CONSTRAINTS IN WATER MANAGEMENT ON AGRICULTURAL LANDS

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Introduction

Irrigation is one of the most important agricultural practices developed by man, with irrigation being practiced in some form since the earliest recorded history of agriculture. The economic base for many ancient civilizations was provided by irrigation. Indians of the western hemisphere were irrigating crops long before the discovery of the New World. Much of the economy of the western United States depends on irrigation, which has been the dominant factor in the development of land and water resources in the arid and semi-arid regions of the western states. Irrigation is practiced on about 10 percent of the total cropped land in the United States, but this land produces approximately 25 percent of the Nation's total crop value. Irrigation farming not only increases productivity, but it also provides flexibility which allows shifting from the relatively few dryland crops to many other crops which may be in greater demand. Irrigation contributes to strengthening other facets of a region's economy in that it creates employment opportunities in the processing and marketing of agricultural products.

Irrigation return flow constitutes a large portion of the flow in many streams of the western United States. Some degree of water quality degradation due to irrigation has been accepted as the price for irrigation development. However, as pressures on water resources increase, there is a mounting concern for proper control of such serious water quality deterioration.

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The water quality problems associated with irrigation return flows are of special concern because irrigation agriculture is the largest consumer of our Nation's water resources. As societies become much more complex and diversified and demands continuously increase and expand in scope and intensity, the use of scarce water resources and the preservation of the natural environment become much more important concerns in the planning and evaluation of development efforts. In any water resource development, three major problematic situations give rise to a continuous re-examination of the parameters of any water use system: 1) Continuously changing economic and social conditions, such as increasing population demands for more food, urbanization, and industrialization; 2) The strong presence of institutional constraints, the result of long historical and cultural practices, embodied in laws and judicial doctrines and in traditions reflecting the norms and practices of a given society and community; and 3) Increasing concern with adverse environmental impacts and consequences, which stems either from an already ecologically fragile environment (natural sources of pollution), or from man-made perturbation, such as the misuse of the land and the various forms of the despoliation of the water supply. Irrigated agriculture has to be viewed as an integral part of these larger socio-economic trends and of increasing awareness of new equations between technological intervention and ultimate ecological balance.

An irrigation system is a combination of physical facilities and the institutions by which the acquisition, distribution, use, and reclamation of water contribute to increased agricultural production in a given enterprise setting. Whether the goal is minimizing water quality degradation in receiving streams or maximizing agricultural production on existing croplands, the solutions are identical--improved water management practices. In order to achieve either of these two goals, then, the initial problem becomes the identification of constraints in improving water management.

Technological Solutions

An irrigation system can be subdivided into three major sub-systems: a) the water delivery system; b) the farm; and c) the water removal system. The water delivery system can be further subdivided into components; namely, a) the transport of water and pollutants from the headwaters of the watershed to the cross-section along the river where water is diverted to irrigation croplands, and b) the transport of water and pollutants from the river

diversion works to the individual farm. The farm sub-system begins at the point where water is delivered to the farm, which is usually the point of highest elevation on the farm, and continues to the point where surface water is removed from the farm, which is usually the lowest elevation ground surface and terminating at the bottom of the root zone. The water removal sub-system consists of a) the surface runoff from the tail end of the farm, and b) water moving below the root zone.

There are a number of potential solutions for improving water management, thereby controlling the quantity and quality of irrigation return flow and increasing agricultural productivity. Using efficient practices in the delivery canals and pipelines, as well as improving on-the-farm water management, will minimize the problem in the water removal system. In most cases, the key element is to improve water management practices on the croplands.

The water delivery system can be improved by lining canals and laterals, using closed conduits for water transportation, providing adequate control structures, and installing flow measuring devices.

Improved practices that can be used on the farm include judicious use and application, or placement, of fertilizers, use of slow-release fertilizers, controlling water deliveries across the farm, use of improved irrigation application methods (e.g., subsurface application or trickle irrigation), control of soil evaporation, use of a pumpback system to allow recycling of surface return flows, erosion control practices (e.g., contour farming), and irrigation scheduling to insure that the proper amounts of water are applied at the times required by the plants.

In the water removal sub-system, open drains and tile drainage can be used to collect return flows, which can then be subjected to treatment on a large area or basin-wide basis, if necessary.

Water Law

For nearly a century, agricultural development has taken place in the western United States subject to the provisions of water allocation and distribution proclaimed by the state water codes under the appropriation doctrine. Individuals have governed their activities in accordance with their right to use appropriated water and have made investments according to the stability and quality of their right. In turn, irrigation systems resulted in social communities being established where its members were the direct recipients of the economic base made possible through the describable

tures to the point where politicans find it politically desirable to attack the continued horrendous diversions of this scarce resource to a sector of society already subsidized in every way except outright dollar grants. Few have really analyzed the beneficial primary and secondary impacts of agriculture upon the total economy and the stability it has given to local and regional societies. True, the water right has allowed agriculture to continue in operation with little modification in management practices since the mid-1800's. Under the preference system of the appropriation doctrine, agriculture was even given a superior position to such uses as industry, recreation, etc. In a way, the water right has been a security blanket for the farmer; he has not had to compete on the open market for water because he acquired an early right to available supplies which were guaranteed him so long as he exercises his right.

The contemporary push is to compel the maximum use of water to gain the highest economic and social return. Technology has advanced far beyond present agricultural practices to develop new and better water management methods that have not been adopted due to legal, economic, and social constraints.

Therefore, in light of the water problem status and the role of water rights, two opposing principles must be given recognition in the pursuit of changes to implement technology. The first is to protect the current water right holders and recognize their interest in the vested appropriation. Second, changes must be adopted to encourage maximum use of available waters through incentives where possible, strict enforcement of the law where necessary, but, more importantly, through the personal initiative of water users and a recognition of their social responsibility.

Water Right Changes

Recommendations to resolve the water quantity and quality problems of river basins must, in reality, examine the river system as one hydrologic unit regardless of state boundaries. In so doing, the modifications and reinterpretations of the law must be designed to accomodate the overall goal of efficiency and effectiveness in water management. This will require coordination and cooperation by state and federal agencies presently working with water resources management.

Focusing upon the agicultural uses of water, yet cognizant of the multitude of other uses in river systems, the first step is to structure the water

right around three sublevels of the irrigation flow system to integrate quantity and quality constraints in formulation of changes in the exercise of the appropriation. The three sublevels are 1) the water delivery system, 2) the farm and 3) the water removal system. In this manner, the various individuals and organizations holding water rights or transporting waters can effectively be included in any water management scheme.

The concept that is at the heart of the appropriation doctrine and which could make the most substantial impact in solving the legal and institutional constraints is the concept of beneficial use. This is a very nebulous concept which defines the measure and the limit of a water right. In general, beneficial use pertains to nothing more than the reasonableness of the diversion according to the use to which the water is to be applied. At the present, what is a beneficial use for acquiring a water right may depend on whether that particular use is one recognized by the state constitution or statutes. The concept must be conceived and directed not only to types of uses but to the nature of the use on the farm with respect to the user's needs. More importantly, this concept must be viewed with respect to the user's responsibility to other downstream users and the public interest.

A major change in the nature of a water right that would serve to protect the interests of the right holder and later water users would be to add the element of water quality. In so doing, the right holder would have the same assurance and likewise liability in the use of diverted water within the priority system for quality purposes as he now has for quantity flows. This change would be instrumental in encouraging practices to treat or dispose of highly polluted waste waters and encourage the proper application of water on the farm.

Significant to five appropriation doctrine states is the appurtenancy concept which ties water to land. This concept breeds inefficiency by promoting irrigation of certain lands that are not as productive as other available lands belonging to the right holder or other land owners wishing to purchase water rights. Elimination of this concept would allow the landowner to make a proper selection of land that would yield the highest agricultural returns to his operation.

A final doctrinal impediment in the exercise of water rights is the transfer restriction of rights within an irrigation system to other uses, or outside of the basin. This constraint may exist in the substantive water

law or as a result of the organizational and administrative system of the state. There are few states that prevent the sale and transfer of water rights from within or without the present uses. States restricting transfers rely upon the appurtenancy concept to prevent such shifts. However, the law should be modified or changed to reflect state encouragement in the renting, leasing, transferring or selling of water rights to other uses and places so long as the vested rights of others are protected. Changes in the administrative and judicial system should be made to facilitate exchanges of water rights. Recognition of such a right and a change in the concept of beneficial use to include recreation, aesthetics, fish and wildlife and other beneficial uses would serve to nullify the fear of losing that portion of the water right not exercised by permitting the transfer of the unneeded portions to other uses within the system.

Removing these rigidities in the law to give the right holder greater freedom and flexibility will eliminate many of the irrigation problems perpetuated by the appropriation doctrine. Agricultural users are subject to constraints that other users are not, which is frequently passed over when comparing the use of water for agriculture to other uses.

Socio-Economic Issues

Improving irrigation management implies not only technological innovations and better interpretation of water law, but also other organizational improvements. Such organizational improvements include, for example, better irrigation scheduling which is very closely associated with the present negative aspects of western water laws. When we combine better information regarding soil moisture management in the root zone of the crops and more sensitive equations concerning application efficiency criteria, the farmer may still wish to use his full water right. It is assumed, at this point, that various positive incentives and resulting changing attitudes will allow a saving of water, and transfer of saved water to other uses of a comprehensive water resource development plan of a river basin.

A major problem in the overall management efforts is the lack of single management units in most of the irrigated valleys of the West, which are characterized by the existence of quite a number of fragmented irrigation companies and districts, with each company responsible for water delivery to only a part of the valley. In addition, separate institutions may be created to handle the water drainage system. In order to develop not only

effective irrigation return flow quality control programs, but also to improve the overall efficiency of a water system in a given irrigated valley, it is imperative that the entire irrigation system should be coordinated on an integrated basis. The need is to move from private, single company oriented management units to what may be described as primarily valley-wide alternative. This brings forward a very difficult, but challenging water management problem, that is, an attempt towards consolidating separate small irrigation companies into single entities which would have advantages of size, economies of scale, and potential for comprehensive valley-wide development. Water quality degradation will be reduced if attempts are made to face the problem not only as an integrated approach of various units within a valley, but also as a much larger effort to integrate the particular valley with other surrounding systems. (This same goal could be applied to urban systems, where the consolidation of water supply and wastewater would greatly facilitate urban water management.)

Many other suggestions have been offered concerning the solution to problems of irrigation water management. Essentially, most of them can be summarized around a cluster of individual and community attitudes which seem to have consequences for the quality of a given water system supply. There exists a host of social practices, as well as traditional ways of irrigating and using the water, which directly degrade the quality of a given water supply system. The immediate solution and the attack against such practices can be easily perceived as a simple problem of social control. Perhaps, one of the immediate attacks to this problem would be to require that anyone degrading the quality of water pay the cost of treating this water. However, this approach treats the problem of water quality degradation from a symptoms points of view, rathering than addressing itself to the essential cause. It is not only difficult to assess penalties, but also to provide a very complex and expanded system of policing and mechanisms of law enforcement. The attack to the problem would be an attempt to reach the roots or the causes of the water quality degradation; that is, the kinds of social practices and the types of attitudes which would improve water use before degradation of water takes place. From the social point of view, in changing practices, and provided that there are also technological solutions to both natural and man-made pollution of water, the following major areas should be of major concern:

1. Priority of use (and the interpretation of legal doctrine);
2. Geographic area (and the increasing scope of planning);
3. Population affected;
4. Political units involved; and
5. Disciplinary scope (and the attempt towards a multidisciplinary systhesis).

To bring about changes in the organizational behavior of all types of units involved in water management, as well as effective response from individual irrigators, three major categories of policy decisions and social action must be made: first, strong incentives for efficient or new uses (economic benefits, redefinition of the doctrine of beneficial use, etc.); second, structural changes (such as new organizational arrangements, creation of inter- and intro-state agencies, appelate bodies, water brokerage--either private or public, etc.); and third, "regulatory counterincentives" (such as stricter enforcement, pricing policies, etc.). More than anything else, however, all the above changes or attempts for modification must be guided by a pervasive spirit of social consciousness and a new outlook of individuals and collectivities away from their small closed system of their particular community, to the larger and much more complex regional scene.

To be able to give answers to the above major areas of concern, we need to develop an assessment methodology which would enable us to identify in a systematic way potential causes and corresponding effects, a description of their characteristics, and possible consequences in the overall water system.

In trying to achieve effective water management, it should be kept in mind that alternatives offered should be evaluated under three different conditions of "effectiveness." Traditionally, the most widely used term has been that of *efficiency* which attempted to relate in simple economic benefit-cost analysis the relationship between resources (input) and proposed goals or attempted targets (output). An efficient system has been an easy one, that with minimal cost, and that cost has always been understood in terms of dollar values.

The term *effectiveness* has been used mostly in terms of organizational performance or the meeting of purely organizational goals, that is, the relationship between a given organization (thruput) and perceived goals (output). It has been also used in the context of the overall measure of achievement for a system, derived from its sub-system's performance or related to its interactions with other systems.

And last, but not least, the term *efficacy* is used, which attempts today to incorporate the meeting of social goals and a much more comprehensive relationship between input, thruput, and output. Efficacy, in other words, attempts to move beyond purely economic considerations, or criteria of organizational effectiveness, and tries to answer the question of how a particular system can efficiently, effectively, and guided by principles of social awareness, meet goals of a given society. The term of efficacy brings forward an increasing awareness of a whole number of intangible benefits to be accrued from a given water system that cannot be directly measured by existing economic or other quantitative criteria. Qualitative criteria and the consideration of social goals transcending purely utilitarian criteria provide us with the very difficult task of trying to strike a balance of fulfilling water use goals in expedient, technologically and economically feasible ways, to larger questions of social policies and attempts of environmental balance. This implies that any water management system, as well as any attempt for comprehensive water use development, would be also dependent on subjective models which are much more difficult to construct, yet they contain long-range policies for a social use of natural resources.

These kinds of considerations probably provide the answer to questions regarding the advisability of continuous water use development in the arid West under the adverse or fragile ecological conditions of the territory. It would have been easier to have water systems responding only to technological imperatives. However, the valleys of the West and the irrigation systems are not abstract simulation models responding to the whims of any experimentor. They include individuals and communities that have developed a pattern of life and whose welfare and future may even depend on inefficient water systems. Even a marginal or not particularly efficient agriculture fulfills the purpose of being a supportive social system for a number of individuals and part of the ongoing life of a number of Americans. It is not easy to dictate a social policy that would be based solely on criteria of efficiency and effectiveness without considering at the same time the so-called "human factor." And in many respects the human factor involves questions of inefficiency (and ineffectiveness) because the social costs of dislocation and disruption may be so high--when examined under criteria of efficacy--that they may dictate a policy of continuing present practices with little technological intervention.

The above discussion, however, does not mean that there is very little to be done with the irrigated valleys of the West or with any presently declared inefficient or ineffective water management system. It only points out that the problem of water quality management control is a complex one that requires considerations beyond accepted technical, economic, or even political constraints. Our effort for improving water quality management implies, therefore, a manyfold attack and a series of efforts aimed at improving project irrigation efficiency and effectiveness, under the larger rubric of efficacy and the achievement of larger social goals.

Conclusions

Whether the goal is minimizing water quality degradation in receiving streams or maximizing agricultural production on existing croplands, the solutions are identical--improved water management practices. Technology has succeeded in developing feasible solutions to improving irrigation water management, but the law has been slow to encourage or direct implementation. The villain of the western United States water problem is the property right concept of the appropriation doctrine. The most substantial impact in solving the legal and other institutional constraints inherent in the appropriation doctrine would be more stringent application of the beneficial use concept. In addition, water quality should be made a part of each water right. Also, the appurtenancy concept, which ties water to land, should be eliminated. Finally, water laws should be modified to encourage the renting, leasing, transferring or selling of water rights to other uses and places so long as the vested rights of others are protected. Improving water management also implies organizational improvements, such as the consolidation of fragmented irrigation and drainage districts into valley-wide single management units. All attempts for modifying water use must be guided by a pervasive spirit of social consciousness.

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