MULTIPLE USES, MULTIPLE USERS OF WATER RESOURCES

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1. INTRODUCTION

Increasing demands for water for irrigation, municipal, industrial, and environmental uses are creating scarcity and competition for vital water resources in many parts of the world. Usually these competing demands are considered on a macro inter-sectoral scale and policy makers are primarily concerned with addressing competition among agriculture, industry, and municipal water supply systems. However, competition for water is also important at the local level, affecting water availability within sectors for various uses and users.

Some water use sectors, in particular irrigated agriculture, provide water for many types of water needs besides their primary stated purpose. Although the success of irrigation systems is predominantly evaluated in terms of their ability to provide water for agricultural production, irrigation systems also provide water for other uses. The quantities of water used in these activities may be small, but these uses have high value in terms of household income, nutrition, and health. The importance of non-agricultural uses of irrigation water in livelihood strategies has implications for irrigation management and water rights, especially as increasing scarcity challenges existing water allocation mechanisms. Greater attention to the allocation of water is needed; that is, to the assignment of water rights and decisions on when, how, and where water will be delivered.

Systems of formalized individual water rights are developing in response to increased competition for water. In the process of allocating formal rights, minor water uses such as livestock, gardens, and other domestic micro-enterprises are often ignored and those who use water for such purposes lose access. Common property management systems, which explicitly acknowledge the validity of different claims, offer potential mechanisms for accommodating the needs of multiple users of water resources.

The purpose of this paper is to provide an overview of the ways in which common property water regimes may be suited to accommodate multiple uses of irrigation water. In the first section we examine different types of water uses and the critical issues associated with these uses using irrigated water as an example. Next, we discuss the existing public allocation mechanisms, trends towards formalization of water rights and the implications of these for existing water rights regimes. The next section provides an overview of various levels of rights to water resources and discusses how these bundles of rights shift according to changes in social and physical conditions. Finally, using irrigation systems as examples, we examine the potential and challenges of common property management of water resource.

2. MULTIPLE WATER USES

Water is an essential element in biological, social and economic systems. Humans, animals, and plants require predictable intake of water to survive. In ecological systems water cycles through the atmosphere, soil, plants and animals, providing a critical input in the food chain. Water plays an environmental role in maintaining aquatic ecosystems and protecting endangered species. Household livelihood strategies also depend upon water at the most basic level, such as for washing or for food production.

Most institutions for water management deal only with one set of uses and users. As a result, strategic planning and decisions on how water should be used are often poorly developed. This is not problematic as long as there are "unused" sources of water to tap for increasing supplies. But water for different uses does not flow in neatly separate channels in most developing country contexts: it is drawn from common sources, and wastes from each use mingle with the source for other uses.

Although one obvious purpose of irrigation systems is to provide water at the appropriate time and quantities to agriculture, these systems also provide water for a wide variety of less documented non-agricultural needs. An understanding of these non-agricultural uses is essential in the development of flexible water management systems which can meet the needs of a variety of water users (Yoder 1981, Salem-Murdock et al. 1994). These uses include consumptive uses (such as gardening, drinking water, livestock watering, fodder production and construction), and non-consumptive uses (such as washing and bathing, fishing, and religious and recreational uses).

Irrigation systems which are channeled through villages provide a convenient water supply for a variety of household consumption needs (Pitana 1993). Since in many systems water is diverted from the main canals to homes through small side channels, the distance to water supply is an issue in determining the level of use. In those areas where irrigation water is close to the house, water will often be diverted from canals to irrigate homestead crops or may be collected for drinking water (Zwarteveen et al 1994). Canal water is also used for construction activities such as for mixing mud for bricks (Fleuret 1985).

Although they do not explicitly encourage these activities, irrigation departments often take steps to ensure that the physical structures do not suffer from repeated non-agricultural uses. Steps may be built on canal banks to control damage to canal walls by washers and bathers or lined to protect from damage by livestock use (Yoder 1981). In some systems special water outlets are constructed which divert water from canals into pools for livestock drinking water and bathing (Fleuret 1985). When grazing is scarce, water may be diverted out of the main canal system to promote the growth of grass for fodder (Stanbury 1991, Fleuret 1985). [1]

The vast majority of irrigation water goes to field crops, particularly cereals. But water is also diverted from irrigation or domestic water supply systems to irrigate gardens. Because these are smaller in scale (and often under the control of women), gardens are generally overlooked as a form of irrigated production. But because they grow horticultural crops, gardens can be a significant source of income and household nutrition (especially micronutrients).[2]

Water plays a critical role in ritual in many religions. This link is strongly articulated in Balinese subaks, which serve as both religious and water management societies. Many South Indian temples maintain their own tanks for religious bathing, but the water may also be used for other purposes. Even mosques require water for ritual washing before prayers.

The water stored or conveyed in irrigation systems can also be used for non-consumptive activities, such as fishing and recreation (Keller 1989). Aquaculture is an important source of protein and income in some areas , and is likely to increase in importance as demand grows and capture fisheries

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[1] This process may actually lead to the degradation of land resources surrounding water sources. For example, Pauline Peters cites an example from Botswana where, under drought conditions, the concentration of livestock around boreholes aggravated already severe overgrazing (Peters 1994).

[2] In a comparative study of irrigation systems in Zimbabwe, small-scale gardens on dambo wetlands were found to have significantly higher productivity per unit land and per unit water than formal smallholder irrigation systems (see Meinzen-Dick, Sullins and Makombe 1996).

become depleted. Hydropower--from both big dams and micro-systems in hill areas--is yet another important use. The irrigation systems (and the artificial "wetlands" created on irrigated fields) can be important for the preservation of wildlife, especially migratory birds. With the rise of environmental movements, a number of countries are reserving a certain amount of water for critical biodiversity and ecosystem preservation.

CRITICAL ISSUES FOR WATER USERS

Clearly many different groups use irrigation water for essential functions which are not directly related to irrigated agriculture. Each type of water user will have specific needs for quantity, timing and quality of water depending upon the intended use. Although all users benefit from having access to water from irrigation systems, these uses are not necessarily in conflict with one another, either because they do not consume water or because the water requirements occur at different times. Nevertheless, because the water resource is shared, different groups of water users participate in implicit and explicit relationships revolving around the provision and use of the water resource.

Quantity and timing of water needs affects the relationship of different types of users (Pitana 1993). Some uses, such as domestic water supply require constant predictable water supplies throughout the year. In other situations, especially those related to food production, water needs will be correlated with growing cycles and fluctuate accordingly. Non-consumptive uses, such as hydropower, fishing and recreation, do not alter the quantity of water but may require certain amounts of water be held in reserve, or alter the timing of its use by other sectors.

The interrelated nature of water uses, and the impacts of return flows are often neglected (Vaux and Howitt 1984). The drainage from agricultural fields becomes the source of irrigation for other fields, gardens, or other uses. Surface irrigation systems are a major source of groundwater recharge, which is used for domestic water supply systems or other irrigation. Acknowledging the link between irrigation and domestic uses is particularly critical. For example, a subak system in Bali, Indonesia was originally constructed for domestic water supply, and then used the surplus for irrigation. As a result, consistent availability of water for all users is a priority, so instead of a timed rotation, each "share" receives a small flow over a proportioning weir. But in Bangladesh, many handpumps drawing domestic water from shallow aquifers have gone dry seasonally or permanently because of increasing use of groundwater for irrigation (Sadeque and Turnquist 1995).

Consumptive uses, such as domestic water supply, depend upon having access to water of particular quality. Some uses, such as the use of canal systems for washing and bathing, change the quality of the water. However, perceptions of quality vary from situation to situation and may not always coincide with the actual cleanliness of water from irrigation canals. In one case in India villagers considered water which had been filtered through the earth to be clean, and water at the surface to be of lower quality (Rosin 1993). Islamic law considers running water to be pure for drinking and ablutions (Wescoat 1995; Ahmed 1994). The use of water by other ethnic groups or castes may be perceived as contamination. Perception of cleanliness, regardless of whether the perception accurately reflects the physical condition of the water resource, will influence water use decisions.

Although the many uses detailed above may not directly conflict with one another, when water demand increases, or when water supply decreases, competition for water resources follows. Increases in demand from agricultural as well as urban and industrial sectors are contributing to scarcity situations. When changes in water rights lead to changes in access some users will also experience scarcity and water users who once had adequate water for their needs, no longer have access to quantities and quality of water which they need. Water scarcity challenges existing property rights systems which were able to allocate water under conditions of surplus.

3. CONCEPTUALIZING WATER RIGHTS

Property right regimes shape all systems of natural resource management. The assignment of property rights and the incentives which encourage cooperation will influence the interaction among resource users and the relationship of users to the resource.[3] Systems of rights may be highly individualized, such as in private property regimes, or they may include diverse groups of users, such as systems of collective action. Privatization usually entails full ownership by individuals or legal individuals (ie. corporations) whereas other property regimes include more complex systems of rights held by groups of users. In these types of systems, users often have overlapping rights to the resources which shift according to physical and social conditions.

In general property rights to natural resources can be conceived of as a hierarchy ranging from limited, short term rights to extensive, long term rights to the benefit stream as follows (Schlager and Ostrom 1992):

- access
- withdrawal
- management
- exclusion
- alienation

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[3] Resource characteristics, such as boundedness and storage capacity, will also determine how property rights for resources can be assigned and therefore influence resource management.

Rights of access allow resource users to enter a defined physical property.[4] Rights of withdrawal allow users to obtain the benefits from that property. Management rights give users the right to regulate use patterns, thus transforming the resource and potentially altering the stream of benefits from that resource. Management rights also give resource users the ability to define withdrawal rights. Exclusion rights determine who will determine who will have access to the resource. Individuals who have rights of exclusion can define access rights. Alienation rights give individuals the rights to sell or lease either of the previously mentioned collective choice rights.

Individuals, groups, or other legal entities can hold some or all of the above rights. The rights are cumulative and groups or individuals can hold well-defined property rights while not holding the entire set of rights (Schlager and Ostrom 1992).

In this hierarchy of rights, access to water is critically important in the determination of who will be able to benefit from irrigation canal water. Spatial distribution of the canal systems, as well as by the rules of water use which determine who has the right to access this water will influence access (see discussion below on nested resources).[5] Many sets of rules exist and may

[4] Uphoff distinguishes between water allocation and water distribution. Allocation assigns official water rights to specific users, whereas distribution is the actual process of delivery of water to users in specific quantities at specific times (Uphoff 1986).

[5] In Islamic law animals have the right to drinking water and often customs exist which provide them access to canals (Wescoat 1995).

overlap for even one type of use. Statutory legal frameworks, but also customary law, religious law, and other institutional and normative repertoires provide basis for claiming rights to water. The coexistence of such different legal and normative frameworks, or legal pluralism, means that individuals can orient their behavior and rationalize their decisions based on a number of normative repertoires. These decisions will be based on knowledge, expediency, and relative power of the various actors (Spiertz 1995).

NESTED RESOURCES

At any one time access rights to a variety of products from water may be in place. For example, domestic water users may take water from canals, at the same time that fishing is occurring off of the canal banks, at the same time that the water is being used for irrigation. Recognition of overlapping domains of property rights which are defined by space, time and product can contribute to the development of equitable systems of water rights (Rocheleau and Edmunds 1995).

Access rights will vary over time depending on seasonal, as well as periodic events. Seasonality introduces predictable water scarcity which can influence the type of access rights that exist for specific types of water uses. For example, in the dry season, the relationship between users who depend upon irrigation water for domestic use and livestock owners who use canal water to water their animals may change. Periodic events, such as drought, also change the hierarchy of needs and will influence the system of property rights which influences the control of water use.

USER GROUPS

User identity and the relation of user groups to other users are particularly important in determining what types of users have rights to access and use of irrigation water and how they will be affected by changes in water rights. Irrigation research documents rarely acknowledge the social differences among various users. Some of the relevant dimensions of user characteristics include gender, kin relations, patron-client relations and ethnicity.

Women often have many fewer explicitly acknowledged rights to water access and withdrawal. Although they depend upon irrigation water to water cattle, irrigate homestead crops, cultivate vegetables, as well as for domestic purposes such as washing, bathing and drinking water, their rights for non-domestic uses are often minimal (Zwartezeen 1995a). Women usually have fewer property rights to productive resources, such as land and livestock and men's use of water generally takes precedence over women's use (Cleaver and Elson 1995). Men usually have greater access to formal decision making bodies and local organizations which are involved in water management decisions, while women depend upon informal mechanisms to ensure their access to water.

Kin groupings and ethnicity provide easy identification of who should have access to resource controlled by that group (Bruce, Fortmann, and Nhira 1993). Ethnicity provides signals of group membership, and usually has embedded in it explicit and implicit power relationships among various ethnic groups. In South Asia, caste has particular significance for water use. Lower castes are seen as polluting water with which they come in contact. They may therefore be excluded from using many sources, or have to depend on higher castes to draw the water and give it to them (Sadeque and Turnquist 1995). Where occupations (e.g. pastoralism, agriculture, or crafts) are divided along ethnic or caste lines, control of water sources by particular ethnic groups may also determine the sectoral use of that source. Similarly, patron-client relations and other forms of social differentiation establish hierarchies of user group with varying degrees of power.

As mentioned above, a hierarchy of claims on irrigation water exists and shifts according to physical and social conditions (Fleuret 1985) Although agriculture often has first claim to irrigation water, the hierarchy of priority shifts under different scarcity conditions. For example, in the Taita hills of Kenya during the driest season the use of canal water for providing adequate watering for domestic animals takes priority over other uses. This situation may, however, result in an inequitable distribution of water because, in the short term, it favors those people who own livestock (Fleuret, 1985).

These various relationships among users and their property rights have implications for management of irrigation systems, particularly those systems which are under transition. Therefore, the establishment and maintenance of community based management systems will depend upon a clear definition of water rights, the identification of the range of uses and user groups, and an understanding of their overlapping and/or conflicting needs. This identification is particularly important for the less powerful members of society who will suffer the most from the lack of definition of rights because they are less able to protect their access to water resources.

4. WATER ALLOCATION AND FORMALIZATION OF WATER RIGHTS

As long as resources are abundant, there is little need to assign rights. But with population growth and economic development, demand for water increases dramatically, so that many countries (and especially local areas) experience water scarcity and competition between uses and users. In these contexts, open access regimes need to give way to some form of water rights. What type of water rights will accommodate the many types of uses and users?

There are three major types of water allocation: administrative, market, and user-based allocation. These three allocation mechanisms correspond to the three sectors in which water resource management can take place: (a) the public sector; (b) the private sector; and (c) the collective action sector.

Property rights in the public sector are assigned to the state, in the private sector to individuals, and in the collective action sector to groups.

In practice, different types of allocation mechanisms often overlap. For example, there may be public allocation between sectors and within large-scale irrigation systems, with user-based allocation through organized groups of farmers on tertiary units, and market allocation of groundwater used conjunctively. User groups may also allocate water within domestic water supply systems, supplemented by private water vendors.

In recent years there has been increasing attention to the allocation of water rights, with particular emphasis on the potential for market allocation of tradable water rights (Rosegrant and Binswanger 1995). But much of this analysis has tended to evaluate systems in terms of the efficiency of water use, and in practice efficiency is often defined in terms of maximizing output of one product per unit water (ignoring subsidiary uses). In the remainder of this paper, we examine the scope for alternative allocation mechanisms to accommodate a diversity of water users, and the implications of this concern for the definition of water rights.

In most countries the state holds the rights to water, allocating it to users through administrative and political procedures. Administrative allocation of water includes publicly managed allocation of water among nations, across sectors, or within basins and irrigation systems, through quantity distributions or administered water pricing schemes. Quantity-based administrative water allocation is the traditional mode of operation in most large developing country irrigation systems and is by far the most common mechanism in use at all levels in the developing world today. With current trends in economic liberalization and increasing water scarcity and water demand, these allocation mechanisms are being called into question.

Heavy state involvement in water allocation has been justified based on the strategic importance of the resource, scale of systems required to manage it, and positive and negative externalities in its use (World Bank 1993). The large-scale systems used to deliver much of the water for irrigation and municipal needs lend themselves to natural monopolies, and would be beyond the capacity of most communities or private firms to organize and fund. The positive externalities of irrigation systems in improving national and regional food security, or of domestic water supply systems in improving public health, have also been used as justifications for state involvement in such systems. The high individual costs of internalizing negative externalities such as deterioration of water quality from agricultural runoff, sewage, and industrial effluent, or deterioration in groundwater levels, provide further arguments for a strong state role.

While public allocation or regulation is clearly necessary at some levels, particularly for intersectoral allocation, problems with this form of allocation are seen in poor performance of government-operated irrigation systems, leaking municipal water supply systems operated by public utilities, licensing irregularities and inadequate controls over industrial water use, and damage to fish and wildlife habitats. A major reason for such problems lies in the failure of public allocation to create incentives for water users to conserve.

Under public management the dominant incentive to comply is coercion; that is, setting regulations and using sanctions for those who break them. But this type of incentive is only effective if the state detects infractions and imposes penalties. In many cases the state lacks the local information and ability to penalize, e.g. for breaking water delivery structures or for excessive water withdrawals. It is relatively more effective where there are fewer points to monitor; for example, main canals of large irrigation systems rather than tertiary delivery structures or small-scale irrigation, or withdrawal and discharge points for a few large factories rather than for many small business enterprises.

Furthermore, most implementing agencies dealing with water resources have only sectoral responsibility (e.g. to deal with irrigation or drinking water or industry or environment). While the state as a whole has responsibility for overall water use, the executing agencies have neither mandate nor incentive to create integrated projects or to balance the needs of various users (Yoder 1981). Thus, the agencies operate within strict limits on the quantity of water use, or respond only to single constituencies (e.g. farmers, industrialists). This provides very little flexibility to respond to changing patterns of water demand, and the decision-making mechanisms for allocation are either unclear or highly politicized.

Economists argue that market allocation may be the most efficient means of allocating water to its highest value use. Market allocation of tradable water rights attempts to structure economic incentives for water users, whether irrigation, industrial, or municipal users, to consider the full opportunity cost of water when making water use decisions (Rosegrant and Gazmuri 1994). Compared to the other allocation methods, the design and implementation of policies to encourage the establishment of tradable property rights and the development of markets in water have not been vigorously pursued. However, market allocation of water may be difficult due to the existence of market failures, public goods nature of water supply, and high transactions costs (Svendsen and Meinzen-Dick 1996).

Fundamental to market allocation is the establishment of well-defined, quantifiable, and tradable water rights. This means assigning the full bundle of rights, including alienation rights, to a single holder. The existence of subsidiary rights for other uses complicates the assignment of rights.

Traditional water rights systems which facilitate coordination of uses are invisible to the state will also complicate the allocation of water rights. For example, farmers may have complex hierarchies of rights which shift under changing demand and supply of water (Ambler 1994). The danger of transitioning to more formalized systems of rights is that in the process of allocating rights to water users, the less acknowledged rights will be ignored.[6] This is particularly troubling because these types of uses tend to be integral parts of livelihood strategy for poorer, less powerful water users (Vani et al 1995). Rather than replacing customary systems, it may therefore be preferable to look to such institutions for mechanisms to allocate water among the many uses at the local level.

Effective market allocation requires that third-party effects of water trades can be identified and accurately quantified, and the associated costs are fully taken into account in the exchange process (Meinzen-Dick and Mendoza 1996). From the equity viewpoint, compensation for these third party effects should be paid to those who have been harmed as a result of the agreement. Mexico's new water law provides explicitly for the protection of the environment. Third party impacts are being incorporated in the current legal reforms in Chile. However, legal processes can be long and arduous, and claiming compensation for third party impacts through the legal process may be nearly impossible, especially for those who held informal rights for non-productive or minor uses.

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[6] Rocheleau and Edmunds make a similar argument in the case of forest resources. "Unfortunately, because women's rights to resources do not generally include the primary rights of disposal and control, interventions which invest exclusive ownership rights in a single individual undermine women's customary rights of access...Outside agents, in designing their projects and programs, can better protect women's access rights by allowing for multiple uses of specific spaces and resources by multiple users, prioritizing nonconsumptive uses...which do not preclude most other uses."

5. USER BASED ALLOCATION

User-based allocation systems are controlled by users with a direct stake in the use of the water, often operating within the confines of a pre-defined water right. These types of common property resource regimes have been proposed as solutions to resource management situations where multiple users depend upon the resource. Institutions undertaking this type of allocation include irrigation districts, groundwater districts, cooperatives, irrigator associations, village-based organizations, or more informally constituted user groups.

A major advantage of user allocation is the potential flexibility to adapt water delivery patterns to meet local needs. Because those directly involved in water use--either for agriculture, home consumption, or industry--have more information on local conditions than the agency staff possesses, they do not have to rely on rigid formulas for allocation. For example, certain fields may be given more water than others, based on the water retention capacity of the soils. User organizations may also take into account local needs for watering animals, washing clothes, bathing, or other small enterprises--needs which a sectoral agency has no mandate to meet. The result can be improvements in output per unit water, or in equity, or both.

Farmer-managed irrigation systems provide one of the clearest examples of user-based water allocation. Studies of such systems have shown a wide diversity of rules for allocation within such systems; by timed rotation, depth of water, area of land, or shares of the flow (Yoder 1994). In the domestic water supply sector, user-based allocation is seen in community wells and handpump systems, as well as in a growing number of more sophisticated systems under the control of water and sanitation associations (Watson et al. 1994). Intersectoral allocation by users is seen in the management of village tanks or other local water sources used for domestic water, irrigation, and even animal watering or other activities.

User-based allocation requires collective action institutions with authority to make decisions on water rights. While empirical studies of common pool resource management (including water) have shown that such institutions can develop spontaneously or through an external catalyst, the institutions are not always in place or strong enough to allocate water efficiently. The creation and ownership of irrigation property--including water and structures--form the basis for relationships among the irrigators, which "become the social basis for collective action by irrigators in performing various irrigation tasks." The cohesive force of property is important in many aspects of water management, but it is especially critical for allocation. User groups cannot make decisions regarding water if they have no rights--*de facto* or *de jure*--over that water.

Local user-based institutions can be limited in their effectiveness for inter-sectoral allocation of water because they do not include all sectors of users. A village community may readily identify with the needs for domestic use, animals, and irrigation, though the particular interests of different groups within the village (e.g. women's greater interests in domestic water, pastoralists in animal supplies, farmers in irrigation) will differ (see Boschmann 1994). But industrial demand is often seen as "outside" the local community, and therefore not amenable to user-based allocation. A recent study of negotiations for water rights for textile factories in rural West Java (Kurnia and Bruns 1996) shows that this is not necessarily true. Because the same families have members employed in fields and factories, local allocation institutions are being adapted to accommodate industrial use.

Even where intersectoral competition is not localized, but requires coordinating between municipal and industrial demand in one area, and irrigation in another part, user-based allocation can work through federations of user groups. User associations that include all who hold rights to water from a common source (including agricultural and other uses) are able to negotiate intersectoral allocation amongst themselves in Chile. During periods of acute water scarcity, agriculture receives lower priority than urban needs. However, even during the three most severe droughts, agreements were reached in the vast majority of cases because all parties negotiate directly and prefer to "keep the state out" (Rosegrant and Gazmuri 1994).

The tanks of South India provide a clear illustration of such locally-managed multiple use. Many of these earthen dams and reservoirs, ranging from a few hectares to over a thousand hectares, date back hundreds of years.

Although their largest consumptive use is for irrigation, the water is also used for bathing, laundry, watering animals, and raising fish and trees. Village panchayats, local temples, or specialized tank associations have traditionally managed the tank resources, deciding such issues as how much water should be released for irrigation or retained for fish, animals, and domestic uses. However, since the colonial period the state has taken on an expanded role in managing the tanks, which have come under the Public Works Department for irrigation, the Fisheries Department for fish, and various other authorities. This has eroded the user-based management institutions, and caused greater problems for inter-agency coordination.

Local management institutions for dambo wetlands in Zimbabwe provide an example of local multipurpose land and water use. These wetlands are important sources of water for livestock, domestic use, building materials, as well as gardens. The state does not sanction water rights for garden irrigation on dambos. In fact, the Streambank Protection Regulation and the Water Act officially prohibit irrigation on wetlands or streambanks. But traditional authorities in many areas do allocate implicit water rights when they give permission to establish garden plots, while reserving other land for grazing and other uses. Careful study of four sites with effective local institutions indicated that they were balancing water allocation to gardens with other needs (especially livestock): "The farmers' perceptions of the availability of resources are generally accurate and they are willing to limit the expansion of their [irrigation] systems when land and water resources become fully allocated (Andreini 1996:71)."

The need to accommodate multiple uses presents both challenges and opportunities to user groups. The challenges arise in developing institutional mechanisms that allow different users a voice in how the water is managed. Even within the community, women's interests in convenient, clean water for domestic purposes or gardens may be less strongly represented than men's interests in water for irrigating fields (Cleaver and Elson 1995; Zwarteveen 1995). The problems are even more complex when water uses cross community boundaries, as when pastoral and agricultural ethnic groups share water sources.

Multiple uses of water provide an opportunity for user groups because they broaden the base of support for water management, and increase the resources that can be used to manage the systems. Pitana (1993) provides a more recent case of a locally-developed multipurpose water delivery system in Bali, Indonesia. After a serious drought, a group of 70 villagers in Bunutin identified a water source in another village. They raised $50,000 plus local materials and voluntary labor to construct a dam, tunnel, and canal, with the state providing only technical advice. "The villagers voluntarily assisted the group because the water would be used not only by group members, but by all villagers who would have access to it for domestic purposes (Pitana 1993:14)." When water supplies exceeded domestic needs, the remainder was allocated for irrigation in equal shares for all group members. However, the need for continuous flow for domestic use influences the type of water distribution: instead of a timed rotation, each "share" receives a small flow over a proportioning weir.

Control over fishing rights or other water uses can also be a source of revenue for water user groups. Because water users' associations cannot operate at a deficit, and farmers are often unwilling to pay high fees for water, the financial viability of such groups, and their ability to pay for adequate maintenance, is a serious concern (Meinzen-Dick et al. 1994). Traditional irrigation associations in South India auction fishing rights, or rights to trees planted along the irrigation system as an additional source of revenue (Meinzen-Dick 1984; Wade 1988). Cross subsidization from fishing, recreation, and other uses has become a significant source of revenue for local irrigation management in China (Svendsen and Changming 1990)

The operation of users' associations for irrigation or water supply and sanitation are receiving increasing attention (e.g. Meinzen-Dick et al. 1994, Watson et al. 1994), as sectoral agencies seek to transfer responsibility to user groups. By contrast, the functioning of local institutions (including organizations and norms) involved in intersectoral allocation have received little attention. We therefore need to study local decision-making processes and institutions for water allocation in order to learn from successful examples, and identify policies that can promote efficient, equitable, and environmentally sustainable water use.

Some of the difficulties associated with user based allocation mechanisms are related to matching rights to management responsibilities. Water users will have rights to particular products, but these rights will be subject to various rules regarding timing and amount of withdrawals. The challenge of user based management is to structure incentives and compliance measures so that individuals will also fulfill their designated responsibilities. Responsibilities will include maintenance activities related to maintaining water withdrawal and conveyance structures, as well as monitoring of withdrawals in order to maintain specific stocks of water resources. Incentives for continued compliance are critically important since group management of resources without these incentives may lead to "free ridership" and accelerated deterioration or decreased investment in critical resource management activities at the individual level.

Another challenge to user based management systems is the development of local organizations with representation of all user groups. When new organizations develop as off-shoots of existing organizations, they are likely to reflect existing societal prejudices and may perpetuate inequity rather than providing a forum to meet the needs of diverse user groups. For example, in many situations, women are under-represented in organizations and thus have limited input into management decisions, and less ability than men to lobby for their own needs. If occupations of user groups fall along ethnic lines, traditional social organizations will also have more trouble meeting all needs.

6. CONCLUSION

Although user based allocation mechanisms for water may not be suited for all water management situations, they are well suited for situations in which multiple users depend upon the water resource. The flexibility of these mechanisms is particularly important to address the shifting social and physical conditions that alter the relationships among user groups. As policy makers become increasingly interested in developing formalized systems of water rights to address competition for water resources, traditional rights regimes may provide lessons on how to structure user based allocation mechanisms to meet the needs of many types of users. Although tradable water rights have recently begun to attract attention as a solution to water scarcity, caution must be exercised to ensure that the rights of "minor" water uses (which may play a major role in local livelihoods) are safeguarded or adequately compensated. Instead of formalizing simple ownership rights to water resources, it may be that "a flexible multi-user tenure framework is the only way to bring all these issues of space, time, . . .products and end uses together on a dynamic and shifting base (Hoskins 1994)."

Where water rights are being formalized, maintaining access to water for critical livelihood uses depends upon the careful evaluation of all uses of the water resource. Maximizing the output of a single product may not provide the optimal solution. Although cost-benefit analyses should consider all costs and benefits associated with resource use, in practice most secondary uses remain invisible. The consideration of full economic and social returns to all water uses is necessary to increase the accuracy of evaluation of alternative water development strategies.

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