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Irrigation in the Mediterranean countries is an essential requirement for agricultural production, while water for agriculture is used only marginally in central and northern European countries. There are significant pressures on water resources and aquatic ecosystems in Spain, Italy and Turkey because of the very large areas under irrigation, with a combined annual water demand close to 80,000 hm^3. Irrigation development in these three countries has been driven by large and sustained public investments in water projects to store, transport and distribute water to irrigation fields. In addition, there have been large increases of groundwater extractions in Italy and Spain during the second half of the twentieth century. The escalation in groundwater extractions has been driven by the falling costs of pumping technologies, especially in areas with profitable irrigated crops. In contrast to the large collective irrigation systems, these private groundwater extractions are not subject to much control by the water administration.

In Italy, pervasive aquifer overdraft and water quality problems are located in the Po basin, Romagna and Puglia, and in the coastal plains of Campania, Calabria and Sardegna. Highly profitable fruit and vegetable production, based on individual pumping from aquifers, takes place mainly in the Po basin and in Emilia-Romagna. In these regions, the problem is not so much of water scarcity, but of water quality.

In Spain, the most severe scarcity and quality problems occur in the Southeastern Iberian Peninsula. A dual situation exists for irrigation in Spain. In one case, inland irrigation districts are based on collective surface irrigation systems and low value crops, and water resources degradation is moderate. The reason is that the basin authorities regulate water extractions, and the aquatic ecosystem is protected to a certain extent. In the second case, high-value crops, such as fruits and vegetables, are grown primarily in the Mediterranean coastal areas, which rely on individual pumping from the aquifers. There is a lack of effective control on groundwater extractions, both from the legal and illegal wells, and on the volumes of water extracted. Decades of mismanagement of water in these areas have resulted in severe scarcity and degradation of water resources.

There are two general policy approaches when dealing with quantity and quality problems faced by the Mediterranean irrigated agriculture. One is the traditional water policy based on the continuous expansion of water supply, and the other is a comparatively new approach based on water demand management initiatives. These emerging initiatives rely on measures such water pricing, revision of water rights, abstraction limits on surface and groundwater, development of regulated water markets, and water resources reuse and recycling.

A good illustrative example of the conflict between these two approaches is the type of solutions that have been considered for solving water scarcity and degradation in Southeastern Spain. Two projects have been proposed in the last four years: the Ebro interbasin transfer and the new AGUA project designed to replace the Ebro transfer. Both projects rely on the traditional approach of expanding supply with subsidized public investments, and both are questionable on economic grounds.

However, measures based on the new approach of water demand management initiatives require careful application and a reliable information base, since implementation of these measures is a complex process that meets with resistance from farmers. Banning aquifer overdraft is very difficult to achieve, since aquifers are a common resource, and thus pose significant managerial challenges. Water pricing is also difficult to implement because of farmers' opposition to price increases, lack of administrative control on aquifer pumping costs, and non-response of water demand to water pricing in aquifer areas with high-value crops. Establishment of water markets is another difficult task, because institutional reforms require major and persistent efforts, and because farmers distrust such schemes.

Augmenting water supply in the Mediterranean coastal areas by publicly financed desalination is a much simpler option, but it will mean ensuring that irrigation water is not subsidized and the farmers are obliged to pay high desalination costs. Currently, farmers are extracting water from aquifers at pumping costs that are lower than desalination costs. Thus, it is somewhat unlikely that farmers will not buy desalinated water. Public investments in desalination plants can be justified only under a strict enforcement of an aquifer overdraft ban by the water authority, which would force farmers to buy desalinated water.

The quality problems faced by the Mediterranean agriculture are illustrated in the second example presented here, which deals with nonpoint pollution abatement from the agricultural sector. This example shows that nonpoint pollution control instruments cannot be accurately assessed without a correct understanding of the key underlying biophysical processes. Neglect of these processes may lead to adoption of incorrect policy measures.

Water Framework Directive and Mediterranean irrigated agriculture

The European Union approved the Water Framework Directive to protect all continental, coastal and subsurface waters. The objectives of the Directive are to improve water quality and ecosystems conditions, promote sustainable use of water, and reduce discharges to water bodies. Water pricing should approximate full recovery costs in order to improve water use efficiency, by including extraction, distribution and treatment costs, environmental costs and resource value costs. It requires a combination of discharge limits and water quality standards, with deadlines to achieve good status for all waters.

The European Water Directive has the potential to solve water scarcity and nonpoint pollution in the Mediterranean countries. This initiative is supported by the findings of the European Environmental Agency, which point to agricultural nonpoint pollution as the primary cause for water quality deterioration in many European watersheds (EEA 1999 and 2003). However, the reliance of the Directive on water pricing to curb demand may fail in the Mediterranean countries such as Spain and Italy, where high irrigation demands and quality problems are compounded by water scarcity.

Water pricing is unlikely to solve scarcity or improve quality in the more degraded areas, because rising water prices would reduce consumption in the large irrigation districts of inland Spain or southern Italy, based on collective systems and low-value crops, where degradation problems are moderate. But water demand will not respond to higher prices in areas based on individual aquifer extractions for the Mediterranean high-value crops, where pressure on water resources is pervasive and degradation is severe (Massarutto 2003).

Water pricing will fail as a workable policy for curbing demand for several reasons. The first is that, after decades of mismanagement, the number of illegal private wells is very high and there is no control over the volumes of water pumped from either legal or illegal wells. Consequently, it is almost impossible to implement a tax on water pumped from aquifers. A second reason is related to the water price level that is needed to curb demand. In Spain, shadow prices of water in coastal areas under greenhouse production can reach 3 to 5 €/m^3, against 10-20 cents €/m^3 in inland Spain, while current water prices in coastal areas are between 6-21 cents €/m^3, compared to 2-5 cents €/m^3 in inland collective irrigation systems. With urban prices in Spain close to or below 1 €/m^3, and seawater desalination at around 50 cents €/m^3, it would seem unacceptable to set agricultural prices in water scarcity areas above urban and desalination prices. Though a policy designed to control aquifer overdraft would be quite difficult to implement, a water pricing policy that would drive prices above the 3-5 €/m^3 shadow price for private extractions would be impossible to implement, both because of its technical and administrative unfeasibility and the daunting prospect of social opposition from the farmers. These more degraded areas will require other Directive instruments, such as controlling aquifer overdraft by reducing concessions, and enforcing quality standards and pollution discharge limits.

These facts indicate that the Water Framework Directive would be difficult to implement in the Mediterranean countries. The issue is the following: water pricing is *technically* (but not *politically*) feasible at least for the collective irrigation systems managed by the basin authorities, but measures to control aquifers extractions are much more difficult to implement. The information needed by the policymakers includes rates of aquifers recharge and pumping by the farmers, discharges from activities using both surface and groundwater, soils, transport and fate processes, pollution to the environment, and ecosystem damage costs. This information is not available in developed or developing countries with significant irrigated agriculture, and is neither available in the Mediterranean countries such as Spain, Italy, Portugal, Greece and Turkey. Without this information base, it is impossible to design reasonable control measures to prevent aquifer overdraft and reduce nonpoint pollution. The consequence will be that water pricing measures suited to reduce industrial and urban demand, which are paramount in northern and central European countries, would be implemented for irrigation in the Mediterranean countries, instead of the measures that are really needed.

Even under the now binding Water Framework Directive, policy formulation in Spain shows that the traditional approach of increasing water supply remains the main option for water policy initiatives. The recent Ebro water transfer project and the new AGUA project, highlight the weaknesses of this traditional approach in Spain.

Example of the Ebro transfer

The Ebro interbasin project was intended to solve the acute water quantity and quality problems of southeastern Spanish basins. The main argument against the Ebro transfer was the need for new policy initiatives based on reasonable management measures. A research effort was undertaken (Albiac et al., 2003 and 2006) to evaluate alternatives to the Ebro water transfer. In the first alternative, a strategy was analyzed in which groundwater overdraft was forbidden, and there were no transfers of water from external basins. In the second scenario, a price increase is considered in order to find the price level that could balance water demand with the available water resources in the Southeastern basins. This scenario follows the full recovery cost principle of the Water Framework Directive. The third alternative was to expand water supply with transferred water from the Ebro, linked to water subsidies to maintain the present low irrigation water prices. The fourth alternative combines water trading among counties with prohibition of aquifer overdraft. Water trading may take place along present conveying facilities of main rivers and canals, allowing for additional supply of desalinated water. Desalinated water is considered in coastal counties that exhibit very high shadow prices of water.

The results from each water management alternative are summarized in Table 1. Under the present baseline scenario, quasi-rent is above 1,700 million €, which is reduced to around 1,400 million € by raising water prices to 0.12 €/m^3, and to 1,300 million € by raising water prices to 0.18 €/m^3. Banning groundwater overdraft reduces quasi-rent to 1,300 million €. Under the combined alternative, quasi-rent exceeds 1,600 million € which is larger than under any other demand management measure. The Ebro transfer project maintains current quasi-rent of farmers, but requires 300 million € in subsidies to keep the low water prices currently charged to farmers.

Table 1. Water and quasi-rent scenarios for southeastern basins.

	Júcar basin	*Segura basin*	*Sur basin*	*Total Southeast*
Current Water Demand (hm^3)	1,450	863	232	2,545
Water demand reduction for agricultural use by…				
...banning groundwater overdraft	139	213	70	422
...increasing 0.12 €/m^3 water prices	313	142	54	509
...increasing 0.18 €/m^3 water prices	350	181	74	605
...combined alternative (overdraft ban, water markets, desalination)	139	213	10	362
Current Quasi-rent (million €)	586	536	589	1,711
Quasi-rent losses to farmers by...				
... banning groundwater overdraft	46	101	261	408
... increasing 0.12 €/m^3 water prices	166	94	27	287
... increasing 0.18 €/m^3 water prices	232	136	37	405
... combined alternative (overdraft ban, water markets, desalination)	39	49	-5	83
Subsidies needed for the Ebro Project…				
… to cover gap between costs of transferred water (0.20 to 1.05 €/m^3) and present low water prices	54	187	60	301

A sharp reduction in water demand is achieved by raising irrigation water prices in the range 0.12-0.18 €/m^3. The current annual 2,550 hm^3 of water demand for irrigation falls by 500-600 hm^3, but the costs to farmers in quasi-rent losses are also quite high in the range 300-400 million €. Prohibition of groundwater overdraft is the worst solution because the fall in annual water demand is only 400 hm^3, considerably below the reduction achieved by raising prices, whereas costs to farmers are higher than under the water pricing alternatives. The combined alternative of banning overdraft, water markets and desalination, reduces the annual irrigation demand by almost 400 hm^3 at a much lower cost, less than 100 million € in terms of farmers' quasi-rent. The combined alternative also secures an end to aquifer overdraft.

This combined alternative of banning groundwater overdraft, allowing water markets among counties and expanding water supply by seawater desalination, is a very good alternative that improves with any other demand management measure and is superior to the Ebro transfer project that the former Spanish government was planning to implement.

Some caveats should be made on the difficulties of implementing demand management measures. Decades of water resources mismanagement in the southeastern basins of the Iberian Peninsula have created pervasive pressures on both water quantity and quality. The measure of banning aquifer overdraft is very difficult to implement since there is currently no effective control on the number of wells or the volumes of abstractions.

Water pricing measures are also difficult to implement for the following reasons: i) farmers will oppose price increases; ii) basin authorities could increase the water prices charged to collective irrigation systems with surface water, but they have no control on costs incurred by individual farmers for pumping from the aquifers; iii) even if water pricing could be implemented for individual abstractions, raising water prices will not reduce demand in irrigated areas, based on greenhouse production with very profitable crops. The example is the shadow price of water in Campo Dalías, where prices should escalate above 3 €/m^3 from current 0.21 €/m^3, in order to curb demand.

Establishment of water markets is also a difficult task. Although there are informal water transactions, the possibility of formal water markets introduced by the 1999 reform of the water law, has not spurred any significant trades during the last five years. The reason is that farmers distrust formal water markets.

Augmenting water supply by desalination with public financing is a much simpler option, but the problem is the effective irrigation demand if water is not subsidized and farmers face the high cost of desalinated water. The potential for desalination can be seen by its effective demand, which reaches almost 400 hm^3 per year in coastal counties of the area. Currently, farmers are extracting water from aquifers at pumping costs around 0.09-0.18 cents €/m^3. Since pumping costs are considerably lower than desalination, farmers will not buy desalinated water. The public investments is desalination plants are only reasonable under a strict enforcement by the water authority of aquifer overdraft prohibition, that would force farmers to buy desalinated water.

This last point summarizes the problem faced by the new AGUA project that is supposed to substitute the Ebro transfer. The AGUA project includes investments of 1,200 million € to build a desalination capacity of 600 hm^3, with around 300 hm^3 for irrigation in coastal counties. As indicated above, there is an hypothetical effective demand in these counties amounting to 400 hm^3, but implementation of the AGUA project requires the strict control of aquifer overdraft, and this will be a daunting challenge for the water authority. The risk of the AGUA project is that public funds will be invested in desalination plants, but the irrigation demands may not materialize.

Example of agricultural nonpoint pollution control

Agricultural nonpoint pollution is a complex issue requiring information on pollution emissions at the source, transport and fate of the pollutants, ambient pollution loads and their damage costs. Moreover, the physical, economic and social dimensions of the problem are such that they require multi-disciplinary and multi-scale approaches. In the case of Spain, nonpoint pollution is addressed at present by both domestic and European agricultural and environmental policies. The main current policies are the domestic National Hydrological Plan and National Irrigation Plan, and the European Union's Common Agricultural Policy, Water Framework Directive and Nitrates Directive. The consistency of these policies to abate pollution is far from evident and difficult to assess. An example of their inconsistency is the nonpoint pollution impact of higher water prices advocated by the Water Directive, which is discussed below.

The information presented here comes from the study by Martínez and Albiac (2004). These authors indicate that their results are limited and do not cover the whole range of factors affecting agricultural nonpoint pollution. The CAP reform of 2003 and further trade liberalization by the EU will change land use patterns for irrigated agriculture. Both abandonment and a more intensive use of irrigated land are expected, depending basically on the availability of human and capital resources in agricultural regions. More intensive irrigated agriculture is likely in the Mediterranean coastal areas of Spain, while inland collective irrigation areas are expected to stagnate. Another limitation relates to the range of pollution instruments considered. This is the case of wetland creation or recovery, which is an efficient instrument for large nitrogen abatement reductions (Ribaudo el al. 2001).

Among the different nonpoint pollution issues, the present discussion focuses on the appropriate base instrument for nitrogen pollution abatement, which requires information on the underlying biophysical processes. This is a key question for the design of policy measures, and, in particular, for the design of the Programme of Measures of the Water Directive. The acute scarcity of information for the Mediterranean agriculture, on the biophysical processes involved in pollution and the associated damage costs, means that measures cannot be reliably assessed.

Evaluation of the efficiency of alternative nitrogen abatement measures requires the consideration of biophysical aspects linked to the dynamics of nitrogen in the soil, including crop type and soil class. The effects of selected abatement measures were examined through a dynamic model, which included six crops and one representative soil, in the Flumen-Monegros irrigation district located in the Ebro basin of Spain. Ranking the nitrogen control instruments by their cost efficiency contributed to the information needed in the policy decision process. The results obtained agree with previous literature, and indicate that a fertilizer standard is the second best efficient measure to control nitrogen pollution (Table 2).

Table 2. Results of alternative policy measures in the district.

		Welfare (10^6 €)	Quasi-rent (10^6 €)	Water (hm^3)	Nitrogen (Tons)	Percolation (hm^3)	Nitrogen leaching (Tons)
Base Scenario		22.3	24.1	190.7	4,525	66.1	1,459
Water price	0.06 €/m^3	21.2	18.8	86.4	4,367	43.3	1,381
	0.09 €/m^3	19.6	12.6	109.1	4,039	20.2	1,346
Nitrogen price	0.90 €/kg	22.4	22.6	200.6	4,265	45.3	1,222
	1.20 €/kg	22.7	21.5	186.6	3,976	56.2	990
Nitrogen standard		23.7	23.8	98.1	4,134	14.1	634
Emission tax		23.9	23.8	185.4	3,596	43.4	697

Several measures to reduce emissions were simulated and compared to the present baseline scenario. An increase in water prices only slightly reduced nitrogen discharges at very high costs to farmers and society. A tax in the use of nitrogen fertilizer resulted in more significant pollution reduction at much lower costs. A limit on nitrogen application curbed emissions by more than half, with a very moderate impact on quasi-rent and gains in welfare. The introduction of subsidies linked to the standard could be a good second best instrument to achieve nitrogen pollution control.

The finding that higher water prices are very inefficient to abate discharges, questions the reliance of the European Water Framework Directive on water pricing as a pollution control instrument to reach the “good status” target for all water sources. The implication is that other instruments included in the Directive, such as ambient quality standards and discharge limits, need to be applied in order to curb pollution. Looking at the Spanish domestic policies, the main piece of legislation affecting nonpoint pollution is the National Irrigation Plan, which promotes irrigation modernization through public subsidies. Although yields increase and pollution is reduced substantially by renovating secondary canals and plot irrigation systems, the problem is that the required investments are not financially sustainable, even when public subsidies are accounted for (Uku 2003). Accordingly, nitrogen pollution can be controlled by the abatement measures examined here, but not by the National Irrigation Plan legislation.

Additionally, the results obtained provide further evidence to the discussion on the choice of the appropriate policy instrument for nitrogen control. Horan and Shortle (2001), using the empirical results by Helfand and House (1995) and Larson et al. (1996), state that instruments based on irrigation water are more cost-efficient than instruments based on the use of nitrogen fertilizer. The reason given is that irrigation water is more highly correlated with nitrate leaching, implying that the appropriate instrument base is not the nutrient responsible for pollution but rather the input most highly correlated with pollution. This interpretation appears inaccurate, because the dynamics of nitrogen in the soil are ignored. Neglect of the dynamic aspects of nonpoint pollution may have serious consequences for the design of effective policy measures.

An important question for the choice of the correct pollution control instrument is the implementation costs of the instruments. Measures that seem suitable may be associated with implementation difficulties relating to their political and social acceptability or transaction costs, and thus the trade-off between cost-efficiency and simplicity of implementation should be carefully assessed.

Conclusions

The Mediterranean countries have a large water demand for irrigation, which creates significant water quality problems compounded by water scarcity. The heated policy debate that has been taking place in Spain to overcome water scarcity and resource degradation, highlights the difficulties of achieving sustainable water resources management, because of the conflicting interests of diverse stakeholders, including regions, economic sectors, and political and environmental groups.

Two distinct general policy approaches for dealing with water quantity and quality problems in the Mediterranean are the traditional approach of expanding water supply and the newly emerging water demand management initiatives. Examples of the traditional approach are inter-basin transfers and seawater desalination. The newly emerging initiatives rely on measures such as water pricing, revision of water rights, abstraction limits on surface and subsurface waters, development of regulated water markets, water resources reuse and recycling, and targeted subsidies to upgrade irrigation systems.

The effects of these measures on water quality is difficult to ascertain. It seems that expanding water supply may have negative effects on nonpoint agricultural pollution, because it favours the expansion of irrigation in Mediterranean coastal agriculture for high value crops that can pay for this additional water supply. Upgrading irrigation systems tend to reduce river flows with a negative impact in the water quality. In order to avoid this, public subsidies to irrigation upgrading have to be coupled with cutbacks in concession volumes to irrigation districts.

Several water quantity and quality issues in Mediterranean irrigated agriculture have been examined by presenting empirical evidence from Spain on alternative policy options and measures. The measures examined cover two cases: the evaluation of alternatives to solve water scarcity in the basins of southeastern Spain, and ranking agricultural pollution control instruments by their cost efficiency.

The first case is the recent Ebro transfer project and the new AGUA project designed to substitute for this transfer. Both projects are illustrative examples that highlight the failure of approaches based on expanding water supply. Results from analyzing the Ebro transfer show that a combined alternative of banning aquifer overdraft, water trading and a small volume of desalination, is by far a better alternative than building the Ebro transfer. This combined alternative reduces farmers' quasi-rent by a smaller amount than the subsidies required by the Ebro project.

Augmenting water supply by publicly financed desalination is politically appealing for the new Spanish government after cancelling the Ebro transfer, and its AGUA project seems to be an appropriate alternative. However, the problem with the AGUA project is finding the effective irrigation demand, especially when water is not subsidized, because farmers will face high costs for desalinated water. Farmers are extracting water from aquifers at pumping costs considerably below that of desalination, and they will avoid buying desalinated water. Only a strict enforcement by the water authority to prohibit aquifer overdraft would force farmers to buy desalinated water. This is a daunting challenge for the water authority, and the risk of the AGUA project is that public funds may be invested in desalination plants, but then the irrigation demand may not materialize.

The second case examined compares several measures to abate agricultural nonpoint pollution. Selecting the right policy measure requires knowledge of the underlying biophysical processes involved in pollution and the associated damage costs to the aquatic ecosystems. Ranking nitrogen control instruments by their cost-efficiency shows that a fertilizer standard is a good abatement measure. In contrast, rising water prices is very inefficient and this finding questions the reliance of the Water Framework Directive on water pricing as a pollution control instrument.

The empirical findings presented here indicate that water pricing does not appear to be an efficient measure for solving water quantity and quality problems for the issues discussed. Nevertheless, some minimum price of water is required to make farmers understand that water is not a free good. The Spanish example shows water pricing to be ineffective not only as a means to reduce water demand in coastal areas with high-value crops and severe pollution problems, but also as a pollution abatement instrument for inland areas with low value crops. The introduction of water rights and markets appears more reasonable than trying to allocate water through water pricing. However, the development of water markets is not easy, since institutional reforms require enormous and persistent efforts.

One issue deserving special attention is the acute lack of knowledge that exists in the Mediterranean European countries regarding aquifer dynamics, pollution loads in surface and subsurface waters, soils, transport processes and fate of pollutants, ambient pollution, and economic valuation of damage costs to aquatic ecosystems. This lack of knowledge precludes the design of reasonable policy measures to solve water quantity and quality problems in the Mediterranean countries. The consequence is that the popular water pricing measures suited to reduce industrial and urban demand in northern and central European countries is likely to be implemented for irrigation in the Mediterranean countries instead of the measures that are really needed.

Bibliography

Albiac J., J. Uche, A.Valero, L. Serra, A. Meyer and J. Tapia. 2003. The Economic Unsustainability of the Spanish National Hydrological Plan. International Journal of Water Resources Development 19: 437-458.

Albiac J., M. Hanemann, J. Calatrava, J. Uche and J. Tapia. 2006. The Rise and Fall of the Ebro Water Transfer. Natural Resources Journal. In press.

European Environmental Agency. 1999. Nutrients in European Ecosystems. Environmental Assessment Report No 4. EEA. Copenhagen.

European Environmental Agency. 2003. Europe's water: An indicator-based assessment. Topic Report No 1. EEA. Copenhagen.

Helfand G. and B. House. 1995. Regulating Nonpoint Source Pollution under Heterogeneous Conditions. American Journal of Agricultural Economics 77: 1024-1032.

Horan R. and J. Shortle. 2001. Environmental Instruments for Agriculture. In J. Shortle and D. Abler (Eds.) Environmental Policies for Agricultural Pollution Control. CABI Publishing. Wallingford.

Larson D., G. Helfand and B. House (1996). Second Best Tax Policies to Reduce Nonpoint Source Pollution. American Journal of Agricultural Economics 78: 1108-1117.

Martínez Y. and J. Albiac. 2004. Agricultural pollution control under Spanish and European environmental policies. Water Resources Research 40, doi:10.1029/2004WR003102.

Massarutto A. 2003. La demanda de agua de riego en Europa: el impacto de la Agenda 2000 y la Directiva Marco del Agua. In J. Albiac (Ed.) Los Instrumentos Económicos en la Gestión del Agua en la Agricultura. Mundi-Prensa. Madrid.

Ribaudo M., R. Heimlich, R. Claassen and M. Peters. 2001. Least-cost Management of Nonpoint Source Pollution: Source Reduction Versus Interception Strategies for Controlling Nitrogen Loss in the Mississippi Basin. Ecological Economics 37: 183-197.

Uku S. 2003. Análisis económico y medioambiental de los sistemas de riego: una aplicación al regadío de Bardenas. Ph. D. dissertation. Departamento de Estructura Económica. University of Zaragoza. Zaragoza.