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Designing Water Institutions: Market Failures and Institutional Response

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Abstract. Efficient resource use is increasingly central to the economic well being of individual regions and countries. Institutional arrangements set the ground rules for resource use. At best, institutions facilitate achievement of economic and social goals. At worst, they establish impediments to efficient resource use and significant resources must be expended by individuals to compensate for their obsolete or poor design.
In general, efficient water use requires a secure and flexible system of water rights. In the first regard, the peculiar physical characteristics of water resources pose special challenges for institutional design. Water resources are prone to market failures that must be addressed by institutions in order to yield efficient allocation and use. A section of the paper is devoted to presenting institutional approaches to establishing security in water use. Proportionality, prioritized rights and licenses are discussed in terms of their advantages and disadvantages.
Concerning flexibility, water allocations must change in response to changing physical and economic circumstances. In the context of drought, administrative rationing, priority and drought water options are analyzed. For demand based transfers, a full range of institutional options are considered, from a complete ban on transfers to no restriction, including market and administratively based transfers. The special issues of infrastructure, transactions costs, and secondary impacts are also discussed. Finally, conclusions are drawn concerning how the mix of institutional arrangements affects incentives guiding water use.

Key words: Institutional design, economic efficiency, market failure, water transfers, policy alternatives, water law, Asia, Australia, Thailand, Western U.S.

1. Introduction

Efficient resource use is increasingly central to the economic well being of individual regions and countries. Institutional arrangements set the ground rules for resource use. Institutions are 'ordered relationships among people which define their rights, exposure to rights of other, privileges and responsibilities' (Schmid, 1972, p. 893). They determine who has the right to claim the benefits from resource use and who must bear costs (Bromley, 1982). Therefore, institutions establish the incentives, information and compulsions that guide behavior and influence economic outcomes.

Institutional arrangements establish the basis for market or administrative control over water. At best, institutions create order and relative certainty for water users which facilitate achievement of economic and social goals. At worst, they establish impediments to efficient resource use and significant resources must be

expended by individuals to compensate for their obsolete or poor design (North, 1987). The structure of water institutions continues to be important because while significant investments have been made in water facilities, realizing the potential of these investments requires appropriate institutional arrangements to guide their use.

Poorly functioning resource institutions tend to generate pressure for innovations in policy. It is common for institutional arrangements to lag behind evolving technology and social values. This phenomenon has been studied in general (North, 1987; Ruttan and Hayami, 1984) and in the context of water policy (Dunbar, 1977; Livingston and Ruttan, 1990; Runge, 1987). One important question concerns which institutional forms should be considered in addressing changing needs.

The peculiar characteristics of water resources pose special challenges for institutional design. Water resources are prone to market failures that must be addressed by institutions in order to yield efficient allocation and use. Also, water allocations must change in order to adapt to changing physical and economic circumstances. In order to facilitate sound economic development, water institutions must create security and flexibility (Ciriacy-Wantrup, 1956).

The objective of this paper is to describe problems faced in designing water institutions and to discuss institutions that have been found to be particularly successful or unsuccessful in dealing with typical market failures and for reallocating water in times of climatic and economic change. The following section discusses market failures endemic to water resources and potential institutional responses to them. Subsequently, the topic of institutions for reallocating water within and between sectors will be addressed.

2. Water Resources and Market Failure

Economic theory suggests that under specific conditions, markets will yield accurate incentives and foster efficient resource use. These conditions are very restrictive, but are met to greater or lesser degree in specific resource and goods markets. When particular conditions are not met, markets do not yield appropriate incentives and 'fail' to achieve efficient resource use (Randall, 1983). In the case of water resources, many assumptions are violated insofar as water is fugitive, lumpy and rife with externalities. Moreover, water use is often nonrival, entails substantial transactions costs and is subject to information deficiencies.

The physical nature of water alone violates a number of economic conditions, and institutional and technical accommodation are necessary to render efficient markets (Livingston, 1985). Two central conditions necessary for a market system of resource allocation to function efficiently include: (1) the resource user must be certain of the quantity, quality, location and timing of resource availability, (2) the resource must be perfectly divisible and (3) resource use must not affect, or be affected by, utilization of the resource by another party. Certainly, in the absence

of institutional control, these conditions are not met in the case of water resources. The applicability and significance of each is explained below.

The nature of the hydrologic cycle determines water supply. The distribution and form of that supply changes over space and time, which effectively changes the supply of water available for use at a specific site. Extreme within year variability in precipitation and streamflow tend to be the rule, rather than the exception in water supply. This is especially true in arid regions where water allocation is more critical. Uncertainties as to the physical quantity of water available at particular times and locations impede efficient resource use by lessening the expected value of engaging in water related activities.

The fugitive nature of water also creates physical uncertainty. Without institutions, the right to use water is gained solely through capture in a canal or reservoir. Under these conditions deferred use carries no guarantee of future availability. Institutions are necessary to establish the rules for diversion from streams for direct use and for storage for later use.

The fact that water is not perfectly divisible in terms of storage or transportation also poses special problems for institutional design. Water supplies are naturally concentrated into site specific, common pools or streams. The implications are dramatic. First, very significant economies of scale exist in pumping and delivery. Where diversion is necessary, individual irrigators, for instance, are usually unable to transport small amounts of water in isolation, due to conveyance losses. Therefore, indivisibility means that water allocation and use must, by necessity, involve group decisions and actions. Therefore management becomes a problem for the group as a whole, rather than for specific individuals.

Second, indivisibility violates perhaps the most important condition for efficient water use: independent production and consumption functions. Because water supplies are concentrated, withdrawal, consumption and return flows by one individual, in all likelihood, affects the quality, quantity and timing of supply for individuals downstream. Without adequate institutional arrangements, efficient utilization is inhibited because all costs imposed by water users are not necessarily born by the users themselves. That is, private costs and benefits diverge from social costs and benefits, which yields serious distortions in allocation.

3. Institutional Response to Market Failure: Security

Societies around the world necessarily (explicitly, implicitly, or by default) establish institutional arrangements that govern water use. Some systems utilize markets, with various degrees of imperfection and efficiency. Many other resource allocation systems lack market mechanisms all together. Whether market or administratively based, some regimes are more effective than others in addressing the characteristics of water and creating a system of secure water rights necessary for efficient resource use. A few illustrative examples are presented below.

3.1. PROPORTIONALITY, PRIORITY AND ABSENCE OF DAMAGE

Much of the world in need of rigorous water management experiences extreme variability in precipitation and streamflow throughout the year. In an analysis of 35 developing countries, Cestti (1989) reports that nearly half of these countries experience 40% variability in rainfall. Typically, this physical uncertainty has been dealt with through a combination a technological and institutional accommodations, in order to produce relatively secure water rights.

The technical aspect of creating security involves developing storage facilities to capture water during periods of high streamflow (usually due to spring snow melt) and preserving it until times of lower streamflow and higher demand. This activity, in itself, greatly enhances the security of water availability.

The institutional approach to security may be based on proportionality or priority. In the case of proportionality, the insecurity inherent in variable water supplies is shared among water users of a given supply. Water rights are defined as a percent of the water available in any given year. For example, some localities in Australia use the concept of 'capacity sharing' to reduce uncertainty (Dudley, 1991). Share holders in a dam project receive a certain percentage of dam capacity and streamflow. While the percentage is constant, the actual quantity of water received will vary from year to year. In this way, the structure of water rights spreads the risk of variability equally among share holders.

An alternative approach to the security issue is represented by the concept of priority in time, as used in the Western U.S. Actually, the approach is two-fold. First, the doctrine of prior appropriation (in contrast to riparian water rights) addresses the market failure of uncertainty in supply. The appropriation doctrine stipulates that senior (prior) water rights are fulfilled before junior rights, which are acquired later in time. Thus, based on temporal priority, a water user can be relatively certain about the prospects for receiving water in a particular year. The more junior the right, the less likely that right is to be fulfilled.

Second, the joint problems of indivisibility and interdependence are addressed by the far-reaching doctrine of 'absence of damage'. This principle dictates that the appropriation of a new water right cannot in any way damage existing rights. In this way, existing water users can be secure in the knowledge that subsequent right holders cannot adversely affect the quality or quantity of streamflow available to them. Because many surface and subsurface water supplies are physically connected, this principle has been extended to apply to conjunctive management of surface and groundwater (Young, Daubert and Morel-Seytoux, 1986).

In the Western U.S., a water right must be continually used in order to be valid. Non-use results in 'abandonment' or 'forfeiture'. This principle has a two pronged effect on security. Some economists argue that in order to protect the security of a water right, right holders use their maximum entitlement, regardless of need. This incentive may result in overuse of water resources. On the other hand, these loss doctrines negate 'sleeper rights', which increases certainty in the overall system.

Enforcement of these doctrines requires both technology and institutions. The number of senior rights expected to be fulfilled in a given year is determined by snowpack measurements and satellite monitoring of streamflows. Water commissioners are 'river cops' who also monitor water withdrawals to ensure actual use and compliance with priority. Violations of priority and absence of damage rules are institutionally enforced either administratively, or through a system of water courts.

3.2. LICENSES AND SECURITY

Some aspects of the Australian system of water allocation result in water rights that are significantly less secure than those discussed above. All water supplies are held by the state, and rights to use are acquired by obtaining a license, which are not prioritized. Rather than relying on strict legal principles, state officials have wide discretion in determining the conditions that apply to licenses (Delforce *et al.*, 1990).

The security of a licenses is lessened by several factors. First, the license can be modified at any time. Second, licenses are not granted in perpetuity; they expire periodically. Finally, there are a significant number of 'sleeper licenses' on the books, meaning licenses that have been granted, but are not currently in use. These sleeper licenses are not lost through non use, and can be activated at any time, which introduces another element of uncertainty into the water allocation system.

The security of water rights in the Western U.S. is also compromised by sleeper 'reserved water rights'. Reserved water rights are those accruing to Indian or other Federal reservations of land. These lands carry an implicit right to the water necessary to achieve the designated purpose of the land and carry a priority date equal to the reservation date. Unlike other water rights, reserved rights are not lost from non use. To date, reserved rights are largely unexercised and unquantified, which creates great uncertainty. Under most scenarios, the full and eventual use of these rights will likely supplant a significant fraction of existing water uses.

3.3. LACK OF SECURITY AND THE RULE OF INTRUSION

Thailand exemplifies the case where market failures are totally ignored, with devastating impacts on water security and efficient use. The old saying 'not to decide, is to decide', certainly applies to Thailand. There are no formalized institutional rules for water allocation (Johnson *et al.*, 1990). In the absence of formal rules, the informal rule of right by intrusion and capture applies (Randall, 1983).

In this case, a water 'right', is obtained simply by diverting water from the stream. However, this right is, in no sense, secure. As the demand for water grows, additional diversions from the stream are not constrained from damaging existing use. If an entity wishes to increase its water security, the typical approach is to simply increase efforts devoted to water capture, which may negatively impact

downstream users. The result is extreme overall resource insecurity. Significant pressure exists to develop institutional arrangements capable of dealing with the inevitable chaos and conflict that results.

Informal, customary rights to water can be somewhat secure and yet susceptible to intrusion. In both India and Indonesia, water rights are gained prescriptively. Customary rights are recognized based on historical use of communal systems (Berkoff, 1991). In general, such water users achieve considerable protection from intrusion from outside the basin in question. Typically, they would not be afforded the same guarantees against additional users within the basin itself.

In the Philippines, prescriptive water law has been entirely repealed (Cruz *et al.*, 1987). Until recently, Philippine water recognized acquisitive prescription in the use of public waters. However, the current Water Code expressly reverses this principle.

Establishing security in water use is necessary in order to establish efficient water use, but it is not sufficient. Water rights must also be flexible. The next section outlines the flexibility issue in general and its importance to efficiency.

4. The Importance of Flexibility in Water Allocation

In order to facilitate economic well being and growth, institutional arrangements must accommodate the need for reallocating water ower time, in response to legitimate and accurately represented social and economic need. Institutions are critical in determining whether water transfers are in response to bona fide efficiency concerns, whether they incorporate inappropriate or inaccurate considerations, or disallow reallocation altogether.

Reallocation of water within and between sectors is supported on grounds of economic efficiency, wherein water is transferred to its highest valued use (Howe *et al.*, 1986; Hartman and Seastone, 1970). Fluctuation in water demand and water supply can create substantial discrepancies between the existing allocation of water and the efficient allocation wherein net economic returns are maximized (Vaux, 1986).

Certainly, the developing world faces substantial changes in future water supply and demand conditions, that call for water reallocation as part and parcel of an overall solution. Future water supplies are subject to change, given 'regular' drought occurrences as well as atypical changes due to desertification, climate change and the like. Decreases in water quality are increasingly significant to water supply problems.

Population growth alone indicates an increase in water scarcity. Cestti (1989) defines three categories of scarcity based on the number of people competing for one flow unit of water (one million cubic meter per year). The categories are (1) adaptation problems at 500 people/mcm yr, (2) absolute scarcity at 1000 people/mcm yr and (3) water barrier at 2000 people/mcm yr. Assuming stationary population, countries in category 1 include China, Cyprus, El Salvador, India, Iraq,

Mexico, Sri Lanka, Sudan, Thailand, and Turkey. Category 2 includes Ghana, Iran, Madagascar, Mauritania, Peru, S. Africa, and Togo. Category 3 includes Algeria, Cape Verde, Egypt, Israel Jordan, Morocco, Oman Saudi Arabia, Ayria, Tunisia and Yemen.

Increases in irrigated acreage in the developing world will also place additional demands on local water supplies. Growth rates in irrigated acreage averaged at about thirty percent during the 1970's (Cestti, 1989). In some areas, urbanization will necessitate reallocation. Mexico City, Amman Jordan and Beijing are examples of cities facing water shortages in the face of growth. Industrialization is also a key factor in some parts of the world, especially the newly developed economies of Asia.

When water is locked in historical uses, rather than reallocated as economic conditions change, efficiency losses can be substantial. For example, in terms of overall shortage, Fallon and Dixon (1989) conclude that an estimated water shortage of 3.5 billion cubic meters in Beijing in the year 2000 could be alleviated through a combination of technical and policy options including reallocation within and among sectors.

Water economists in the developed world have increasingly reliable estimates of the savings to be realized through water trades and transfers (Gisser and Johnson, 1983). Vaux (1986) estimates that reallocation of 10% of agricultural water to cities in California could yield benefits of 169 million dollars by the year 2000 and reduce overall water use. Kelso, Martin and Mack (1973), suggest growing water demands in Arizona could be met at lower cost through reallocation of existing supplies rather than through the structural Central Arizona Project.

If one accepts the fact that reallocation of water over space, uses and time is necessary and desirable in order to maximize development benefits, the question becomes what vehicle should be used to achieve such changes. The answer lies in some mix of administrative and market control.

The mix of market and administrative mechanisms chosen and used will necessarily vary between countries. The efficiency implications of particular combinations will vary somewhat depending on local circumstances. The degree to which a market or administrative approach dominates depends on the following factors. First a country's experience with command and control versus a market based economy will influence, to substantial degree the type of approach selected. A country's stage in development and historical background will necessarily impact selection of water transfer mechanisms.

Second, the organizational skills and leadership ability held by state agencies versus individual water users is a factor in reallocation approaches. Where individuals lack organizational ability, markets may be unable to function and a government agency may be able to supply the integration required for orderly transfers of water. However, if agencies themselves are lacking organizationally, market failure may be replaced with government failure.

Similarly, a third set of considerations is the analytical skill and independence of an agency potentially involved in orchestrating water transfers. The agency must have the ability to accurately evaluate the economic gains and losses involved in a potential transfer. Moreover, the agency must not be biased towards or against a particular user group. At the same time, client relationships with agriculture, industry and municipalities must be maintained in order to have broad based political support.

A fourth consideration is the scale of the transfer involved. In order for large scale transfers to be efficient, a system wide evaluation must be undertaken (Easter, Dixon and Hufschmidt, 1986). If water transactions are taking place on a small scale within use type, it is more likely that individuals working through markets can function effectively. However, the larger the scale of the proposed water real location, the more likely it is that state agencies must be involved to evaluate, negotiate, and implement the transfer.

The foregoing principles not withstanding, it is useful to characterize alternative approaches to water transfers, in response to fluctuating supply and demand conditions. Supply-side changes tend to be relatively shortrun (e.g. drought) but conceivably could be long run (as in the case of climatic change). Demand-side changes are usually relatively longrun, or permanent. As a result, transfers elicited on these grounds tend to be substantially more controversial.

4.1. SUPPLY SIDE IMPETUS FOR TRANSFERS : DROUGHT

Times of unusually short water supply call for special institutional arrangements for water allocation. Coping with drought often calls for reallocation of water both within and between sectors. In order to minimize overall economic disruption, the most profitable and drought sensitive enterprises must be assured continued water supply, while less sensitive and less economically important endeavors must be sacrificed. Institutional arrangements determine the degree of difficulty encountered in achieving needed water reallocation.

4.1.1. *Market Based Priority*

Adaptation to drought in the Western U.S. is achieved through market reallocation based on the institution of priority combined with tradeability regarding both ownership and location. As explained previously, water rights are defined such that senior (older) rights are fulfilled prior to junior (more recent) rights. There is no guarantee that within the initial allocation of water, the most senior right carries the greatest net economic benefit. Economically efficient reallocation is made possible only because water rights are tradeable.

Under the priority system, one of two approaches may be taken in order to be assured of water supply during drought years. First, a sufficiently senior water right may be purchased from an existing water user. The more senior a water right is,

the more valuable it is it terms of certainty of supply. Only those enterprises with large profit margins, or with great ability to pay (e.g. municipalities) will be in a position to buy senior water rights, Second, it may be possible to buy a 'drought year option' (Michelsen and Young, 1990). In this case a contract is drawn up wherein a right holder with a low valued use agrees, for a monetary consideration, to forego water use and transfer it to a high valued use, under conditions of drought. This alternative does not require permanent water transfers and is, in all likelihood, less disruptive to local economies.

4.1.2. *Administrative Rationing*

It is fairly typical for water allocation during drought conditions to be decided through bureaucratic means, via private water user groups or by the state itself. Drought year water allocation in Valencia, Spain is representative of many privately organized water distribution systems. Private institutional arrangements specify that in times of shortage, water is to be allocated proportionate to land holdings among irrigators (Maass and Anderson, 1978). The result is greater time intervals between water deliveries. It appears the primary goal is equity, rather than economic efficiency. In Pakistan, proportionate allocation is found to be ineffective or unworkable, due to conveyance losses. In response to this physical problem, water allocation is prioritized based on proximity to head waters (Chaudhry and Young, 1990).

In response to the 1990–91 drought in Thailand, the Royal Irrigation Department engaged in a kind of rationing. Officially, water for electricity generation carries first priority. This is based on its higher economic return (Boonkrob, Thongdeelert, Ayuthdhaya and Sripim, 1991). Consequently, reductions in acreage for some crops were ordered. Other plantings were delayed while some were increased. Implicitly, this rationing may have mimicked what markets would accomplish, but without compensation and transactions costs.

California has historically relied on reductions in overall use rather than reallocation between sectors as a means to deal with water shortage. However, in February of 1992, after five years of drought, the California legislature and California Department of Water Resources (CDWR) abandoned rationing in favor of a drought emergency water 'bank' (Macaulay, 1991).

The state wide water bank allowed market like transfers. However, a significant amount of bureaucratic control was involved. First, all trades were administered by CDWR using uniform contracts. Based on expert economic advise, the price of water was fixed at CDWR's buying price of $125 per acre foot and a selling price of $175 per acre foot. The difference was estimated to cover transportation, negotiation and administrative costs. The water bank program was highly successful in transferring water from less to more economically sensitive sectors of the state. The big sellers were farmers in Northern California. Water purchases were made by

farmers with permanent crops and urban users in southern California (Macaulay, 1991).

4.2. DEMAND SIDE IMPETUS FOR WATER TRANSFERS

Transfers of water are often stimulated by changes in the economic demand for water. The most typical case concerns municipal and industrial growth. The result is pressure to move water between use sectors or between regions. Changes in demand for water also occur within sectors. Shah (1991) suggests water markets are critical to farmers in India who may not share in an initial allocation of water, yet wish acquire the resource in pursuit of economic opportunity.

Because demand based transfers tend to be permanent, they are usually controversial. Institutional arrangements for dealing with this type of transfer range from the absence of any rule, to complete bans on transfers, to (perhaps undue) institutional accommodation of permanent transfers. The following paragraphs contrast alternative approaches to demand side transfers, including some advantages and problems associated with each type.

4.2.1. *Institutional Voids for Transfer*

The current situation in Thailand exemplifies a case where no steadfast rules exist for either intersectoral or interregional transfers. The result is near chaos, and a growing demand for innovation in water institutions to deal with the insecurity and inefficiencies that result (Johnson *et al.*, 1990).

During the past decade, Thailand has experienced exponential industrial economic growth, accompanied by an increase in overall water demand. Industrial users have met this demand by constructing new diversion works, or by pumping water from existing irrigation canals (Johnson *et al.*, 1990). This is done without regard to its very substantial impact on the water quality or quantity available to downstream users. In effect, de facto transfers have occurred, as enabled by the institutional void. Water reallocation depends solely on technology, backed by political power.

Transfers of water from agriculture to industrial uses in Thailand may be justified on economic grounds. However, no institutional provision is made for formal purchase from existing users. Water is taken, not traded. These transactions may meet the criterion of standard benefit cost analysis, wherein those who gain could (but may not) compensate losers and still be better off. However, a fundamental equity requirement of voluntary market transactions (actual compensation) has been violated, making such transfers ethically offensive and economically disruptive.

4.2.2. *Bans on Permanent Water Transfers*

Bans on permanent water transfers are often accomplished by adopting institutional arrangements that make water appurtenant to land. This principle pervades many areas of the developed and developing world (Maass and Anderson, 1978). The water allocation system in Valencia, Spain, is typical of many around the world. Water rights are appurtenant to specific tracts of land. In Spain, individual users belong to an irrigation group. Water is allocated proportionately among landholders according to the size of their holdings (Maass and Anderson, 1987). In the U.S., Elwood Mead was very influential in advancing the notion that water should be appurtenant to land. This system is embedded in Wyoming water law as well as elsewhere in the U.S.

The Great Lakes states in the U.S. officially denounce transfers of Great Lakes water out of the region, regardless of the reason. Any proposed transfer out of the region requires consensus approval by all Great Lake states. Therefore, any state has veto power. Given most transfers do impose some costs, proposals for moving water out of the basin are almost guaranteed to fail. (It must be noted that Federal interstate commerce law may override this arrangement among States.)

4.2.3. *Market Systems for Transfer*

In parts of the Western U.S., notably Colorado, market transfers of water are possible within the overall institutional framework. However, transfers are subject to the absence of damage rule. Any party (senior or junior) who claims to be injured, either in terms of quantity or quality of water availability, may bring suit to modify or stop the proposed transfer, insuring external impacts on other water users are considered.

The effect of the absence of damage rule pertaining to transfers has traditionally translated into the notion that only 'consumptive' water use can be permanently transferred, rather than the full amount withdrawn from the stream. Return flows must remain intact in order to prevent injury to downstream water users.

The informal 'consumptive use' transfer rule has been complicated by the introduction of instream water rights. Environmental uses of water are increasingly recognized, which usually involve a specific amount of water remaining in the stream at a given locality for wildlife or recreational use. If instream water rights are located near the site of a transfer, even transfer of consumptive use may impact the quantity of water available for an instream right. In this case, the absence of damage rule may disallow any transfer of water (Livingston and Miller, 1986). This issue has been documented as a problem arising out of water bank operations (Macaulay, 1991)

Market based water transfers are not without problems (Saliba, 1987). There are several factors that hamper permanent intersectoral water reallocations. These include hydrologic and technical limitations, transactions costs and secondary impacts. At least in the case of the first two, institutions and technology can be

used to minimize their impact. The last consideration is more complicated and is a significant concern in water transfers under the most developed institutional arrangements. The following paragraphs describe each consideration in turn.

4.2.4. *Impacts of Infrastructure on Transfers and Water Value*

Physical circumstances, as well as the economic value of water in alternative uses, determine the gains from trade so critical to market transfers. Transportation costs alone may stymie a potential market (Livingston, 1985). Based on economic value in use, municipal users are often willing and able to bid water away from agricultural users. However, if agricultural water is not readily accessible to the municipality's natural or man-made conveyance system, the cost of transportation facilities necessary to complete the transfer may render the transaction uneconomical.

Typically, a transfer must be fairly substantial in order to justify the cost of physically connecting water systems. Whenever possible, it makes economic sense to utilize the existing water courses to implement water transfers. Barring extreme circumstances, it is useful for the analyst to think in terms of a set of relatively independent market regions defined by water basin, rather than envisioning an entire region or nation as a viable water market.

In this context, it is clear why the Colorado Big Thompson (CBT) project in Colorado is usually cited as an ideal, and certainly one of the very few, large scale water markets in operation today. Large, centralized stored water supplies are most amenable to water marketing because transportation and return flow issues are minimized. CBT project facilities connect three major watersheds with a highly centralized stored water supply.

In the same vein, expanding water markets may require additional physical linkages. The agency that operates CBT water studied ways to accommodate uneven growth in regional water demand. The result is a proposal to develop additional infrastructure and to expand integrated (centralized) water treatment (NCWCD, 1991). Shah (1991) also sees infrastructure as key to the development of water markets in India.

Based on the discussion above, it is clear that many state and federal agencies have the opportunity to provide leadership in water marketing. Large scale water supplies are typically controlled by these agencies. Unfortunately, many of these same agencies employ policies that explicitly prohibit gains from trade via water transfers.

4.2.5. *Transactions Costs*

The term 'transaction cost' refers to the monetary expense of completing a particular transaction (transfer of a water right). Typical transaction costs incurred include the cost of negotiation with the other water user(s) involved and the costs of fulfilling legal and/or administrative costs associated with completing the transfer.

Rather than being a minor consideration in market water transfers, transaction costs have proven to be a major element. They are often substantial enough to delay or prevent water transfers altogether. Transaction costs have been cited as a reason why more water transfers do not take place, even when large differences in the value of water in alternative uses exist (Young, 1986; Ingram and Oggins, 1990). Ingram and Oggins (1990) note that a transfer of 15 000 acre feet of water in Nevada required 15 months of transaction time and that in Utah, 7 of the 85 million dollars spent of water rights for the Intermountain Power Project went to lawyers and engineers.

A case in Colorado exemplifies the complexities in market water transfers. Beginning in 1985, in an effort to procure municipal water supplies, the Denver suburb of Thornton purchased approximately 20 000 irrigated acres and the water shares associated with them provided by Water Supply and Storage Company in rural northern Colorado. Simultaneously, Thornton applied for roughly 18 000 acre feet of unappropriated water on the Poudre River.

Any party who claims injury due to the transfer or new application may appeal to the courts. In this regard, Cache La Poudre Water User Association was concerned about the transfer's affect on the timing and amount of return flows and the possibility that it would stymie many long term exchange arrangements on the river.

Northern Colorado Water Conservancy District (NCWCD) was concerned with the changes in water quality arising from the proposed transfer, especially considering quickly evolving water quality regulations. NCWCD also questioned the population growth projections upon which the new application was based. An over arching issue pertains to the amount of water that is subject to the regular 'consumptive use' rule and the amount that is exempt, due to special 'importation' considerations.

Certainly, the amount Thornton was willing to pay for water far exceeds the value of water in agriculture. On these grounds alone, there were substantial gains from trade. However, the seven years spent in court to determine the transferable amount significantly reduced the overall net benefits realized. The agencies involved spent untold amounts of money to defend their position.

As explained previously, the only constraint to water acquisition or transfer in Colorado is the 'absence of damage' rule. Establishing injury takes legal time and money, which constitutes significant transaction costs. Market based water transfers typically have to overcome very substantial transaction costs in order to become a reality.

4.2.6. *Secondary Impacts of Water Transfers*

As discussed in the context of market failure, efficient resource use requires that externalities imposed on other water users be accounted for in decisions to transfer water. However, this stipulation does not take into consideration that there may be

other parties, who are not water users, who are adversely impacted. These 'secondary impacts' tend to be on people who supply water users and the community at large (Howe and Easter, 1971).

Theoretically, secondary impacts on suppliers and community tax base are negligible if full employment exists and resources are completely mobile. Under these conditions, losses in the water selling area are offset by gains in the purchasing area. However, some unemployment, and imperfect resource mobility is the rule, rather than the exception. Moreover, the distribution of economic activity is of concern to local officials, regardless of aggregate impacts (Nunn, 1985; Fort Collins Coloradoan, 1987). Input-output analysis can be used to estimate secondary impacts (Young, 1984). A study of the California water bank shows significant and differential secondary impacts by crop type and by region (Macaulay, 1991).

Beyond economically identifiable secondary impacts, water transfers are often objected to on more general ethical grounds (Brown, McDonald, Tysseling and DuMars, 1982). Around the world, transfers are often resisted because they may engender 'speculation', 'capitalist accumulation' (Maass, 1990) and 'water hogging'. There is also evidence that community members perceive a loss in opportunity for growth, a loss of culture and control over the future (Ingram and Oggins, 1990) and an unfounded emphasis on individual over community values (Nunn, 1990) when water is transferred permanently out of a locality.

4.3. ADMINISTRATIVE SYSTEMS FOR TRANSFER

Certainly, market systems for water transfers are the exception, rather than the rule, throughout the world. Many countries, because of inexperience with market systems, recognition of the problems outlined above or simply because of historical, cultural and political circumstances, have adopted administrative systems that reallocate water. In general, many countries throughout Asia currently lack the experience or institutional foundation necessary to undergird market transfers of water (Berkoff, 1991). Unfortunately, many of the administrative systems in place also lack the basin-wide focus, organizational skills, independence and technical information required to implement efficient water reallocation.

The Philippines exemplifies countries that face serious problems in water administration (Cruz, Cornista and Dayan, 1987). Specifically, this study reports that staff charged with implementation of the current Water Code lacks the technical ability to estimate true water availability and to evaluate the impact of water allocations on third parties (externalities). Moreover, there is a systematic bias in water allocation in favor of landowners and against irrigators. Finally, due to organizational problems, the process is rife with delays.

However, there are examples of relatively efficient administrative systems in Asia. Management of the Mahawela in Sri Lanka and the Bhakhra Beas Management Board in India come fairly close to meeting the criteria for efficient water allocation (Berkoff, 1991). Both employ a basin-wide focus and use relatively

sophisticated evaluation techniques. Real time management is based on a yearly seasonal plan, a monthly policy and weekly technical meetings.

In Australia, institutions for water transfer are evolving rapidly. There are increasing pressures to develop water institutions that are flexible, because economic development has been impeded by fixed allocations of water. Until recently, transfers were achieved primarily through changing the conditions attached to permits, at the time they are renewed.

Since the middle 1980's, in response to the problems inflexibility generates, institutional arrangements have been changing to accommodate transfers. However, they must be pursued through and sanctified by the state bureaucracy. Additional conditions may be attached to the transfer on a case by case basis (Maass, 1990). It is significant that the price attached to the transfer is negotiated without state interference.

Some private water agencies in the Western U.S. allow transfers, subject to agency imposed conditions including price restrictions. For example, Kern County Water Agency stipulates that any water sold through the 'pool' cannot carry a price in excess of the original cost of the water (Livingston, 1982). Essentially, the policy states that no profit may be achieved via transfers. This policy presumably discourages speculation, a recurrent theme in public policy debate about water transfers. Unfortunately, in the process of negating profit, the vital mechanism that spurs efficiency is rendered inoperable.

In the United States, New Mexico employs an administrative system for water reallocations, that appears to be quite efficient. Any individual may apply for a water transfer. The application will be approved 'if the state engineer determines that the change is not detrimental to existing water rights, is not contrary to the conservation of water within the state, and is not detrimental to the public welfare of the state' (Nunn and BenDavid, 1991). Therefore, great responsibility for determining economic merit rests on the state engineer. Evidence suggests that in fact, most transfer decisions in recent years have been based on an independent evaluation of aggregate benefits and costs. Given an effective organization and a system wide scope, this administrative system has some great advantages in terms of reducing transactions costs.

5. Concluding Remarks

The foregoing discussion rests on the well known premise that in order to foster economic efficiency, rights to water resources must be both secure and flexible. Designing institutions to deal with the physical peculiarities of water in a way that establishes sensible incentives and enables efficient resource use is complicated, at the very least.

Fundamentally, establishing security in water rights requires that water users are protected against intrusion by others. This is challenging given that water users are naturally interdependent. Security does not mean that one must be guaranteed an

exact amount of water, all the time. Rather, security means knowing the probability of water availability, and being certain about allocation procedures under changing circumstances. Security also means that established water users are protected against new users and against unpredictable acts by policy makers.

Economic efficiency in water allocation, in response to short term supply changes, such as drought, requires that economically sensitive sectors take precedence over less sensitive or more adaptive sectors. This can be accomplished through markets or by administrative means (i.e. by government agencies or private water user groups). In a market scheme, rights must be differentiated according to the probability of receiving water in times of shortage. High valued uses can then either acquire high probability rights permanently, or can negotiate an option to be exercised only in drought years.

There is less agreement among experts about designing institutions to provide flexibility in water allocation in response to long run changes in water demand. Certainly, no one interested in economic efficiency would suggest either a complete ban on transfers or completely unrestrained transfers. The basic difficulty is in insuring that water transactions allow economic development and do not impose externalities on other water users.

Market mechanisms for water transfer can entail substantial transaction costs, which threaten to delay or stymie transfers altogether. Moreover, third party and community impacts continue to be of concern to those involved in water transfers. Local citizens and officials raise issues concerning the distribution of economic activity, rather than its aggregate level (economic efficiency). Perhaps these issues are negligible when the amount of water transferred is small in proportion to total supply. However, when the transfer threatens the fundamental economic base of a community, these concerns deserve more consideration.

Successful water institutions require a delicate interplay between administrative and market control. Institutions establish the basis for markets and can improve competitive conditions. Water agencies will always be involved in allocation, given the economies of scale in centralized water management. Structuring institutions such that the overall incentives that emerge foster sound economic development poses an important challenge for water resource professionals.

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