international river and groundwater allocation exceeds that of interstate allocation. Famous historical cases include the Nile, the Ganges, the Danube and Rhine Rivers and, in the United States, the Colorado and Rio Grande Rivers. The compacts negotiated between Mexico and the United States over the Colorado and Rio Grande present an interesting case of "inter-connected bargaining or inter-connected games" (Ragland et al ref). The dependence of the downstream party on actions upstream renders equitable bargaining difficult unless there is a second issue that favors the downstream party and that can be bargained simultaneously. In the case of the Rio Grande, downstream water users in Texas were highly dependent on inflows from Mexican tributaries, so successful simultaneous negotiations were completed.

Additional complications for inter region, interstate and international water transfers arise from the highly symbolic and emotional relationships people often have with water. Plentiful, cheap water, especially in arid lands, signals security and opportunity that are threatened by losses of water that objectively seem like mutually beneficial transfers. Historical, anthropological, and contextual case study analysis suggests that water has a communal value that transcends its commodity value (Brown and Ingram, 1997). This communal value is often described as being tied to specific places, like the Middle Rio Grande in Northern New Mexico. Increasingly, however, "imagined" communities are arising that transcend localities, regions and even nations and are rooted in ideologies and belief systems. Such communities exist in support for such natural monuments as Lake Tahoe and Old Faithful and may be coalescing around other concepts like ecosystems (Blatter and Ingram, 2002).

C. Allocation Over Time

The issues involved in allocating water over time differ between renewable supplies and non-renewable supplies, the latter represented by non-renewable groundwater in major aquifers like the Ogallala aquifer in the High Plains region (Nebraska to Texas) of the U.S.. The intertemporal issues include (1) the allocation of surface water over time intervals ranging from a season (out of small local reservoirs) to

several years (for example on the Colorado River where storage equals 5 years average flow), (2) the allocation of renewable groundwater over wet and dry climate cycles of several years, and (3) the long term allocation of non-renewable supplies as the support base for regional economies.

The function of surface storage is to transform highly variable hydrologic flows into more regular, "reliable" (at some level of probability) supplies of water. There are physical limits to the reliable flow that storage can generate from a given streamflow pattern, and there are even more binding economic limits to the amount of storage. These are exhibited by the so-called "storage-yield curve" for a particular stream, showing that a maximum physical yield is reached at some volume of storage, while the economic limit of useful storage will be reached at smaller volumes of storage because of the steeply rising marginal costs of added yield. The Colorado River, with aggregate storage of 5 times annual flow, has passed the point of maximum yield, so that any additional storage will further reduce the overall yield of the river. There are also trade-offs between water supply and flood protection.

Groundwater supplies vary from patterns of annual draw-down and recharge to multiple year cycles and, finally, to the large aquifer non-renewable supplies. The Edwards aquifer in Texas (various refs) is a large regional karst formation that is readily recharged by precipitation and quickly drawn down by agricultural and urban pumping and from the discharge from several large natural springs that support endangered species. The large alluvial aquifer of the South Platte River in Colorado (used mostly for agriculture) exhibits a 6 to 8 year cycle of drawdown and recharge dependent on wet and dry climate patterns (ref). Some aquifers are artificially recharged when surplus water is available (exmples).

Non-renewable groundwater supplies present challenges concerning the most responsible patterns of use over long time horizons. Failure to use the resource because it is non-renewable makes no economic sense, but there is a danger that overly rapid economic development may occur because of a short-sighted failure to recognize the finite nature of the resource (see Howe on optimal regional development based on a non-renewable resource). An underlying theoretical principle is the "Hotelling rule" (Harold Hotelling, 1931) that identifies the use pattern that maximizes the "present value" of the resource. However, many factors affect the actual pattern of use and its results. On the Ogallala aquifer, some areas have stopped pumping irrigation water either because of increasing cost or exhaustion, but developments in dryland crop yields have offset much of the loss of irrigated production.

Other value questions such as obligations to future generations of human and nonhuman species complicate questions of allocation over time and introduce criteria for judgement that are not amenable to standard economic calculation. Some legal and philosophical perspectives suggest that precautionary principles should apply to

irreversible commitments of resources. A precept of deep ecology, for instance, is that humans should respect the rights of other species to continue to exist and flourish.

3. Social Objectives of the Allocation Process

The major objectives sought by society through the allocation of all resources (not just water) can be classified as (1) economic efficiency, (2) equity and (3) sustainability, each broadly interpreted. If these objectives can be clearly defined, a major question is to what extent is society forced to make trade-offs among these objectives and to what extent might they be complementary rather than competitive.

A. Economic Efficiency

Economic efficiency is, in practice, what is measured in "benefit-cost analyses" (B/C) of projects. B/C analysis is required for all water projects that involve federal participation (Howe, 1988). The procedure requires the monetization of the beneficial and detrimental impacts of a project and their summarization as the "present value of net benefits" that accounts for the time patterns of impacts through "discounting" of future values. The immediate questions are "Can all significant impacts of a project be monetized" and "What is the appropriate way of discounting future values?". Libraries are filled with tomes on these questions, still without complete agreement on the answers. Suffice it to say that while techniques for monetizing positive and negative impacts have been greatly expanded (e.g. recreational benefits from reservoir use, valuation of improved water quality, etc.), impacts of importance to society are still beyond monetization techniques (e.g. community solidarity values, cultural values, indirect economic impacts). Thus, B/C is highly useful in weeding projects that are very poor from an economic viewpoint by implying the need for very important social rationale to overcome the economic loss involved.

B. Equity

Equity is a catch-all term that "exists in the eye of the beholder" but still serves as a caption for important social values that are usually beyond monetiztion. It includes issues of the distribution of project benefits and costs, community and cultural values. In the early days of B/C following WW II, economic doctrine dictated that economic efficiency was THE criterion to be used in project design and selection, that maximizing the "size of the pie" was what counted and that equity issues would be settled through various social safety net and tax programs (e.g. Musgrave. 1958).

It is now recognized that equity and economic efficiency are not independent measures if only because the set of prices on which B/C analyses largely depend are

functions of the distribution of income and wealth. "Who gets what" is politically and socially important and the safety nets referred to by Musgrave frequently are non-existent. Further, failure to address equity issues in project design and selection can have direct impacts on the net benefits measured by B/C if, for example, project design or construction leads to social unrest or social rejection of project operation and maintenance. Many examples are found in Third World water development projects such as the Sardar Sarovar project in the Narmada Valley of India, the Kousou Dam in Ivory Coast, the Manantalli Dam on the Senegal River where the potential economic benefits have been largely offset by the costs of social disruption.

Moreover, there are important issues of "who gets to decide". Even apart from who wins and who loses, there is an organizational and political interest in who is "at the table" and what "rules" govern decision-making. Increasingly communities are insisting upon open and transparent decision making and "civic" science, which is accessible to nonexperts.

In sum, there are several valid criteria for the design and selection of water projects and policies and these require "multi-objective" and "open" approaches to water decision-making. While many formal multi-objective procedures have been proposed in the literature (e.g. Lindsley et al, Mays, Major and Lenton), in practice rapidly evolving political processes and institutional arrangements are making trade-offs and adjustments in practice.

C. Sustainability

The Brundtland Report (WCED, 1987) defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". This is hardly an operational definition, although it imparts the spirit of the sustainability notion. Here we interpret sustainability to be largely on the supply side, i.e. in terms of the ability of a society to maintain or increase some measure of aggregate well-being over time. Well-being, however, depends on the current and future generations' own definition of their "needs". The achievement of sustainability is more likely the more humble our interpretation of needs (Howe, 1997 and other refs).

The sustainability literature has distinguished "hard sustainability" from "soft sustainability", the former indicating that each renewable productive system should be maintained in a non-impaired state while the latter emphasizes that the productivity of the over-all system should be maintained while sub-systems may come and go, one substituting for the demise of another. This is akin to the sustainability of ecosystems wherein higher level systems can be sustainable in the face of fluctuations in their component species (Costanza and Patten, 1995). The "soft" interpretation seems the only relevant one.

Sustainability has a geographical dimension again akin to ecosystems: a larger region may exhibit sustainable production capacities while its sub-regions do not. In the case of agricultural production, an individual farm's productivity may be negatively impacted by climate variability or pest infestations while the regional farm economy may be able to sustain total production because of different soils, different crop varieties or micro-climates. Nationally, farm production can shift among regions in response to climate change or extended droughts. Internationally, production can shift among countries in response to climate change, soil exhaustion or salinization or crop and animal diseases.

Sustainability also has a temporal dimension, exemplified by the conifer forests of the Upper Midwest that were extensively cut at the turn of the century, yet have re-grown to become valuable recreational areas (Barlowe, 1983). Forests in the East and Midwest were extensively cut in the 18th and 19th centuries for agriculture, but the eastern forests have regrown to the extent that the total forested area is greater now than 100 years ago. This arguably "sustainable" sequence of events was certainly not planned but has been influenced by the land, timber and agricultural markets.

How does sustainability apply to water systems? Sustainability of renewable water systems obviously depends on climatic conditions and protecting the run-off conditions of the water shed or river basin.Given a stable climate regime, the catchment area must be protected from erosion to sustain run-off and storage capacity. A widely ignored issue is the ever increasing sedimentation of all reservoirs. While reservoirs are designed with "excess" capacity to allow for sedimentation, their capacities are declining over time, in some cases very rapidly, the most notorious case being the reservoirs on the Yellow River in China. Even Lake Powell on the Colorado River is losing thousands of acre-feet of capacity (check cite) annually. While these events may not be important in the short term, they clearly are relevant to the long-term future.

Non-renewable groundwater deposits cannot, by themselves, be sustained unless we leave them untapped-an uneconomic alternative. The larger production system that uses the water may, however, be sustainable if increasingly efficient methods of water application and more responsive crop varieties are developed. This is what is happening in the High Plains regions that are dependent on the Ogallala aquifer.

4. The Role of Government in Shaping Water Allocation Institutions

Institutions serve a wide variety of social purposes. Once established, institutions take on their own identities and missions and make up their own reasons for existence. Consequently, some water institutions persist today, even though they would seem to have outlived their usefulness because various important individuals and groups have stakes in their continuance. Representation of values and interests is among the functions of institutions, and overlapping and conflicting jurisdictions and missions often serve

political purposes. In the section that follows, we illustrate several institutional features that have characterized water management:

- The confusing and contradictory legacy of water rights and water law that recognize both the prior appropriation rights of individual users and the water-dependent public welfare of communities;
- The variety and multiplicity of water agencies that has evolved over time, creating fragmentation and conflict but, at the same time creating flexibility and permeability so that parties holding conflicting values have continuing access to decision making;
- A legacy of independent grass-roots entrepreneurship has coexisted along with a strong federal emphasis on centralized planning, construction, and management.
- The legacy of governmental involvement and intrusion into water markets is both positive and negative.

A. Legacy of the Past

Like the layer after layer of rock of different colors and compositions exposed on the walls of the Grand Canyon cut by the Colorado River, the history of water management in America has left a plethora of different kinds of institutions. From the beginning of human settlement, water and social organization have gone hand-in-hand, and over the centuries institutional experimentation has varied widely (Maas and Anderson, 1978). Much of water law, custom and practice in the American West were inherited from Spain and its four hundred -year conquests and occupation of territory in the New World. The dual legacy is a marriage of private ownership and public responsibility. While water in Northern New Spain was considered a public resource to be developed for the public, private ownership and development was the mechanism through which the public interest was served. Water rights were allocated along with grants of land, and the grantee had free rein in the use of that water so long of general purposes of public welfare were served. Private water rights owners' obligation to the general welfare were minimal, and mainly imposed by the courts, but were nonetheless real. According to Michael Meyer (1996), the judiciary insisted that water rights be utilized in ways consistent with protecting water quality supplies to towns and villages and insuring that some water was reserved for native tribes.

As Western territories and states joined the Union, each brought somewhat different traditions reflecting different settlement patterns, varying historical experience, and levels of water scarcity. State constitutions institutionalized different state customs and practices. Some state constitutions, like that of New Mexico, specifically stated that water was a public resource. Other states, like Colorado, recognized a hierarchy of water uses with municipal uses taking priority over agriculture and mining. Most states recognized the doctrine of prior appropriation (first in time is first in right) but California embraced a unique combination of prior appropriation and riparian doctrines (right to use flowing waters appurtenant to lands so long as the use of other riparian rights owners is

not adversely affected) which is followed in much of the Eastern U. S. Differences among state water laws continue to this day, and are the cause of much confusion as well as difficulty in management of interstate waters. In particular, states vary enormously in terms of the extent to which they embrace and regulate water markets.

The variation of state water law is particularly pronounced as it affects groundwater. The importance, use, and availability of groundwater varied enormously among Western states. For good or ill, much water law, and groundwater law in particular, was made in state courts, and judges were slow to recognize the hydro logic interconnection of surface and groundwater laws. The registration of wells and measurements of use is a relatively recent phenomenon.

Irrigation and water users associations were responsible for much of the early development of water resources in the American West. Dryland farming is impossible in much of the West, and agriculture necessarily involved the installation of dams, diversion and ditches that required capital and cooperation. Some commentators trace the development of civil society in various regions in the West to the comity among neighbors forged in the construction, operation and maintenance of rural water delivery systems (Crawford, 1998). Political leadership training often began through recruitment to the office of ditch rider and membership on local water commissions. While water users at first were regulated by informal norms that grew up over time, the strain of scarcity and drought often caused conflicts that required court settlements and ultimately to state legislative action. Along with state courts, the office of state engineer became important in many states as the repository of water rights information and an arbiter of disagreements among rights-holders.

Private land and water companies were important entrepreneurs fostering early agricultural settlements. Such companies raised the capital for dam, diversion, and ditch construction through the sale of shares to early settlers from whom they also collected user fees. Where private land and water companies were the instigators of settlement, water districts were organized from the top-down and water users were treated more as clients than participating members. Local and state government enforced the contracts with such development companies, and were frequently called upon for rescue when such private operations got into trouble financially or were otherwise unable to deliver water.

Western cities depended at first upon licensed monopolies through long term contracts with private water companies. Up until the mid nineteenth century, the City of Los Angeles depended for its water supply on a series of franchises to such companies with generally disappointing results. Not only was delivery of water falling behind growth, but also maintenance of infrastructure lagged. The City withdrew from one failed arrangement after another until the city established its own municipal water utility. The municipal utility was able to act more aggressively than previous private suppliers were. As early as the 1870's the City of Los Angeles laid claim to the total supply of the Los Angeles River. The city declared war on upstream users, and won a series of court

victories. What could not be achieved through the courts was won by an aggressive campaign of annexation. Expanding the city's boundaries was seen as a way of justifying–indeed requiring–more water to build an even more magnificent metropolis. The annals of water history in the West are filled with stories similar to that of Los Angeles Water and Power. Publicly owned municipal water utilities such as the Denver Water Board and Tucson Water served not just as water suppliers but as aggressive participants in contests to acquire water rights that Western cities, far into the future, would be assured that cheap, plentiful water would be available for growth.

To promote orderly development of water resources, the federal government has been a continuing presence in water development. Early in the nation's history, the Army Corps of Engineers established itself as the engineering arm of the government through the development of transportation and flood control projects (Maas, 1957). In 1903, the Bureau of Reclamation was established to build multipurpose water projects throughout the West. The era of large -scale water development in the American West in the middle of the 20th century was dominated by federal agencies, often at war with one another.

Some rational choice scholars read the era of large scale federal water development as runaway politics in which political entrepreneurs sought to build political capital at the expense of economically efficient developments that would have rendered much expensive and environmentally damaging construction unnecessary (Anderson and Leal, 2001). Our understanding differs, and we believe that government involvement had both positive and negative consequences. Government, particularly the federal government, got strongly involved in water planning and management because it had authority and resources to accomplish critical tasks difficult to manage outside government. These tasks and accompanying outcomes are discussed below.

To Settle and Legitimate Water Rights. The Colorado River Compact of 1922, which divided water allocation between the upper and lower basins entered into by the basin states with the strong encouragement of the federal government, was fundamental to the predictability as security of all water rights holders. Absent such involvement, long, expensive, contentious litigation was the only alternative. Even with the 1922 compact, continued contention between Arizona and California precipitated one of the longest and most contentious court battles in history. Such litigation would have increased exponentially without federal government involvement. Similarly, the action of state engineers and intrastate stream commissions has been essential to resolving in-state water rights disputes.

To Undertake Comprehensive Water Planning and Development. From the earliest days of the republic, the Army Corps of Engineers built facilities to accommodate navigation to ports and harbors and on interstate rivers. While admittedly the Corps was highly responsive to parochial interests, its broad jurisdiction insured a more comprehensive perspective than would have been present in private development. Similarly, the surveys of the Corps of Engineers and Bureau of Reclamation of virtually

all the major rivers in the nation provided basic basin-wide geographic and hydro logic information critical to all future development. The differences among state laws and the divisions represented by state boundaries would have made such comprehensive basin-wide perspectives impossible for private developers. At the same time, the identification of future dam sites on rivers all over the country build up shelves full of plans that could be pressed forward at the first political opportunity. To some extent, such planning represented solutions in search of problems to address, and inevitable droughts and floods were quickly responded to by government agencies with standby construction plans.

To Recognize the Value of, and To Undertake, Multipurpose Water Development. The mission of the Bureau of Reclamation, established in 1906, was to build multipurpose projects that served not just irrigation, but also flood control, electric power needs, fisheries and wildlife, municipal and industrial water supply, and the needs of native peoples. The Flood Control Act of 1936 made the prevention of floods completely federally reimbursable, and a great number of flood control projects were built under a system that inflated the benefits. Such projects also probably encouraged construction in flood plains and a continuation of flood losses. However, it seems likely that absent federal agency involvement, particularly through the Bureau of Reclamation, less comprehensive, single purpose projects would have been pursued forgoing the possibilities of benefits to a wider public. Single purpose projects would have been more attractive to private investors because direct beneficiaries would have been easier to identify and to collect payment from. Moreover, benefits to fish, wildlife and native peoples might have gotten even shorter shrift than they received at the hands of the federal government. There are records that private water developments ignored fish and wildlife values and encroached shamelessly on Indian Water Rights. In fact, such a private encroachment resulted in a federal court case that established the Winters Doctrine that assured native people that sufficient water to "practice the art of civilization" was reserved for them.

To Apply the Disciplines of Efficiency and Safety. The criteria for evaluating the benefits and costs adopted first by the Army Corps of Engineers and later embraced by all federal water agencies imposed a certain amount of economic, market-like discipline on project construction. Moreover, cost-sharing rules embraced user-pay principles at least in part. The record shows that narrow interests were often well served by federal construction projects, and that benefit/cost criteria were sometimes no more than a fig leaf of economic respectability. There is no question that federal subsidy in terms of low interest rates and long repayment periods artificially inflated the demand for projects. It is likely that the market would have disciplined private water developers with economic failure, but developers might have put too much emphasis on short term gains and ignored long term consequences. The pay out of huge multipurpose projects like Hoover Dam on the Colorado and the Bonneville complex on the Columbia was extended out over such a long period of time that private investment might not have been forthcoming had such projects been privately developed.

Experience with some private development suggested that risk of private failure was unacceptable to the affected public. A breach of privately constructed water works on the Colorado River, caused by miscalculation dues to lack of engineering expertise and insufficient monetary and human resources, diverted the whole flow of the Colorado into the Imperial and Mexicali Valleys early in the 20th century causing loss of life and enormous property damage. The responsible corporations were bankrupted, and the federal government was called in to force the river back to its normal channel. Subsequently, the federal government took over development of the All American Canal delivering water from the Colorado to Southern California (Garcia-Acevedo, 2001).

To Provide Mechanisms for Addressing Equity and Environmental Issues. Critics of federal water projects have argued that they have been damaging to both native peoples and the environment (See Ingram, 1990). The considerable overbuilding encouraged by federal subsidies clearly threatens sustainability. Native American water needs were under served, and federal overbuilding encroached upon whatever reserved rights Indians had in water which remained until relatively recently mainly unquantified. The trust obligation the U. S. Department of Interior has to protect the water rights of indigenous people has been performed poorly (Brown and Ingram, 1984) At the same time, federal involvement provided a structured opportunity for mobilization and protest. The Fish and Wildlife Coordination Act, the Administrative Procedures Act and the National Environmental Policy Act combined with the opportunities presented the authorizations and appropriations processes for water projects structured public arenas in which opponents could voice and mobilize support for their concerns. Economically disadvantaged interests have generally fared poorly in private markets. While fewer projects might have been built absent federal involvement, private projects would not have provided the structured opportunity to raise equity and environmental concerns available in federal programs.

B. Contemporary Institutional Changes

Federal agency involvement in water development has declined and changed in nature. The percentage of the federal budget and the amount of congressional time spent in hearings related to federal water management have declined precipitously despite, and perhaps because of the increased level of criticism of federal water programs beginning in the 1970's. While the proportion of the federal budget spent on public lands and water management hovered between 2 ½% and 3 1/4% from the late 1950's through the early 1970's, since then there has been a precipitous drop, and less than !% of the budget is currently spent on these issues areas. The fall in congressional attention has been as dramatic. While in 1948 Congress spent about 18% of its hearing days on these matters, currently it spends only about 9% (Baumgartner, 2002). There is a consensus among critics and supporters alike that the era of large-scale federal water development is a thing of the past.

While the federal government continues to be involved in water decisions, the nature of that involvement is different. Rather than advancing development, the federal government now facilitates conflict resolution and environmental restoration. As demand for clean water has outstripped supplies in many areas of the U.S., sufficient water for sustaining endangered fish and wildlife species is threatened. The dictates of the Endangered Species Act, if followed, would halt further public and private development in the habitat areas of threatened species. Rather than strictly and inflexibly applying the law, the U. S. Department of Interior has encouraged mediation, and negotiation among affected interests and commitment to habitat improvement (Doremus, 2001). An "adaptive management" approach has been embraced by federal agencies, particularly in such large restoration projects as CALFED and the Everglades Restoration Program. In these cases the Department of Interior leadership provided the impetus for cooperation among different levels of government, and a wide array of private actors including environmental, development, and Native Americans. In these arrangements substantial water is reallocated to restore wetlands and revive endangered fish populations and scientific experimentation with different management tools is encouraged. Adaptive management involves creating strong feedback from researchers to managers in the effort to learn how some of the environmental damage of past water projects can be undone. (Doyle and xxxx, 2002).

Community conservation efforts and watershed associations, frequently with federal and state agency collaboration and encouragement, are sprouting in what was previously thought to be very inhospitable soil. The Trout Creek Working Group in Oregon is one example. The ranchers in the high desert grasslands wanted their livelihood protected and the environmentalists wanted the native cut throat trout preserved. Contentious parties got together and agreed that the watershed and its streams had been so degraded that both ranching and wildlife were threatened. Sufficient mutual understanding made possible a voluntary moratorium on grazing and the creation of a habitat recovery plan (Cortner and Moote, 1999). State legislation, like the Oregon Plan, has encouraged the establishment of voluntary watershed management working groups including government officials and private interests the aim of which is to build a common sense of place and stewardship. While it is far too early to judge such efforts successful, grass roots collaborative arrangements certainly represent an important institutional change in water management.

Water marketing and market like arrangements are experiencing a contemporary resurgence although markets still encounter substantial resistance. Some water marketing continued to occur even during the era of water supply construction projects such as the 100-year history of water rights trading in Colorado. (MacDonnell, 1990). The Northern Colorado Water Conservancy District of Colorado (NCWCD) is an especially interesting marketing example with low trransaction costs and clear efficiencies. The Colorado-Big Thompson Project completed by the Bureau of Reclamation in 1957 delivers water acquired from the western slope of the Rocky Mountains to the NCWCD on the eastern slope. The NCWCD then delivers water to users on the basis of shares owned in the

NCWCD. These shares are easily tradable in an active market, and the NCWCD facilitates trades through maintaining a bulletin board of offers to buy and sell. (Howe, 2001, 1986).

Numbers of states, most notably California, have adopted legislation to encourage rural to urban water sales that are intended to move water to higher value economic uses. California state government has actively encouraged water sales between the Imperial Irrigation District and the City of San Diego. During the severe drought between 1986 and 1991, California and the Bureau of Reclamation operated a water bank. Transfers were for one year only, 1991, during which approximately 800,000 acre feet changed hands (Howe, 2001).

5. Examples of Problems Stemming From Inappropriate Institutions

Contemporary water institutions embody vestiges of the public attachment to historical tastes and values related to water, and frequently fail to evolve sufficiently rapidly to serve present needs. More recent institutional innovations exhibit flaws that were not anticipated by their designers. In the section above we discussed many of the consequences, both positive and negative, of large-scale federal government water development. This section will illustrate other problems related to the way in which institutions have evolved as well as concerns raised by many new institutional approaches. These examples are symptomatic of larger problems of institutional fragmentation that occurs among levels and branches of government .

A. Separation of Water Quantity and Quality Management

Environmentalists concerned with water quality whose influence was at its zenith in the early 1970s were understandably suspicious of longstanding government agencies historically in charge of water allocation. At their insistence, the task of regulating water quality was given to new environmental agencies at the federal level (The Environmental Protection Agency) and at state levels (cf California Water Quality Control Board). As a consequence, water quality and quantity management are generally handled separately, even though physically the two are inseparable. As a consequence interagency conflicts abound. Water quality and public health agencies in California have resisted the increase in the proportion of reclaimed water allowed in municipal water supplies while water allocation agencies have encouraged recycling of water because growing demands are outstripping virgin supplies. Water quality agencies often regulate the parts per billion of salinity, heavy metals, and pesticides in water, although water allocation agencies determine the amounts of water available for dilution. Separation of quanity and quality regulations are especially acute when it comes to matters of non point sources of pollution. The new multiparty participatory mechanisms that include the involvement of

many different agencies with jurisdiction over both quality and quantity, such as CALFED and the Everglades Restoration Project may mitigate some of these difficulties.

B. Failure of Surface Water-Groundwater Conjunctive Management

Because groundwater was an after thought as a source of water supply, quite different legal regimes emerged from the courts-embodying the failure to integrate law and physical science.. In some states, like Texas, owners of surface lands have practically unlimited rights to pump groundwater. Unless the price of electricity for pumping becomes prohibitive, there is little incentive for groundwater owners to use more expensive surface water supplies, even though these are more renewable. Other states, like Arizona, have placed groundwater under a fairly strict regulatory regime in which quantitative rights are supposed to be reduced over time until overdraft of aquifers ceases to occur. Despite legal impediments, conjunctive management of surface and groundwater does occur in some places. Groundwater replenishment districts have been set up on Southern California, and pump taxes become very expensive when there are ample surface water supplies, thus encouraging municipal water utilities to balance surface and groundwater uses according to availability. These replenishment districts also buy excess surface water from regional water suppliers such as the Metropolitan Water District at low rates and recharge aquifers with it (Bloomquist, 199x) .

C. Lack of Congruence of Physical and Political Regions: "Jurisdictional Externalities"

The failure of political and administrative boundaries to match hydrologic imperatives continues to bedevil water management. In fact, jurisdictional externalities may have become a more serious problem with the fading influence of large federal agencies with basin-wide jurisdictions. Interstate sales of water are essentially prohibited, even when they make enormous economic and environmental sense. While the State of California and the Department of Interior have proposed interstate leases and sales on the Colorado River, most other basin states have opposed for fear of permanent loss of their water rights. Water districts that receive water from federal and state projects generally restrict water sales and leases to district boundaries in order to protect the repayment base for project costs. (Wahl, 1989, Howe 2002). Even when interjurisdictional sales and leases represent win-win situations, jurisdictional problems often persist because of the inability of winners in one jurisdiction to adequately compensate losers in another.(Howe, 200x).

Where the federal government has sponsored and convened multiparty collaborative arrangements such as CALFED, some jurisdictional externalities can be overcome. For watershed associations, however, jurisdictional problems may be quite acute. While participates may be committed to collective action, the source of many severe problems is often outside the individual watershed. Consequently, watershed associations may encounter the same jurisdictional difficulties that previously led localities to turn to the federal government for more comprehensive solutions.

6. The Roles for Water Markets

Given the high economic and environmental costs associated with new water supplies, flexibility in the allocation of existing supplies becomes very important. From the point of view of economic efficiency, water supplies should be shifted around until the marginal social values are the same in all uses. Marginal social value is hardly an operational term since it ought to include non-monetizable values, but a water use pattern that leaves large discrepancies among measurable marginal values should warrant attention.

In designing mechanisms for water allocation, the following criteria require consideration (Howe, Schurmeier and Shaw, 1986): (1) flexibility in allocation over time; (2) security of tenure for water owners; (3) reflection to the water user of the real opportunity cost of the water being used; (4) fairness to the participants in the water system; and (5) allowance for water users to adjust the levels of risk they face from hydrologic uncertainty. It can be argued that water markets (broadly interpreted) fulfill these criteria quite well. If water rights are considered personal property subject to purchase and sale, flexibility is created. Since market transactions are on a "willing seller-willing buyer" basis, the water owner has a solid property right on which long term plans can be laid and transactions must be considered "Fair" to both buyer and seller. Where active water markets exist, the water user is continually confronted with a market price that can be compared with the value created through water use. Even where supplier charges for water are distorted by subsidies and out-dated repayment agreements, the market price will show the real cost of continuing to use water. Finally, where an active market exists, water users know they can always go into the market to secure additional water to meet growth or drought protection needs. Under a priority rights system, water users can assemble a portfolio of senior and junior rights that meets their willingness to face the risks of hydrologic uncertainty. Thus there is a solid argument for the establishment of water markets.

Various types of water markets and market-like arrangements have been used (MacDonnell et al, 1994). As noted earlier, water rights in Colorado have been traded among users on a permanent basis for more than a century even though no centralized trading arrangements have been in place. Individual buyers and sellers scouted around for

satisfactory "deals", facilitated by the legal interpretation of water rights as personal property subject to exchange while subject to water court oversight (MacDonnell, 1989). The efficient water market in shares of the Northern Colorado Water Conservancy District has been extensively described and analyzed (Howe, 1986;Tyler, 1992). The operations of the Idaho and California water banks are described in MacDonnell (1994), Wahl (1994) and MacDonnell and Rice (1994). "Market-like arrangements" would include the drought year lease-out arrangements between the Metropolitan Water District (MWD) of Southern California and the Palo Verde and Desert Irrigation Districts, as well as the agreements between MWD, San Diego County and the Imperial Irrigation District to invest in improvements in the irrigation system, with the salvaged water going to MWD and the County.

The State of New Mexico has just established a water market on the Pecos River to facilitate efficiency-increasing trades among users (Albuquerque Tribune, March 5, 2002), while Colorado is in the process of designing a water market in the Arkansas Valley to facilitate temporary trades with the hope of preventing further out-of-basin sales.

7. Problems with Water Markets

Public values are values that are unlikely to be taken into account by private transactors in the market process. In the water resources area, these values include the unique importance of social and cultural values generated by water, the important instream values that are not protected by property rights, external costs imposed directly on other parties due to jurisdictional boundaries that relieve water users of liability for damage, and the "secondary economic impacts" imposed on areas-of-origin, especially agricultural communities when agricultural water use is substantially reduced. The importance of these values, in the case of water transfers, implies that market-based transactions in water are likely to generate inefficiencies and inequities to a greater extent than market-based transactions in other sectors of the economy. Ignoring or under-weighting these values can occur for various reasons.

Many community values cannot be captured in monetary terms but warrant consideration in decisions about water transfers. A recent study points out that water is one of the most attractive visual elements of the landscape and that in arid landscapes, especially, there is a wide range of cultural, spiritual, and religious values related to water. Current policies for water management address only a few of the relevant human values. This is particularly true in traditional, low-income communities in which water often plays an important symbolic, cultural role. In the Southwestern United States, the acequia system not only supports local agricultural needs, but also maintains social cohesion because maintenance of the canals and distribution of the water are community efforts. Costilla County, Colorado, provides a good demonstration of the acequia

community's cohesion the village of San Luis, Colorado has banded together to fight the degradation of its waters caused by logging on the adjacent Taylor Ranch.

Cultural values associated with water are not confined to particular ethnic groups. Farm families place a high value on the farm or ranch lifestyle. Kenneth Weber interviewed farmers engaged in agriculture in the Arkansas Valley of Colorado, farmers who "stick it out" on marginally profitable farms because they value the farm lifestyle. Even after selling the water from their lands, many farmers retain their farm homes. Weber found that of thirty-six Crowley County, Colorado farmers who had sold their water, thirty-four remained in the county. This is not to argue that traditional societies should forever remain unchanged, but it is to argue that the economic "playing field" is uneven between low-income traditional societies and the more advanced sectors, and that maintenance of these cultures is of concern to society at large.

Some of the undervalued services provided by water systems, like the environment and recreation, share two unique characteristics: (1) the benefits can be enjoyed by many people without diminishing the quality of the benefit for others; and (2) it is impractical to require people to pay for the benefit. An example would be an improvement in water quality that can be enjoyed by many downstream parties including recreationists, urban utilities, agricultural irrigators, and all parties who value healthy riparian ecosystems. Such a benefit or good is called a "public good" in economic jargon, not that it is necessarily publicly provided, but that it provides widespread, non-rival benefits. Public goods are significant because private parties tend not to provide for or be concerned about them. For these reasons, public good values associated with instream flows are likely to be slighted by private water rights owners and even by public agencies that cannot gain revenues from their provision.

It is clear that water transfers can affect water quality, instream values, and riparian habitat. It is axiomatic that out-of-basin transfers will have a negative effect on the basin-of-origin and a positive one on the basin-of-destination. Diminished flows in the basin-of-origin eventually affect the streambed and riparian vegetation, which in turn affect wildlife dependent on certain bank and vegetation conditions. This is only an example of the negative effect.

Once it is observed that there are important public values that are unique to water resources that are not adequately protected in water market transactions, the issue arises as to how to protect the values in an economically efficient manner, *i.e.* at the least cost to the rest of the economy. Water markets will, and should, continue to play a major role in the allocation of water. However, the functioning of markets needs to be strengthened through institutional reform and constrained where it fails to account for important social values

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