ENVIRONMENTAL ECONOMICS AND WATER RESOURCES MANAGEMENT: AN INTERNATIONAL COMPARISON

1. INTRODUCTION[1]

The policies concerning the protection of the environment and natural resources have gradually grown in importance since the 1980s. The reason for this is that the menace of environmental damages and depletion of the natural resources are still far from being under control (European Commission, 1999). As a result, there has been an enormous increase in the adoption of the different measures – legislative, economic, financial, etc. – suitable for protecting the environment.

One of the topics of particular concern is water management. Economic analysis can strongly contribute to promote efficient water use and to provide more protection to the interests of future generations of water users (Tietenberg, 1992). Water use can be divided into offstream and instream uses. Offstream water use involves the withdrawal or diversion of water from a surface water or groundwater source. These uses include municipal/public supply, domestic, residential and commercial uses, industrial and agricultural uses.

Instream uses of water, instead, are those such as habitat for wildlife or for fishing and boating, recreation and other environmental values. As the competition for water increases, the pressure to allocate larger amounts of the river for consumptive uses increases as well. Considering that, water supplies can be insufficient in quantity or too polluted in quality and that, especially in the United States, the maximum extraction rates of water have already been reached, the environmental impact of these factors could be really harmful if not catastrophic.

The actual water use doctrine in the western United States is known as the prior appropriation doctrine, and it poses serious problems since it does not provide adequate protection for the instream uses. In fact, this doctrine recognizes that the first user has a priority right to continue using water regardless of the location of the land. The first person or organization

[1] I wish to thank particularly Cesare Imbriani for his illuminating contributions to the development of this paper. Very special thanks go to Bonnie Colby that provided extensive inspiration for the issue and to Francesco Renna for his important contributions in a first draft of the paper. Sincere gratitude goes to Stefano Burchi that improved the final product with his constructive comments and thoughts. The responsibility for any errors or omissions remains obviously only mine.

to put water to beneficial[2] use has the right to use water;[3] these rights are administered on a first-come basis. During times of water scarcity, people with the most senior water rights have priority over junior water right holders to use available water.

The major water management policy challenge, nowadays, is how to address instream flows, recreation and water quality (MacDonnell, 1990). Probably the most complex challenge water laws pose is the administration of water rights, i.e., the granting of licenses, concessions, permits and other legal titles for the abstraction of water from watercourses (FAO, 2001).

Primary objective of this study is to analyze the potential relationships between two similar cases in two different countries, the Tagliamento River in Italy, and the Deschutes River in the United States, and to demonstrate that modifications to both water allocation systems are strongly desirable and would improve protection for instream flow values. These two study cases provide a good picture of the complex issues on growing urban demands for water, increasing environmental concerns related to instream flows and future conflicts over alternative water uses.

Should Italians learn from the experience of Americans? The actual Italian *state of the art* allows to tell that Italians will face serious challenges as agriculture, industry and urbanization are putting new pressures on limited water resources and are jeopardizing the protection of natural habitat and the supply of recreation.

The paper is organized as follows: in paragraph two is presented the general conceptual framework used to approach environmental problems, focusing the attention on the trade off between offstream and instream water uses; an overview on property rights protection and some insights on water legislation in Italy and United States are given in paragraph three; then, the most relevant economic concepts pertaining to both study cases, the Tagliamento River and the Deschutes River, respectively, are discussed in section four; in the last paragraph some desirable changes in regulatory policies are proposed.

2. THE ECONOMIC PROBLEM AND ENVIRONMENTAL MANAGEMENT ISSUES

The effectiveness with which current institutions manage and have managed the water resource in the past shows whether the allocation is efficient over time or not and how it can be improved in the future. There is

[2] "Beneficial use" as defined by the Revised Code of Washington 90.14.031(2) shall include, but not be limited to, use for domestic water, irrigation, fish, shellfish, game and other aquatic life, municipal, recreation, industrial water, generation of electric power, and navigation.

[3] A water right is the right to divert water from the stream. An instream flow right is simply a right to a specified quantity of water flowing through a particular stream.

a huge literature on water markets and water transfers (Milliman, 1959; Hartman and Seastone, 1970; Howe et al., 1990; Brajer et al., 1989; Solley, 1993); here, are reviewed just some of the more relevant issues contemplating, in particular, the instream and offstream uses.

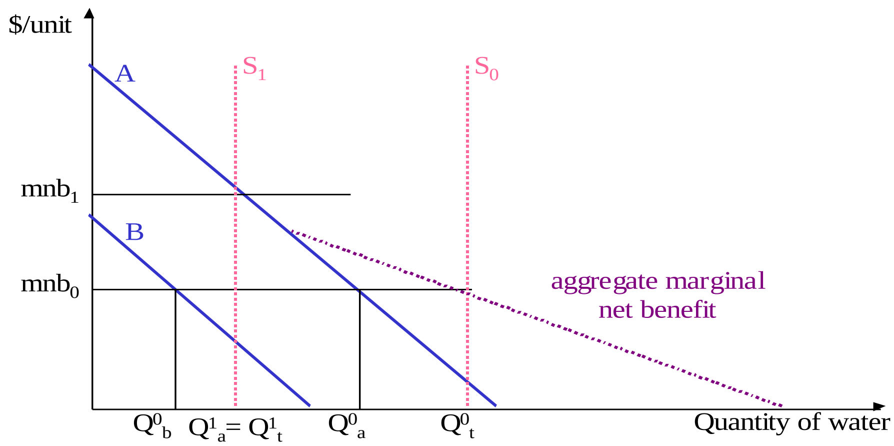
An efficient allocation of water must be balanced among competing users, and must be supplied in the right way in order to handle the intrinsic variability of water flows. The first issue is quite complicated because so many different potential users can have legitimate claims. Water, in fact, can be withdrawn for consumptive use, such as by municipal drinking water suppliers or farmers, and it can be used without being consumed, such as by swimmers or boaters. The second issue derives from the fact that water supplies are not constant from year to year or even month to month. Since precipitation and runoff change from year to year, in some years less water will be available to be allocated than in others. To mitigate the effects of such variability, a system for allocating the average amount of water, as well as a system above/below average flows must be in place.

To have efficiency from an economic point of view, the water should be allocated so that the marginal net benefits are equal for all uses. The marginal net benefit is the vertical distance between the demand curve for water and the marginal cost of extracting and distributing that water for the last unit of water consumed. To demonstrate why efficiency requires equal marginal net benefits, let's consider a situation in which the marginal net benefits are not equal. In this situation, it is always possible to determine some reallocation of the water that could increase net benefits. Since an efficient allocation maximizes net benefits, any allocation for which net benefits are not equal is not efficient.

If marginal net benefits are not equal, it is always possible to increase net benefits by transferring water from those uses with low net marginal benefits to those with higher net marginal benefits. By transferring the water to the users with a higher value of the marginal water, the net benefits of the water use are increased; those losing water are giving up less than those receiving the additional water are gaining. When the marginal net benefits are equal, no such transfer is possible without lowering net benefits.

In the figure 1 are represented A and B as two individual net benefit curves together with the aggregate net benefit curve for both individuals. If the supply situation is S_0, the amount of water available is Q^0_t. An efficient allocation of water would be characterized by equal marginal net benefit (mnb_0) and would give, then, A the amount Q^0_a and B the amount Q^0_b.

FIGURE 1 - *Efficient allocation of water*.

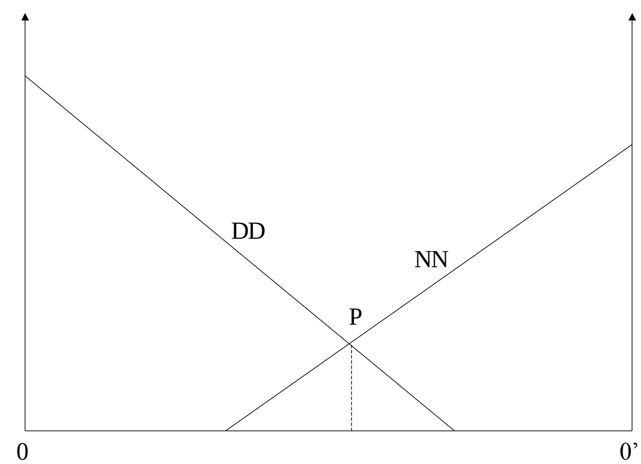


This situation might not be still valid if the water supply level changes over time. In fact, this may involve very different allocations among users. If the water supply is S_1, B does not have any availability of water, while A has the whole amount. This conflicting situation depends by the shape of the two demand curves. The A demand curve is situated above the B curve and this implies that, when supplies decrease, A has to face a higher cost than B. In order to minimize this cost, B has more of the burden of the loss in respect to A. Therefore, in an efficient allocation and when supplies are diminished, users who can easily find alternatives on the use of water receive proportionately smaller allocations than those who have few substitutes.

In the two study cases considered, as stated earlier, there is a strong trade off in the use of water for both rivers between irrigation and instream uses; farmers do not take into account the negative impact on the ecosystem as a result of their extraction of water. Today, this is a serious dilemma and is the number one cause of externalities for the environment and for recreational uses.

Let's consider a typical problem of planning a water budget, consisting in the allocation of a given amount of water among different uses (see figure 2). Considering an average availability of water equal to OO', we can identify an extraction demand (curve DD) equal to the vertical summation of the willingness to pay (WTP), i.e. the water productivity in agriculture. At the same time, it is possible to identify the WTP for instream uses (curve NN) like recreational, fish and wildlife needs. It can be seen from the graph that there is a conflict between the two alternative uses: the usage of water by one party involves a cost on the other party. The efficient allocation can be reached at point *P*, with an offstream consumption of *AO* and an instream quantity equal to AO'. Therefore, the first step to reach this efficient point is the estimation of the two demands.

FIGURE 2 - *Offstream and instream demand for a water flow*



One of the clearest distinctions between environmental goods and ordinary goods is the existence of a market. In the case of an ordinary good, the market allows to observe a variety of prices and different purchases at different price levels. Therefore, it is quite straightforward to deduce the relationship between prices and quantity demanded. It is of course much more difficult to generate a demand curve for water. There is both great interest and great skepticism in attempts to put monetary values on environmental goods.[4] The interest in valuation techniques arises in part from concern that efforts to protect and improve the environment be cost effective. The skepticism has two different sources. First, some people feel that it would be useful to know the economic value of environmental goods, but do not believe that it is possible to measure it accurately. Second, others feel that it is possible to measure economic value, but do not believe

[4] There is an emerging consensus that effective water resources management includes the management of water as an economic resource. The Dublin Statement of the International Conference on Water and the Environment, for example, states that "water has an economic value in all its competing uses and should be recognized as an economic good". The idea of "water as an economic good" is simple. Like any other good, water has a value to users, who are willing to pay for it. Like any other good, consumers will use water so long as the benefits from use of an additional cubic meter exceed the costs so incurred (Briscoe, 1996).

that this is a relevant information for making public decisions regarding the environment (Pearce, 1997).

One of the methods to derive the demand for an environmental good is the "contingent valuation". This technique is quite controversial. In fact, contingent valuation applications are dramatically improving, but the conceptual shortcoming of the adopted methods surveys is the impossibility of creating a realistic and reliable market in which the nonuse commodity is valuated.[5] Contingent valuation technique, the most widely used among stated preference, determines value by asking people their willingness to pay for a change in environmental quality. An alternative method is the travel cost model that is mainly used to evaluate environmental resources associated with recreational activity. Shelby, Johnson and Brunson (1990) have applied both methods for the estimation of the demand for water in the Deschutes River study case, while Massarutto (2000) has applied only the contingent valuation method in the Tagliamento River study case.

The legal and economic implications of creating beneficial instream uses have received extensive attention in the literature and it is demonstrated that leaving water instream can create economic benefits that exceed the benefits from transfers and diversions for offstream uses (Colby, 1990).

The actual Italian situation is characterized by a distribution of property rights that supports farmers since they can extract water without particular constraints. In the western United States, when no more instream rights were accessible, it has become possible to transfer existing properties rights, even though at very high transaction costs. A formal market to transfer water rights for instream uses - just as they are for offstream uses - would be a major step toward facilitating water use transfers to improve stream habitat (Colby, 1990).

If a water market were created to transfer water for instream uses, how might current users react? Agriculture uses nearly 90% of the water consumed in the western United States, often in an inefficient way. With the creation of a market for water, profit-maximizing irrigators will lease their water when it is more valuable in the market than in the crop. A water market can motivate farmers to adopt best technologies to reduce water

---

[5] Since from the early '90s, some events focused interest on contingent valuation and the resulting decisions found that contingent valuation was a reliable method for undertaking estimates of economic damages. Research since then seems to have accelerated the debate over whether contingent valuation can elicit economic choices. The result of this process has been very confused. Most economists outside of environmental economics would likely regard contingent valuation as imprudent. The economists who criticize contingent valuation focus most of their questions on situations where respondents have little experience using the resource and when the source of the economic value is not the result of some in situ use. They argue that stated willingnesses-to-pay from contingent valuation surveys are not measures of nonuse preferences over environmental goods and, thus, reliance on them in either damage assessments or in government decision-making is basically misguided.

loss, making more water available for other uses. This has important implications for the estimation of the demand function for irrigation water. In the short run, since the only alternative to farmers is to fallow the land inefficiently irrigated, the water demand is more elastic that in the long run, in which new technology are adopted and the marginal productivity of water is higher.

3. Property rights protection and water legislation in Italy and United States

In the United States, the current Clean Water Act (CWA) regulatory framework is the result of almost a century of historical development but, despite a great deal of effort resulting in an unquestionable improvement in water quality, much remains to be done in achieving the goals of the CWA.[6] In the western United States when water was first diverted for offstream uses, the economic value of instream flows was really small and reserving water rights for their maintenance was not recognized as a beneficial use of water. Only recently, as the demand for instream flows has increased and created a potential conflict with consumptive uses, it has been recognized the importance of protecting instream flows and implementing policies for their maintenance (Murphy and Howitt, 1998). Instream flow protection has been accomplished in different ways in the western United States and actually there is a big debate about whether and how water markets can be structured to incorporate instream flow demand (Murphy and Howitt, 1998).

Several factors of inefficiency are evident in the actual system of water allocation, especially in the southwestern United States. Reforms are possible and, most of all are needed. A radical transformation is in progress and what used to be a "policy of infrastructure", oriented to the maximum exploitation of resources, it is now turning into a regulation-oriented policy, focused on demand controls and environmental quality standards.

The devastating degradation of rivers, lakes, oceans and seas has worsened everywhere on the planet. Italy is not out of the list and is, at

[6] In order to reach its target, the Clean Water Act declared two goals**,** originally to be met by the mid 1980's, 1) eliminate the discharge of all pollutants into the nation's waters ("zero discharge" goal), and 2) attain water quality levels good for fishing and recreational activities ("fishable and swimmable" goal). To achieve these goals, the act set up five specific policies: 1) the prohibition of the discharge of toxic pollutants in toxic amounts; 2) the provision of federal financial assistance to construct publicly owned waste treatment works (POTWs); 3) the development and implementation of areawide waste treatment management to assure adequate control of sources of pollutants in each State; 4) the development of technology necessary to eliminate the discharge of pollutants into navigable waters; and 5) the development and implementation of programs for the control of non-point sources of pollution.

present, chronically distressed; even the Northern regions, rich in water, now have to face regular periods of drought preceded or followed by ever more catastrophic flooding.

In 1994, the Italian Government passed the law No. 36 (The Galli Law) that realized a structural reform of water management. Ideally, water use should be inspired by three main guidelines: 1) the integration of the whole water cycle with respect to environmental aspects; 2) the economic efficiency in water management; 3) different priority levels in the resource allocation (Weber et al., 2001). The Galli Act explicitly alludes to three different and hierarchical levels: first of all, drinking water, then, during droughts, after having satisfied demand for drinking water, water should be supplied for environmental and agricultural uses, and finally, industrial uses (e.g., in case of persisting water emergency, the hydro-electrical water storage should be depleted). This shows that the Italian approach to water management is similar to the American legislation and, in general, to other international legal systems.

The actual Italian legislation concerning water resources, even though is the result of several improvements and amendments, is still highly fragmentated. In terms of Article 2 of the 1994 Water Law, water use for human consumption takes precedence on other uses. Article 9 of Royal Decree (R.D.) No. 1775 of 1933, states that if there are two or more applications competing for the same water, preference is given to the application which makes for the most effective use, having regard to the quantity and quality of the water resources to be used and to the amount of water returned to the stream after use. All other things being equal, preference is given to the applicant first in time. When water is needed for agricultural purposes, all other things being equal, preference is given to the landowner.[7] Under the terms of article 35 of Royal Decree No. 1775 of 1933, concessions for the abstraction and use of water attract payment of a charge, which varies according to the purpose for which water is used.[8] Italian local governments are mainly responsible for fixing water abstraction charges (following explicit guidelines provided by the national

[7] Under the terms of Articles 17 and 56 of Royal Decree No. 1775 of 1933, a license or a concession is needed in order to abstract and use water resources. A license is granted under these conditions: the water abstracted is less than 100 liters per second; the minimum flow of the watercourse is maintained; no harm is caused to existing water uses; the banks and levees are not harmed. Concessions are granted for "major" and "minor" abstractions of water. The following are regarded as "major" abstractions (Article 6 R.D.): for hydropower purposes, the generation of power in excess of a mean annual Kw 3000; for drinking water supply purposes, abstractions in excess of 100 liters/second; for irrigation purposes abstractions in excess of 1000 liters/second, or a lesser amount if this is sufficient to irrigate more than 500 hectares of land; for industrial purposes, abstractions in excess of 100 liters/second; for aquaculture purposes, abstractions in excess of 100 liters/second.

[8] Unit rates are established in the law itself.

Government)[9] and for exercising such functions as the regional governments may delegate or devolve to them.

Both countries, United States and Italy, have a long and similar history in the way property rights for water uses have been managed along time. In the Italian experience and according to “Galli Law”, as we have seen, there is a system of priorities that administers the allocation of the water supply. In fact, under the Italian law the primary need to be satisfied is the urban demand, followed by irrigation uses and ultimately instream uses. Instead, the legislation that governs and regulates water use in the western United State gives every landowner the right to divert a specified amount of water into their land, as long as they can claim that it is for a beneficial use. Historically in the U.S., instream water uses were not recognized as having any beneficial use but with the considerable change in the ecosystem due to the level of offstream diversions, the need for re-thinking this water policy has become so important that, some states have recently passed legislation declaring instream flow a beneficial use (Anderson and Snyder, 1997).

Since the 1890s, water in Oregon has been distributed on a "first come, first served" basis. The first person to use water from a stream is granted a "water right." The next in line gets what is left, and so on until there is nothing left to distribute. These water rights last forever, and are tied to the land. Unfortunately, in many cases, in the United States the water flow of streams has already been fully appropriated, and the recognition of instream flow as a beneficial use is meaningless since there is no unallocated water. A feasible solution would be to transfer these rights from existing uses to instream uses through a formal market. Optimizing water allocation requires that the net marginal value of a unit of diverted water equals the sum of the net marginal values of nonconsumptive uses. Allowing private parties to purchase existing consumptive rights for instream purposes, is just an example of how to overcome the problems with private provision of public goods (Anderson T., Donald L., 1989).

4. Study cases

4.1 Case 1: The Tagliamento River

Even though the Friuli Venezia Giulia is one of the richest regions of Italy for water, the lack of natural storage - big lakes and glaciers - is one of the principal reasons for the irregular seasonal flows. In fact, despite the abundance of water there exists a very problematic situation: the

[9] Article 13 of the 1994 Water Law.

availability of water for irrigation is highly variable following the seasons.[10]

In Italy a consortium administers the management of the water at the local level. The consortium's willingness to pay (WTP) for taking the water from the Tagliamento River and the WTP for other uses in order to leave the water in the river have been estimated in a study by Massarutto (2000). The reconstruction of the consortium's demand has been effectuated[11] from the transformation value of the water utilized for irrigation purposes and for hydropower production. The Tagliamento River section in the valley is known, mainly, for bathing and sports fishing and this creates a strident conflict between the offstream and the instream uses for recreational purposes. On several occasions, the capacity of the river in the period of greater flow was reduced practically to zero, causing a massive disturbance for the ecosystem and population. The average capacity available in the rainy season is about 80 m^3/s; in the dry years, however, this capacity is reduced to less than 15 m^3/s. In the absence of specific constraints and in situations like these that take place with a frequency of at least 5%, the Consortium can capture for the entire capacity of the river.

The consortium integrates the supply with groundwater during the period of hydrological stress. Even during the non-irrigation period the consortium releases into its own network a large amount of water; this guarantees the operation of the hydropower stations located along the river, of the local firms and maintains activity through all of the channel system. The building of the main network of canals dates back to the years between 1878 and 1881. Therefore, the current allocation of property rights dates back to this period for the use of the water from the river, later ratified in concessions of public water derivation according to the 1993 general law. To determine the answer of the corn's production to the water contribution the so-called '*Mischerlich function*' has been used (Giardini and Borin, 1985):

$$R = R_m * \left[1 - 10^{-c*(b+v)}\right] * 10^{-k*(b+v)^2}$$

This function demonstrates the relationship of the crop's yield with the total volume of utilized water. In particular: R = crop's yield; v = seasonal volume of irrigation; R_m = maximum crop's yield obtainable limit when k=0; c = coefficient that indicates the velocity with which R tends to reach Rm; k = coefficient that indicates the tendency of R to decrease after reaching the highest value; b = water quantity naturally available for crop.

The parameters of the demand's curve have been estimated in this:

$$R = 150\ [1-10^{-0.0013(324.97\ +\ v)}]$$

[10] The two crops that primarily grow in the low plains surrounding the Tagliamento River are corn and soy. Of lesser importance are the cultivation of wheat, sunflowers and beet.

[11] Only the short-run analysis has been considered.

By multiplying the former function by the corn's price and deriving this last one and multiplying it by the number of the irrigated hectares it has been possible to get the total willingness to pay:

$$€ = 128.444* [10^{-0.0013*(324.97 + v)}]$$

From this analysis it is possible to see what the decreasing willingness to pay is for the agricultural sector in order to obtain the willingness to pay for water for irrigation purpose.[12] Massarutto analyzed what happens in "normal" situations, characterized by a medium rainfall, and in periods of drought, where rainfall is particularly low. In the latter case, the scenario changes remarkably.[13]

In analyzing the hydroelectric sector and proceedings in a similar way, the author estimated a WTP relative to different scenarios of prices of the electric power.[14] Summing the two demand's curve for the irrigation sector and the hydropower section, it comes out that the situation is significantly different in "normal" and in "dry" years; in "normal" years, no conflict exists (since the remaining capacity after the consortium derivation is sufficient to guarantee the viability of the instream uses). The situation changes drastically in "dry" years, during which the capacity is severely reduced and the consortium would withdraw at least as the double the water volume.

About the economic value of recreational activities, obtained by analogy with the results of contingent valuation conducted in similar studies on instream uses, the author assumed that the demand has an asymmetric course (extremely inelastic for the recreational uses and tending abruptly to zero beyond such level). Therefore, when the available capacity is extremely low, the willingness to pay for irrigation uses is greater than the willingness to pay for recreational uses. It turns out the convenience to attribute the concession to the consortium, non-without capacity's constraint, but with the obligation to the release of the vital minimum outflow. For greater capacities, conflicts would not have to be verified. For intermediate capacities, the recreational use seems to be

---

[12] So, for example, to achieve the first marginal unit of water for irrigation, the sector would be willing to pay – to the gross of necessary costs to get and use water – about € 57.000; to obtain a quantity of marginal water equal to $10m^3$/sec it would be willing to pay about € 17.000, and so on until the last marginal unit (with which it is reached 25.5 m^3/sec) for which the sector would pay about € 3.500.

[13] In both the cases the use cost of water has been subtracted to the marginal gross WTP. The use cost of water is supposed to be a cost variable with the consumed quantities. In this research, the authors have considered a variable cost around 0.02 €/m^3 as acceptable. This cost would make it rational for the agriculture sector to have a WTP for water for irrigation correspondent to a withdrawal equal to the actual concession.

[14] Three scenarios have been assumed: one very pessimistic, corresponding to the recognized price for the cession to the Authority (ENEL) for thermo electrical energy; the other one relative to the currently cession price of energy from renewable sources of energy; and the third one, that takes into consideration the hypothesis of cession to "suitable customers".

prevalent: it would be opportune, hence, to release the quantity necessary to satisfy the bathing use, reserving to the consortium only the residual capacity.

4.2 CASE 2: THE DESCHUTES RIVER

Like Tagliamento River, low instream flow during various times of the year is a major concern in the Deschutes River. The irrigation districts hold sufficient water right to dry up the river during the summer, but they have agreed to leave a certain amount of water in the river (about 30 cubic feet per second) during the irrigation season. But the flow recommended to meet recreational, fish, and wildlife needs is 250/cfs throughout the year (Oregon Water Resources Department). Water supply in the Deschutes basin depends on winter snow pack in the nearby Cascade Mountains.[15] Snow pack has varied considerably, resulting in variability in irrigation water. Water diversions in the Deschutes Basin have grown so large that entire sections of some rivers and streams run dry. While irrigation remains by far the biggest water user in the Deschutes Basin - accounting for over 90 percent of water withdrawals - the greatest new threat is Central Oregon's explosive population growth.

The economic evaluation of water management of the Deschutes River has been assessed in two papers. Turner and Perry (1997) in their article tried to estimate the water supply curve, i.e. the amount of water that would be possible to bid away from farmers, using a stochastic programming with recourse model (SPR). Since water availability is highly unpredictable, this SPR model has the nice property of modeling sequential decisions intermingled with risky events. Furthermore, this parametric mathematical programming is commonly used to estimate price quantity relationships when market data do not exist. With this study Turner and Perry want to address three issues: first, the quantity of water that can be bid away from agriculture if a water market was created; then, who should free up water for instream uses; and finally how cost effective is canal lining compared to changes in farm irrigation technologies.

Following the standard methodology, this paper analyses three leasing and irrigation management scenarios. Under *Base*, only the irrigation systems that are currently widely used in the area (furrow and sidereal) are hypothesized. The second, *Alltech*, allows farmers to adopt any feasible irrigation technology and crop rotation combination, but requires acreage to be fallowed. The third, *Conserve*, introduces the

[15] Regarding the sources of the Deschutes River, they come from the central Cascades and flows eastward, then northward to the Columbia River. Crops produced in this district include garlic seed, carrot seed, bluegrass seed, peppermint oil, wheat, alfalfa hay, grass hay, grain hay, and pasture.

Oregon's water conservation program. Under this program farmers can sell water saved from adopting a water-conserving technology. Model results were compared to the costs and benefits of lining district canals[16].

The authors derived the water supply curves in the long and short run as the minimum price that irrigators would be willing to accept in order to lease their water away (at each point on the supply curve is the profit maximizing combination of total water leased annually for commercial agriculture).

The *Base* supply curve illustrates supply without adopting any new water-conserving practices. Water is generally elastic from 0$ to 25$/acre-foot. Over 30,000 acre-feet it could be purchased at 25$/acre-foot, which would be over one-third of the critical amount of instream water needed to support recreation, fish, and wildlife. With so few water-conserving options, the model seems to suggest that pasture, alfalfa, grain and grass hay should not be produced. Under *Alltech* and *Conserve*, more technologies to conserve water are available. However, since these technologies will reduce the production costs for the farmers, water will become more valuable to farmers and it will cost more to bid water away from agriculture.

Lining canals to reduce delivery losses is another possible solution to increase the resources of water. This option can provide a great deal of water to a water market in a narrow price range. More than enough water to meet the 80,000 acre-feet requirement for fish, wildlife and recreation purpose could be obtained for $60/acre-foot.

From the analysis of the average annual water supply for short-term lease agreements, it is possible to observe that the crop produced and irrigation strategies followed are very similar to the long-term lease, but now more water could be supplied for instream use at a lower price than before. Farmers could lease excess water in high water years at low prices, because sufficient water would be available to also produce a good crop. Canal lining represents an investment that conserves water regardless of the water supply in the Deschutes basin.

A shortcoming in this study is the lack of an evaluation of the other side of the water market in the Deschutes basin, i.e. the demand for instream uses. Shelby, Johnson and Brunson (1990) analyzed the economic value of the recreational activities on the Deschutes. Among these recreational activities, fishing is considered a highly important reason to visit the Deschutes by 45 percent. The boating season is long, but use is concentrated during the summer months. More than two-thirds of all visitors camp usually for two or three days. Boaters travel in average 109 miles one way to reach the Deschutes.

---

[16] Presently the districts have large (up to 50%) delivery losses from operating unlined canals over lava rock and porous soils.

Estimates of the economic value of a trip to the Deschutes were calculated using both the Travel Cost (TCM) and Contingent Valuation[17] (CVM) methods. The average response to the CVM was $4.72 per person per day.[18] The TCM calculation was based on the number of responses from each of 22 origin zones. The nearest zone is centered on The Dalles, 36 miles from the river, and the farthest on Seattle, 271 miles away. Total Direct Cost (TDC) of making a trip to Deschutes were calculated as follows:

$$TCD = [(D_r)\ (C_m/3\ \text{person/vehicle})] + [(D_r/50\text{mph})^*\ (C_t)^*(Y/2080\ \text{hrs/yr})$$

where D_r = round trip distance from zone centroid to put-in; C_m = mileage cost; C_t = opportunity cost of time (fraction of wage rate) and Y = median reported per-capita income for zone.

Several regression models were fit for different assumptions about mileage costs and the opportunity cost of travel time. The average age of the respondents in each zone was the only variable, which contributed significantly to the prediction of the number of visits, together with TCD. The Rocky Mountains Travel Cost program (Rosenthal *et al.*, 1986) was used to derive a second stage demand curves and the average consumer surplus per trip. Estimates ranged from $4.46 per trip using the variable cost calculation to $29.67 per trip using the most traditional assumptions. Since a typical Deschutes trip lasts about two days, TCM results should be reduced approximately by half, for comparison with the CVM calculation.

A major shortcoming in this study is that it is not possible to effectuate a complete economic analysis in view of the fact that the two researches are not comparable. In fact, the Turner and Perry' analysis try to measure the beneficial use of water as the amount of acre-feet of water that farmer are willing to lease away for a given price. Conversely Shelby, Johnson and Brunson analyze the demand for recreational use as number of trips to the site and the individual cost. The considered valuation techniques have strengths and weaknesses, and the decision on which valuation technique to use for a particular application requires experience and judgment on the part of the analyst.

---

[17] The CVM calculation was based on the following survey question: "As a boater on the Deschutes you currently a fee of $1.75 per person per day. If this fee were to increase, at some price you probably would not purchase a pass. What is the maximum amount you would pay per day for access to the river? Although this question asks you to place yourself in a hypothetical situation, please try to answer it as realistically as you can. Your answer will not affect permit prices on the Deschutes.
The most I would pay for a permit for river access is $_____ per day".

[18] An "open ended" question format was used. This method is susceptible to hypothetical bias, which may occur because users are unable to specify an appropriate price in situations where there is no familiar reference price to use as a basis for comparison. In fact, market conditions can be better simulated by a dichotomous choice format, in which respondents are presented with a single price and asked if they would pay that price or not (Bishop and Heberlein, 1992).

5. CONCLUSIONS

From the comparison of the two study cases it is possible to observe that if more weight could be given to the instream uses, particularly to the recreational uses, a more efficient allocation of water resources will be reached. The instream rights that exist, even though are quite few compared to the rights for consumptive uses, have a lower priority than the consumptive rights. This means that in periods of low water flow, the water can be withdrawn for consumptive uses and the water left for fish habitat or recreational purposes is underestimated. This underestimation is not unavoidable, as some fishermen have discovered (Anderson, 1983). In the Yellowstone River Valley in Montana, for example, several spring creeks are entirely contained within the boundaries of property owned by a single landowner. Landowners can sell the daily fishing rights since these creeks are not subject to the same legal regulations as waterways crossing property boundaries. The revenues from the sales represent an incentive to protect the fish habitat. In England and Scotland, markets are relied upon to protect instream uses more than they are in the United States. Private associations have been formed to purchase fishing rights from landowners. Once these rights have been acquired, the associations charge for fishing, using some of the revenues to preserve and to improve the fish habitat (Tietenberg, 1992). Because the existing regulatory system creates large inefficiencies, moving to a more efficient allocation of water, will necessarily increase the net benefits.

The main finding of the comparison between the two study cases is, therefore, that there is potential social gain for the institution of a water market to improve on the actual situation. Governmental authorities should provide incentives to generate a much more effective set of policy instruments, including those based on economics incentives (e.g., increasing farms' irrigation efficiency and improving districts' delivery systems through improvements of the existing technology and management systems). It is possible to believe that the ongoing market scenario provides good opportunities for adopting more complex policy actions.

The protection of instream values could be enhanced by a) recognizing that instream values can be higher than the benefits generated by offstream uses, b) allowing private parties to appropriate or purchase water rights for the purpose of maintaining instream flows, c) legislating authority and funding to state and local government to acquire water rights for instream flow maintenance, d) clarifying the criteria necessary to change the purpose of a water right from a consumptive use to instream flow maintenance in order to reduce transactions costs and uncertainties for both instream and offstream water users (Colby, 1990).

The most important challenge that the both the United States and Europe face is the management of their water. A perhaps more formidable challenge still is monitoring the compliance of water users with the law in general and with the terms and conditions of the licenses and permits' system, in particular (FAO, 2001). In September 2002 the Oregon Water Resources Commission adopted new rules for the Deschutes Basin that were supposed to mitigate the harms from water pumping. Unfortunately the new rules abandon the State's responsibility to protect the river and instead focus on making it easier to get water rights.

The overall goal of an efficient and equitable system for sharing stream flows between consumptive and non-consumptive uses, with provision of sufficient water to meet environmental needs is, nevertheless, more urgent in the Italian situation, where the forthcoming entrance into effect of a new European legislation (Water Framework Directive) will involve a significant change in the structure of the current water management.

ANNA RITA GERMANI

Institute of Economics and Finance, Law School - University "La Sapienza"of Rome, Italy

REFERENCES

ANDERSON, T.L. (1983), *Water Crisis: Ending the Policy Drought*, Washington, D.C.: Cato Institute.

ANDERSON, T.L. and L. DONALD (1989), "Building Coalitions for Water Marketing", *Journal of Policy Analysis and Management*, 8:432-445.

ANDERSON, T.L. and P. SNYDER (1997), *Water Markets: Priming the Invisible Pump*, Washington, D.C.:Cato Institute.

BISHOP, R.C. and T.A. HEBERLEIN (1992), *The Contingent Valuation Method*, in K. M. Ward and J. M. Duffield (eds.) *Natural Resources Damages: Law and Economics*, New York: John Wiley & Sons, 281-309.

BRAJER, V. et al., (1989), "The Strengths and Weaknesses of Water Markets as They Affect Water Scarcity and Sovereignty Interests in the West", *Natural Resources Journal*, 29: 489-509.

BRISCOE, J. (1996), *Water as an Economic Good: the Idea and What it Means in Practice*, The World Bank, paper presented at the World Congress of the International Commission on Irrigation and Drainage, Cairo.

COLBY, B.G. (1990), "Transaction Costs and Efficiency in Western Water Allocation", *American Agricultural Economics Association,* 11184-92.

EUROPEAN COMMISSION (1999), *EU Focus on Clean Water*, European Communities.

FAO (2001), *Water Rights Administration – Experience, Issues and Guidelines*, Development Law Service, FAO Legal Office.

GIARDINI, L. and M. BORIN (1985), "Proposta Metodologica per l'Esame delle Curve di Risposta Produttiva all'Irrigazione", *Rivista di Agronomia*, 4.

HARTMAN, L.M. and D. SEASTONE (1970), *Water Transfers: Economic Efficiency and Alternative Institutions*, Baltimore, MD: Johns Hopkins Press,.

HOWE, C.W., J.K. LAZO, and K.R. WEBER (1990), "The Economic Impacts of Agriculture-to-Urban Water Transfers on the Area of Origin: A Case Study of the Arkansas River Valley in Colorado", *American Journal of Agricultural Economics*, 1200-1204.

MACDONNELL, L.J. (1990), "Shifting the Uses of Waters in the West: an Overview. In Moving the West's Water to New Uses: Winners and

Losers". Proceedings of the 1990 Annual Summer Program, University of Colorado, Natural Resources Law Center.

MASSARUTTO, A. (2000), "La valutazione Economica della Domanda di Acqua in Agricoltura: Un'Analisi di Breve Periodo", University of Udine, *Working Paper*.

MILLIMAN, J.W. (1959), "Water Law and Private Decision-Making: A Critique", *Journal of Law and Economics*, 2:41-63.

MURPHY, J. and R. HOWITT (1998), "The Role of Instream Flows in a Water Market". Proceedings of the World Congress of Resource and Environmental Economists, Venice, Italy.

PEARCE, D. et al. (1997), *Economic Values and the Environment in the Developing World*, London: Edward Elgar.

ROSENTHAL, D.H., D.M. DONNELLY, M.B. SCHIFFHAUER and G.E. BRINK (1986), *User's Guide to RMTCM: Software for Travel Cost Analysis,* USDA Rocky Mountain Research Station, Colorado: Fort Collins.

SHELBY, B., R.L. JOHNSON and M. BRUNSON (1990), *Comparative Analysis of Whitewater Boating Resources in Oregon: Toward a Regional Model of River Recreation,* Water Resources Research Institute, Oregon State University.

SOLLEY, W.B. (1993), *National Handbook of Recommended Methods for Water Data Acquisition*, USGS.

TIETENBERG, T. (1992), *Environmental and Natural Resource Economics*, New York: HarperCollins Publishers Inc.

TURNER, B. and G.M. PERRY (1997), "Agriculture to Instream Water Transfers Under Uncertain Water Availability: A Case Study of the Deschutes River, Oregon", *Journal of Agricultural and Resource Economics* 22.

WEBER et al. (2001), "Lexicographic Optimization for Water Resources Planning: the Case of Lake Verbano". Proceedings of the iEMSs 2002 Conference, Lugano, Switzerland.

ABSTRACT

The management of water resources is an important tool of environmental economics that is changing from a water-supply to a water-demand system. The importance of such transformation has to be found mainly in the way in which potential conflicts between offstream and instream uses are decided. In this study are presented the potential relationships between two similar cases in two different countries, the Tagliamento River in Italy, and the Deschutes River in the United States, and it is demonstrated that modifications to water allocation system are strongly desirable and would improve protection for instream flow values. After having analyzed the way in which water property rights and water legislation have been managed in both countries, it is concluded that if more weight could be given to the instream uses, particularly to the recreational uses, a more efficient allocation of water resources will be reached.

JEL Classification: N50, Q25, Q26