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The Challenge of Irrigation Water Pricing in the Water Framework Directive

José Albiac
Agrifood Research and Technology Center (CITA-DGA) and IA2, Zaragoza, Spain; maella@unizar.es

Elena Calvo
Faculty of Economics and Business, University of Zaragoza, Spain; ecalvo@unizar.es

Taher Kahil
International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria; kahil@iiasa.ac.at

Encarna Esteban
School of Social Sciences and Humanities, University of Zaragoza, Spain; encarnae@unizar.es

ABSTRACT: The scarcity and degradation of water resources is an important environmental challenge in Europe, which is being addressed by the Water Framework Directive, the Urban Waste Water Directive, and the Nitrates Directive. Water pricing is an essential component of the Water Framework Directive, and the increase of water prices up to full recovery costs is a valuable measure in urban networks. However, water pricing may not be the best reallocation instrument for irrigated agriculture. In irrigated agriculture, water pricing is challenging because water for irrigation is usually a common pool resource. Water pricing could recover costs and indicate scarcity in the long run, but it doesn't seem feasible in the short run for irrigation water reallocation. Other policy instruments such as water markets and institutional cooperation seem more operational for water reallocation. The Water Framework Directive includes the 'polluter pays principle' as the suitable rule for pollution abatement. But the principle cannot be applied to agricultural pollution since this pollution is non-point, and water pricing is not the right abatement instrument. Also, the flimsy outcomes from the Nitrates Directive since 1991 call for a revision of the pollution abatement measures. This paper reviews the water policy instruments that could be more suitable for achieving the objectives of the Water Framework Directive, and the paper highlights the need for combining instruments to deal with the public good, common pool resource, and private good characteristics of water.

KEYWORDS: Policy instruments in irrigation, Water Framework Directive, Nitrates Directive, water pricing, collective action

INTRODUCTION

Water resources in basins around the world are under mounting pressures, resulting in serious water scarcity and quality degradation problems. Water withdrawals in the last century have climbed well above the rate of population growth (AQUASTAT, 2016; WWC, 2000), depleting both surface and ground water systems (WWAP, 2006; Wada et al., 2010; IGRAC, 2010). The degradation of water resources is a common threat to human water security and environmental biodiversity across the world, which is compensated for with large investments to ensure human security in developed countries. However, the threats to natural ecosystems are hardly accounted for (Vörösmarty et al., 2018, 2010). The biodiversity decline in aquatic ecosystems is found to exceed by far that of terrestrial and marine ecosystems

(Arthington, 2012). There have been a number of attempts worldwide to incorporate environmental damages into water management, although the outcomes have not been particularly successful. Some examples are the introduction of natural capital accounting in some countries (UN, 2014), the Millennium Ecosystem Assessment (Reid et al., 2005), or 'The Dasgupta Review' (HM Treasury, 2020). Achieving more sustainable management of water resources requires reforms of existing water policies, mostly in agriculture, which is the major global water user.

Climate change is going to be an important challenge in the coming decades for the management of water resources. Changes in precipitation regimes and extreme natural events will have negative effects on water availability. Precipitations will decrease in mid-latitude and subtropical dry regions, reducing renewable surface water and groundwater resources and escalating the competition for water among sectors (IPCC, 2014a). The challenge for irrigated agriculture will be particularly difficult to harness because global food demand will almost double by 2050 (Alexandratos and Bruinsma, 2012), driven by the growth of world population and income. Climate change will increase temperatures and modify the pattern of precipitations, reducing crop yields of both irrigated and rainfed cropland and also livestock productivity because of prolonged or extreme changes in temperature. The biological processes underlying the productivity of plants and animals will be negatively affected by increasing weeds, diseases and pests, along with changes in the development and pollination periods (USDA, 2012).

The scale of the growing water depletion globally indicates that water mismanagement is quite common, and the sustainable management of basins is a complex and difficult task. The long-standing water governance problem would become especially acute in arid and semi-arid regions, where the combined effects of human- and climate change-induced water scarcity and droughts portend unprecedented levels of water resource degradation (Kahil et al., 2019). These severe threats call for the overhaul of existing water policies in many parts of the world in order to achieve a more sustainable use of water resources. This is in line with the Sustainable Development Goals (SDGs), implying the reduction of water scarcity and the abatement of pollution loads. More sustainable water policies require the suitable combination of policy instruments adapted to the economic, social and environmental conditions of each river basin.

Collective action and interest groups in water resources management

Irrigation water is mostly a common pool resource, and environmental water sustaining water ecosystems is a public good. The traditional division between private and public goods was consistent with the dichotomy of institutions between market exchanges of private goods and government-owned public goods managed by a public hierarchy. Common pool resources are held in common by many individuals, and the typical problem of overexploitation of these resources was addressed in the past by privatisation or enforcement by government coercion. Another solution for effective governance of common pool resources is the collective action or self-organisation of stakeholders, based on boundary rules that determine the use of the resource, choice rules for allocating the resource, and active monitoring and sanctioning in the case of non-compliance (Ostrom, 2010).

The collective action processes in the management of water resources are driven not only by the different types of goods and services provided by water, which can be classified as private goods, common pool resources or public goods (Booker et al., 2012), but are also driven by the technologies employed in water utilization which involve economies of scale and indivisibilities resulting in natural monopolies. Collective action can also address the externalities linked to the use of water resources in order to avoid market failure, such as ecosystems protection, aquifer extractions and surface diversions, or non-point pollution (Rausser et al., 2011).

The overhauling of water governance in basins could be based in furthering stakeholder self-organization or promoting economic instruments such as water markets, water pricing, subsidies, and payments for environmental services. Mainstream water policy recommendations at present are based mostly on economic instruments; these work well when water is close to a private good, but are less suitable when water is a common pool resource or a public good (Ostrom, 1990). Irrigation water is mostly a common pool resource[1] and has strong impacts on water-dependent ecosystems. The purpose of this paper is to show that under these common pool and public good characteristics, water pricing in irrigation is not an adequate instrument for solving water scarcity and agricultural water pollution problems, as advocated by the European Water Framework Directive. The empirical evidence presented in the paper suggests that these problems should be addressed mainly by the local collective action of stakeholders in basins, with economic instruments used as ancillary policy tools.

Policy choices in using both collective action or economic instruments, require coordination and control in the processes of decision making, and the influence of participants shape the decision outcomes. In order to gain influence, stakeholders are often organised into pressure groups to advance their interests. Typical examples in irrigation are water user associations and farmers unions. Water policy reforms involve accommodating the politics of sharing scarce water resources among groups of users with opposing interests. Policy reforms are the result of negotiations between the main groups of stakeholders, and the reform outcomes may not represent the interests of all users or achieve efficient water allocations (Esteban et al., 2018).

Reforms of water institutions and policies imply significant changes in the distribution of power among pressure groups and the benefits accruing to them. The consequence is that water reforms could be under substantial political opposition from groups of stakeholders losing power and benefits, who may be able to disrupt the policy reforms (Dinar, 2000). The results of water reforms are uncertain because of the interplay among pressure groups, and because of the limited knowledge on the interactions between human and biophysical processes. In any case, powerful interest groups will try to influence the political decision process in order to get more favourable outcomes (Bucknall et al., 2007).

In the case of the Water Framework Directive, policy outcomes during the last 20 years have been gradual, with quite slow improvements in both water scarcity and water quality in basins (EC, 2015). The objective of good ecological status for all water bodies was supposed to be reached by 2015 at the end of the first policy cycle. But the meagre achievements indicate the need for considerably more efforts and time, with a timescale for ecosystems' recovery and land use changes of many years, even decades (Hering et al., 2010).

Policy reforms in Europe

Water policy reforms have been undertaken by the European Commission in order to address the scarcity and degradation of water resources. The use of water by different economic sectors creates water scarcity in southern regions and widespread water quality degradation from non-point and point pollution all over Europe. However, the considerable pollution of rivers in the past has been clearly improved in recent decades due to reductions in organic matter loads, the use of phosphate-free detergents, and the operation of wastewater treatment facilities in urban centres. Water scarcity is serious in southern countries, with a strong water demand during summer for irrigation but also for tourism (Zoumides and Zachariadis, 2009). Despite regulations and large investments in urban and industrial water treatment plants, water quality degradation remains high in many river basins because the non-point pollution loads from agriculture are not decreasing.

There has been a sustained effort by the European Union in recent decades to improve water management through comprehensive water legislation. This paper reviews some aspects of the water policy reforms undertaken in the European Union that deal with water scarcity and non-point pollution problems. We specifically focus on the implementation of the Water Framework Directive, whose aim is

[1] Some farmers can get water from urban networks, mostly for livestock production rather than irrigation. Also, some domestic and industrial users are not connected to urban networks, but to private borewells, rainwater harvesting or grey-water recycling.

to achieve good ecological status of all water bodies in Europe. This objective is attained through water planning in each basin, by combining different policy instruments. The water pricing instrument is emphasized by the European Union to address water quality and quantity problems (EC, 2000), while other policy instruments such as command and control, water markets or stakeholders' cooperation are not mentioned.

The paper focuses on the challenges faced by water pricing as an effective policy instrument in agriculture, and highlights the need for combining instruments to deal with the public good, common pool resource, and private good characteristics of water. The next section reviews the types of water policy instruments, followed by the description of European water policies in recent decades. The next section considers the challenges of water pricing in irrigation, presenting the empirical findings in the Jucar Basin (Spain) from the comparison between the three types of policy instruments analysed: water pricing, water markets and stakeholders' self-governance. This evidence shows that water pricing is the less adequate policy instrument for irrigation, both in terms of economic efficiency and social equity. The last section presents the conclusions.

WATER POLICY INSTRUMENTS

Four types of policy instruments are used to address the market externalities created by the common pool and public good characteristics of water (Perman et al., 2011). The first type is command and control by the water authority, based on regulations enforced with sanctions for non-compliance. The second is the 'Pigou solution', based on taxation of water extractions (Pigou, 1920). This is the water pricing approach that is being implemented in the European Water Framework Directive (EC 2000). The third type is the 'Coase solution', which is based on privatising the resource and trading (Coase, 1960). This is the water market approach that has been implemented in Australia (Hart, 2016). The fourth type is the common property governance or 'Ostrom solution', based on the evidence that coercive government rules can fail because they lack legitimacy and knowledge of local conditions (Ostrom, 1990). This is the institutional cooperative approach, where affected stakeholders design the rules and enforcement mechanisms for the sustainable management of common pool resources (Zhu et al., 2019), although this approach has not received widespread attention in either research or policy circles (Arrow et al., 2012).

Water pricing and water markets are economic instruments that can work well when water exhibits private good characteristics such as in urban networks, but they work less well when water exhibits common pool resource or public good characteristics (Davidson et al., 2019; van der Zaag and Savenije, 2006). There is a strong consensus among experts that water pricing could achieve sizable gains in efficiency and welfare in urban and industrial water networks (Olmstead et al., 2007; Hanemann, 1998). Irrigation water from surface watercourses and aquifers exhibits common pool resource characteristics, and thus the use of economic instruments requires transforming the resource into a private good. This transformation is quite difficult (Perry et al., 1997; Dellapenna, 2005), especially in arid and semiarid regions under strong water scarcity pressures, and would require the support of irrigation stakeholders. Holley and Sinclair (2016) describe these difficulties in the case of water markets in Australia.

Water markets may increase water use efficiency, avoid the development of new costly water resources, and achieve significant welfare gains by reallocating water from crops with low to high marginal value of water (although low-profit crops could have a wider importance in terms of their socio-environmental aspects, especially for traditional rural ecosystems hosting valuable biodiversity). The design of well-functioning water markets require challenging conditions such as the definition of water rights, the creation of legal and institutional frameworks for trade, and investments in infrastructure to facilitate water transfers (Crase et al., 2020). The benefits of water markets were demonstrated during the drought of 2002 to 2012 in the Murray-Darling Basin of Australia, with benefits in the range of several hundred million to 1 billion Australian dollars per year (Connor and Kaczan, 2013). However water markets could reduce streamflows in basins because of trading of previously unused water allocations, and also because gains in irrigation efficiency at parcel level from trading reduce return flows to basins (Grafton et al., 2018).

The institutional approach relies on the river basin authorities, where Spain is a good example. The basin authorities there are responsible for water management, water allocation, control and enforcement, planning and waterworks. The special feature of this institutional arrangement is the key role played by stakeholders in managing the basin authority. The management of water is decentralized, with the basin authorities in charge of water allocation, and water user associations in charge of secondary infrastructure and water usage. The main advantage of this institutional setting is that stakeholders are inside all management bodies in the basin authority. They cooperate in the design and enforcement of decisions, rules and regulations, which results in the smooth operation of implementation and enforcement processes. Although conflicts appear among groups of stakeholders, most frictions are solved by agreements among groups rather than by resorting to judicial litigation or political decisions by the central government. An example of successful experience is the case of the Eastern La Mancha aquifer, the largest aquifer in Spain covering 7300 square kilometres, where aquifer extractions have been curbed through stakeholders' cooperation (Esteban and Albiac, 2012).

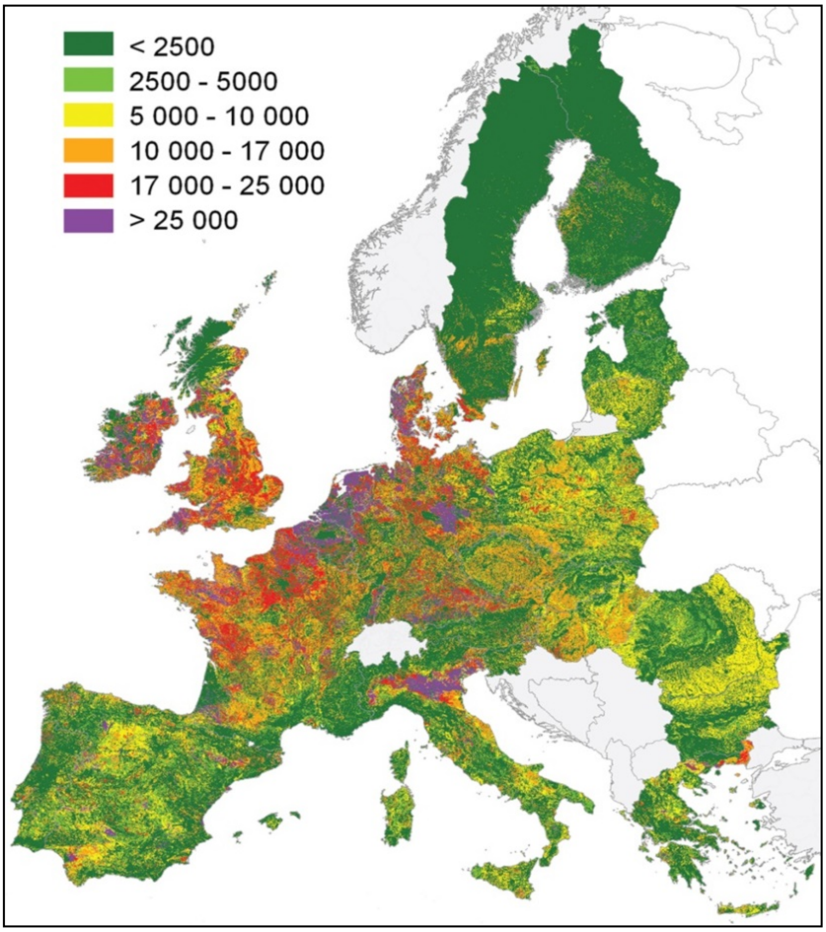
WATER POLICIES IN EUROPE

The initial European legislation on water resources was passed in the 1970s including the so-called Dangerous Substances, Surface Water and Drinking Water Directives. But the major water reforms in the European Union in recent decades are the result of the main water regulations, which include the Urban Waste Water Treatment Directive, the Nitrates Directive, both of 1991, and the Water Framework Directive of 2000. The emphasis of these European regulations has been on water quality issues rather than on water quantity. Early legislation followed emission standards or water quality approaches for pollution abatement. In the 1980s, European governments recognised the need to address industrial, urban and agricultural pollution together. The consequence was the adoption of the Urban Waste Water Treatment and the Nitrates Directives, and the preparation of a framework instrument establishing the principles of sustainable water policy leading to the Water Framework Directive (WFD).

The Urban Waste Water Treatment Directive required building depuration plants with secondary treatment plants or else tertiary treatment plants in special sensitive areas. The investments in urban treatment plants have been large, above €200 billion; this has achieved a significant reduction of organic matter and of nitrogen and phosphorus emission loads into water media, and has resulted in less environmental damage to aquatic ecosystems. The Central and Northern European countries already have depuration plants with tertiary treatment in place, while countries in the south of Europe and in France, Ireland and the UK have depuration plants with secondary and tertiary treatment. East European countries entered the Union in 2004 and are in the process of completing the requirements of the directive. In Southern Europe, treated urban wastewater is reused in areas under strong water scarcity, and the potential is significant. While Spain uses only 400 Mm^3 or 11% of treated wastewater, Cyprus already uses 19 Mm^3 or 90% of treated wastewater.

The Nitrates Directive aims to protect water quality by preventing nitrates from agricultural sources to pollute ground and surface waters. The main policy measures are the identification of vulnerable zones to nitrate pollution, good farming practices, and the setting of fertilisation limits. The purpose is the abatement of nitrate pollution in water bodies and the mitigation of greenhouse gas (GHG) emissions that are generated by excessive nitrogen fertilization and manure surpluses. However, the achievements of the Nitrates Directive during the last three decades are questionable (Albiac, 2009), as can be seen in Figure 1, which shows the strong imbalance of nitrogen in soils. One problem with the Directive is the setting of homogeneous measures across the different European regions, which is questionable since the magnitude of the nitrogen pollution loads in soils varies widely from region to region.

Figure 1. Density of the nitrogen inputs in European soils (in kgN/km^2)[a].



Source: Leip et al. (2011).

Note: [a] = kilograms of nitrogen per square kilometre.

The Water Framework Directive

The WFD intends to achieve good ecological status for all water bodies through water pricing policies, the combination of emission limits and water quality standards, water management at basin level, and the participative management of basins. The main phases of the first management cycle were the drawing up of the basin management plans and programmes of measures, and the introduction of water pricing policies and the programmes of measures to reach the environmental objectives by the end of the first cycle of 2009 to 2015. We are now near the end of the second cycle, 2016 to 2021, and, as indicated above, we are still far from achieving good ecological status for all water bodies.

The European countries with more well-developed basin authorities are Spain and France; their basin authorities were established in the 1920s and 1960s, respectively. Basin authorities in other European countries have mostly been established in the years before or after the approval of the WFD in 2000. The water management approach in Spain is institutional and stakeholders are involved in all their governing bodies and run the local watershed boards.[2] In France, basin authorities include representatives of end

[2] The stakeholders in basin authorities include representatives from water users (urban supply, irrigation, hydropower), federal and state governments, municipalities, farmers unions, environmental associations, business associations and workers unions.

users and of local, regional and national authorities; their main tasks are setting the water taxes and deciding the investments, in which they follow the 'water pays for water' rule which means that financing comes from the water users in each basin. Water pricing in irrigation is being considered in Southern Mediterranean countries but, as described in the next section, not in Central and Northern European countries.

The European Commission (EC, 2015) maintains that there is progress towards addressing the challenges faced by water resources; there is a long way to go, however, before the quality of most EU water bodies reaches good ecological status. Significant water policy shortcomings exist and by 2015 about half of EU surface waters had not yet reached good ecological status; furthermore, due to deficient monitoring, the chemical status of almost half the water bodies is unknown. This lack of information prevents the design and implementation of reasonable measures to achieve good ecological status or even to make improvements in water bodies.

The programme of measures is the instrument for achieving the good ecological status objective in each basin plan, and an essential component of the programme is water pricing. The directive introduces the principle of water prices close to full recovery cost, considering also that water pricing will improve water use efficiency. The full cost must include abstraction, distribution and treatment costs, as well as environmental costs and resource value. The principle of cost recovery is the key element in the policy analysis advocated by the directive (EC, 2012; Treyer and Convery, 2012). Increasing water prices up to recovery cost is an interesting measure in urban and industrial networks; in that context, water has private good characteristics and water demand responds to water prices, thus leading to higher water use efficiency. Massarutto (2020), however, indicates that in urban networks cost recovery and ecological and social sustainability are separate issues that require additional economic instruments beyond 'getting the price right'. Water pricing is paramount in Central and Northern Europe where water demand is largely urban and industrial, while water pricing may not be the best reallocation instrument in Southern Europe where irrigation is the main use of water (Gallego et al., 2011; Garrido and Calatrava, 2009).

THE CHALLENGE OF WATER PRICING IN IRRIGATION

There has been a substantial debate on the use of water pricing as a policy instrument in irrigation. Molle and Berkoff (2007) present a comprehensive review of the origins and developments of the pricing instrument, which gained traction in the 1990s with the Dublin conference on water and the Rio Declaration. The price instrument was supported by international agencies such as the World Bank and the OECD, and was included in water legislation in South Africa, Brazil, Bangladesh, China and the European Union. The difficulties faced by water pricing in irrigation found in the literature and from the experiences on the field have been analysed by Bosworth et al. (2002) and Cornish and Perry (2003). They indicate that the price response to volumetric water charging is widely shown to be minimal, and that the limits on consumption in all locations under water scarcity are established through water allocation or rationing rather than pricing. They affirm that water markets could be more effective than water pricing as a means of achieving allocation efficiency.

This is in contrast to the arguments given by the European Commission to support water pricing as the key policy instrument in the WFD (EC, 2000). The Commission argues that: 1) efficient water pricing drives water demand reducing pressures on water resources, which is considered especially true for the agricultural sectors; 2) water pricing linked to water quantities and pollution loads will improve water efficiency and pollution abatement; and 3) water pricing enhances the sustainability of water resources when including the full recovery costs, the sum of financial, environmental and resource costs. The Blueprint to Safeguard Europe's Water Resources (EC, 2012) insists on the insufficient use of economic instruments, and the need to implement pricing policies as an incentive to use water efficiently. The Blueprint considers that pricing would be a powerful awareness-raising tool, combining environmental with economic benefits, and promoting innovation.

This is also the assessment of the European Environment Agency (EEA, 2013) which states that underpricing in irrigation water is the major cause of waste, and that increasing irrigation water prices will reduce the volume of water used in agriculture. The EEA recommends modernisation of the irrigation system coupled with volumetric pricing, which would have a very high water-saving potential. However, irrigation modernisation leads to the expansion of water consumption rather than water savings (Grafton et al., 2018). The issue about irrigation efficiency is the following: irrigation efficiency gains at plot and district levels will lead to more evapotranspiration and less return flows, resulting in lower stream flows at basin level. This fall in basin stream flows has been observed in Spain and Australia following the multibillion dollars investments in irrigation technologies by both countries in recent decades. This has been called lately the 'rebound' or 'Jevons paradox' effect, although the externality has been identified by water economists for a long time since the contribution of Hartmann and Seastone (1965).

Rey et al. (2019) review the role of economic instruments in Europe by assessing the use of water charges, payments for environmental services, subsidies, and water markets. They indicate that the economic instruments should be designed in relation to local conditions and in concert with regulatory and engineering schemes. They also recognise that the stakeholders' involvement is of critical importance to ensure the achievement of policy goals.

Allocation of irrigation water

Water scarcity is a common problem in Southern European countries, which have semi-arid regions with substantial irrigated agriculture. The countries with the larger irrigated areas are Spain, Italy, France, Greece and Portugal, and the rank by water withdrawals are Spain (21,000 Mm^3), Italy (20,000 Mm^3), Greece (3900 Mm^3), Portugal (3400 Mm^3) and France (2400 Mm^3). The share of advanced irrigation equipped with drip systems is very high in Spain (50%) and Greece (40%), and this technology is linked to high value crops such as fruits and vegetables. Drip irrigation in Italy, France and Portugal is much lower, because irrigated crops are mostly field crops under surface or sprinkle irrigation technologies (EEA, 2020; Eurostat, 2020). In these semiarid regions of Southern Europe, the vulnerability of irrigated agriculture to climate change is expected to be strong (IPCC, 2014b), with reductions in freshwater supplies and rising water demand (20-40% increases for irrigation), and more frequent and intense droughts (Lehner et al., 2006; Jimenez et al., 2014). The adaptation of irrigation to climate change in Southern Europe has become an important objective in European water and agricultural regulations (EC, 2009, 2013).

In irrigated agriculture, water pricing is a quite challenging measure because irrigation water is mostly a common pool resource. Water pricing could be used in the long run to recover costs and to indicate basin scarcity. However, water pricing doesn't seem feasible in irrigation to reallocate water in the short run, because during droughts the water price charge on farmers would be so high to balance supply and demand, that water pricing becomes politically unfeasible. There are also technical hurdles in the *tatonnement* process to find equilibrium prices by sector (including ecosystems), location and season.

During severe droughts in irrigated areas, institutional or command and control instruments seem more suitable than pricing for short run water reallocation. The use of water markets during droughts is also more suitable than water pricing as farmers can sell water and maintain income rather than losing significant income by paying large water price hikes. However, the establishment of water markets involves important economic and institutional costs. In Australia, the setting up of water markets has not been easy because it has required the support of the key groups of interest. This support has been obtained through the commitment of very large public funds (around AU$15-20 billion) in order to make water markets work: payments to states to support the introduction of water markets and payments in exchange of transferring management powers to the federal basin authority, payments to farmers for irrigation investments, and payments to buy back water for the river (Albiac, 2017; Loch and McIver, 2013; Hart, 2016).

Scheierling and Treguer (2016) indicate that water reallocation can be done by using either water pricing or quantity-based measures. They find that the problem with water pricing in irrigation is that irrigation demand is price-inelastic so small reductions in irrigation would require large price increases resulting in large income losses to farmers. Even charging high water prices would not result in real water savings when return flows are important. Quantity-based measures or quotas can achieve an efficient allocation, such as using water markets to exchange quotas from low- to high-value water uses. Other reallocation mechanisms are common in most basins worldwide and in Europe, including informal water exchanges between farmers, transfers based on priority of use during droughts, and transfers according to institutional decisions taken by basin authorities or other water authorities.

In order to assess the performance outcomes of water pricing in irrigation, Kahil et al. (2016) have made a direct comparison in the Jucar Basin (Spain) of three water policy instruments: water markets, water pricing, and the status quo institutional cooperation. The results show the economic and environmental effects of water scarcity under each policy instrument (Table 1). The empirical results highlight that both water markets and institutional policies are suitable instruments for limiting the damage costs of droughts, achieving similar social benefits in terms of private and environmental benefits. This finding is important because it shows that the status quo institutional policy can attain almost the same private benefits as water markets. Water markets minimise the losses of private benefits from drought but disregard the environmental benefits. Results show that water markets entail a larger reduction of water for the environment than the institutional policy instrument, and the reason is the public good characteristic of environmental flows which are external to markets.

In the Jucar Basin, where irrigation is the main water use and where half of extractions come from aquifers, the water pricing policy encounters significant difficulties. Water pricing is quite detrimental to farmers because implementing water pricing instead of water markets or institutional policies triples farmers' losses in severe drought (five times in mild drought). Under the water pricing policy, severe drought reduces farmers' benefits by 72% when the drought loss could be limited to 26% of benefits under water markets or institutional policies. These empirical results demonstrate that water markets and institutional policies are much more economically efficient and equitable than water pricing, and water pricing results in disproportionate costs to farmers. Enforcing water pricing seems a quite unfeasible task facing tough political and technical hurdles.

The information on irrigation water pricing in the European Union is scarce. One source is Berbel et al. (2019), which provides a review of irrigation pricing across Europe. In Mediterranean countries such as Spain, Italy, France and Portugal there are water taxes that cover the costs of storage and delivery facilities, or chargers on abstractions. The range of water taxes is between 0.002 and 0.007 €/m^3, and the water price paid by farmers which includes the management costs of water user associations ranges from 0.03 to 0.07 €/m^3.[3] There are no taxes on water in Germany, the Netherlands and Denmark. In the Netherlands there was a water tax for large irrigation users up until 2008 when irrigation was exempted. In Germany the tax was only applied in the state of Baden-Württemberg and was eliminated in 2011.

These water taxes and water prices are quite low to change irrigation demand. The shadow price of water in irrigation depends on the type of crop, and in Spain shadow prices are around 0.15 €/m^3 for cereals, 0.40 €/m^3 for fruit trees, and 0.90 €/m^3 for vegetables (Esteban and Albiac, 2012), although for greenhouse production areas the shadow price could be up to 5 €/m^3. So current water taxes have to be increased by almost two orders of magnitude to start reducing irrigation demand, which seems politically unfeasible and technically challenging for implementation and enforcement.

[3] Taxes are around 0.005 €/m^3 in Spain, 0.002 €/m^3 in Italy, 0.007 €/m^3 in France and 0.003 €/m^3 in Portugal. Average water prices are 0.07 €/m^3 in Spain, 0.05 €/m^3 in Italy, 0.07 €/m^3 in France, and 0.03 €/m^3 in Portugal and Greece (Berbel et al., 2019, 2007; Montginoul et al., 2015; Massarutto, 2015; Latinopoulos, 2005).

Table 1. Policies under drought: institutional cooperation, water markets and water pricing.

Drought scenario	Normal year	Mild drought			Severe drought		
Type of water policy	Current situation (institutional cooperation)	Institutional cooperation	Water markets	Water pricing	Institutional cooperation	Water markets	Water pricing
Water use (Mm^3)[a]							
Irrigation districts[c]	1030	908	908	908	683	683	683
EM	399	359	363	363	304	316	316
CJT	155	132	150	150	107	146	146
ARJ	200	180	197	197	131	185	185
ESC	33	30	32	32	18	31	31
RB	243	207	166	166	123	4	4
Urban use	119	105	105	105	74	74	74
Traded water	-	-	40	-	-	120	-
Environmental flows (inflows to Albufera)	60	52	50	50	34	29	29
Private and environmental benefits (€ million)[b]							
Private benefits							
Irrigation districts	190	171	175	93	136	148	54
EM	80	72	72	37	61	62	31
CJT	45	40	42	33	36	39	17
ARJ	34	31	32	17	23	25	4
ESC	7	7	7	5	4	5	2
RB	24	21	22	1	12	17	0
Urban use	283	276	276	276	241	241	241
Total	473	447	451	369	377	389	295
Environmental benefits	75	37	32	32	22	19	19
Social benefits	548	484	483	401	399	408	314

Source: Kahil et al. (2016).

Note: [a] = water allocations to irrigation, urban use and environment; Mm^3 = million cubic metres; [b] = private benefits from irrigation and urban use and environmental benefits; [c] EM = Eastern La Mancha Aquifer; CJT = Canal Jucar-Turia; ARJ = Acequia Real del Jucar; ESC = Escalona y Carcagente; RB = Ribera Baja.

Non-point pollution abatement

Regarding water quality, non-point pollution from agriculture is addressed by the WFD and the Nitrates Directive. Non-point pollution from agriculture is a serious problem in Europe resulting in nutrient emission loads into water media, and emissions of greenhouse gases and ammonia into the atmosphere. The WFD includes the 'polluter pays principle' as the suitable rule for pollution, and it is applied in urban and industrial point pollution. But the principle cannot be applied to pollution from agriculture, since pollution loads from agriculture are non-point emissions. Also, water pricing does not seem to be good enough to curb nitrate pollution since the pollution driver is fertiliser and not water. The economic analysis of point source pollution has been broadly dealt with in the literature and the typical control instruments are emission standards, emission permits, and Pigouvian taxes (or WFD's water pricing) on emissions (Baumol and Oates, 1988). The tools used in point source pollution are not suitable for non-point pollution. The control of non-point pollution is more difficult because the regulator lacks information about the source of pollution and the emissions loads. This situation favours the strategic behaviour of agents, since the information is asymmetric and the polluting agent has more information than the agency regulating pollution.

The argument supported by the WFD that water pricing in irrigation would reduce non-point pollution loads is quite flimsy. The fact that there are many pollutants coming from a large number of sources, following transport and fate processes along different paths, and damaging ecosystems and human activities through ambient pollution in water systems and the atmosphere, results in a very high level of complexity for the design and implementation of abatement policies. Source emissions and pollution pathways to receptors are not observable and highly stochastic, preventing pollution monitoring or even predictions with models. Non-point pollution measures cannot follow the 'polluter pays principle' since a single pollution price implicit in taxes or permit markets doesn't exist given the complexity of the biophysical environment (Shortle and Horan, 2017). The consequence is that non-point pollution abatement becomes a 'wicked challenge' for economic instruments, and pragmatic solutions require the inclusion of command and control and institutional instruments, or combinations of instruments. This is the case in Denmark where the abatement of agricultural nitrogen loads has been achieved with a mix of command and control (fines) and institutional instruments, started with the Action Plans in the 1980s. The farmer's collective action has been achieved by showing farmers that substitution of synthetic fertilisers with manure was profitable (Dalgaard et al., 2014).

Agricultural non-point pollution is addressed by the Nitrates Directive. Farmers are required to keep nitrogen balance books, and enforcement is based on random inspections whereby non-compliant farms are penalised in their agricultural policy subsidies. However, control is limited to cultivation areas that are located over aquifers or streams which have been declared officially vulnerable to nitrate pollution. In vulnerable zones, the manure fertilisation limit is established evenly for all European countries at 170 kilograms of nitrogen per hectare (kgN/ha), with no limits on synthetic fertilisers and no rigorous control. The efficacy of these control mechanisms remains to be seen because it ignores whole basins, the nitrogen loads in non-vulnerable zones, the substitution of synthetic fertilisers with manure, and polluting crops not receiving sizable subsidies, such as vegetables or fruit trees. No consideration is given to the biophysical heterogeneity of farms, the pollution transport and fate processes, the interaction among pollutants, or to the spatial distribution of ecosystems and the ensuing disparity of environmental damages by location.

The nitrogen pollution problem in European rivers cannot be solved with irrigation water pricing as claimed by the WFD, but rather by substituting synthetic fertilisers with available manure in order to reduce the nitrogen imbalance in soils. Livestock manure contains 7 million tons of nitrogen (tN) that could be used as a substitute for a considerable part of the 11 million tN contained in synthetic fertilisers. If all manure was used for crop fertilisation, the use of synthetic fertilisers would decrease curbing the entry of nitrogen into soils, reducing nitrogen loads into water bodies, and curtailing the estimated emissions of 4 million tN at the mouth of rivers in Europe (Billen et al., 2011; Seitzinger et al., 2010). Manure recycling would also reduce nitrous oxide emissions contributing to the mitigation of GHG emissions, but it would require a high level of cooperation and organisation among stakeholders. There are also several more costly manure treatment technologies based on biological processes, which have high investment and operating costs.

The available data from the OECD (2008) on the nitrogen load at the mouth of European rivers indicates that after 1991 most major European rivers have shown no abatement of nitrates and some have even grown worse, with high nutrient pollution in the Guadalquivir, Thames, Seine and Scheldt Rivers where data has been submitted by countries. One example of the limited success of the Nitrates Directive is the Seine River in France, where the nitrogen pollution load at the mouth has doubled from 50,000 tons of nitrogen in nitrates (tN-NO_3) per year when the Nitrates Directive was approved in 1991 to 100,000 tN-NO_3 at present (Romero et al., 2016). Other examples are the Po River where nitrate trends in the last decade have been increasing in some areas or not decreasing in the rest of the basin (Musacchio et al., 2020), and the Thames River where nitrate pollution has not decreased since the 1990s with loads from agriculture remaining at around 12,000 tN-NO_3 per year (Howden et al., 2011).

Other economic instruments beyond water pricing such as subsidies for non-point pollution abatement do not seem to be good policy instruments, as shown by the experience in the United States. Non-point pollution abatement policies are addressed by the US Department of Agriculture conservation programmes such as the Conservation Reserve Program and the Environmental Quality Incentives Program. Funding for conservation programmes in the period from 2002 to 2016 has been around US$5 billion per year. Despite this large public funding in agricultural non-point pollution policies, there is no clear general improvement of water quality in basins (Ribaudo, 2015).

The difficulties of using the water pricing instrument in irrigation are being recognised somehow by the European Commission in the fitness check of the Water Framework and Floods Directives (EC, 2019). The fitness check includes the objective of enabling a discussion with all stakeholders. The implication is that the cooperation of stakeholders seems to be recognised in order to get some degree of collective action needed for the sustainable management of water in basins. Under a full institutional cooperation policy, the economic instruments are not the main instruments but only ancillary policy tools.

CONCLUSION

The scarcity and degradation of water resources is a major environmental problem worldwide and sustainable solutions involve very complex and difficult tasks. In Europe, water scarcity is a serious problem in southern regions while water quality degradation is widespread. Investments in wastewater treatment have reduced point pollution but non-point pollution from agriculture remains unabated. Water scarcity in Southern Europe is not improving, and coping with the effects of climate change would be quite challenging.

Water governance is based on collective action since water can be a private good, a common pool resource, or a public good, and because of the economies of scale, indivisibilities and environmental externalities. The market externalities created by the common pool and public good characteristics of water can be addressed with different policy instruments, such as water pricing (Pigou), water markets (Coase), and institutional cooperation (Ostrom). Some examples of the successful application of these instruments are water markets in Australia, water pricing in urban networks in Europe, and institutional cooperation for irrigation water in Spain.

The Urban Waste Water Directive has achieved a significant reduction of point emissions into water media. The Nitrates Directive intends to prevent the nitrogen pollution of water bodies, but the achievements of the Nitrates Directive after three decades are questionable. The Water Framework Directive aims to achieve good ecological status, but the policy outcomes since 2000 are disappointing given that around half of surface waters had not reached good status at the end of the first management cycle in 2015. The reason for this shortcoming is the inadequacy of the programme of measures for agriculture where the key instrument is water pricing.

Water pricing gained traction in the 1990s supported by international agencies, and was included in the water legislation of several countries. The difficulties of the pricing instrument in irrigation derive from the minimal price response, and the evidence that limits in all water scarcity areas are done through rationing. Furthermore, water markets seem more effective than pricing for allocation of irrigation water. On the contrary, the European Commission argues that water pricing reduces agricultural water demand, improves water efficiency and pollution abatement, and enhances water sustainability. These statements are debatable since irrigation water prices in southern European countries range between 0.03 and 0.07 €/m^3 and taxes between 0.002 and 0.007 €/m^3. At present shadow prices of water in irrigation (0.15-0.90 €/m^3), taxes must be increased by almost two orders of magnitude to start curbing irrigation demand.

Using water pricing in agriculture is challenging because irrigation is mostly a common pool resource, and pricing is hardly feasible to reallocate water in the short run. Water markets seem more suitable because farmers maintain income by selling water instead of facing large price hikes. The direct comparison of water pricing, water markets and institutional cooperation policy instruments during drought in the Jucar Basin (Spain) shows that water markets and institutional cooperation achieve similar private benefits. However, environmental benefits are higher under institutional cooperation since water markets disregard environmental benefits. Under drought, water pricing triples farmers' benefit losses (-72%) in comparison to water markets or institutional cooperation (-26%). This finding endorses water markets and institutional cooperation as economically efficient instruments, while water pricing in irrigation is not only an inefficient instrument but also politically unfeasible. Farmers will strongly oppose water pricing given that other alternative policy instruments are available at much lower costs to them.

Agricultural non-point pollution is a significant challenge across Europe and the argument supported by the WFD that water pricing in irrigation will abate pollution is quite dubious. Non-point pollution measures cannot be based on the 'polluter pays principle' because there is not a single pollution price implicit in taxes or permit markets.

The control mechanism of the Nitrates Directive does not seem very effective since it ignores whole basins, the nitrogen loads of non-vulnerable zones, the substitution of synthetic fertilisers with manure, and the pollution loads coming from areas where crops do not receive sizable agricultural policy subsidies. The information available on nitrogen loads at the mouth of European Rivers indicates that most major rivers show no abatement of nitrates, and some even show higher loads. Examples of the limited success of the Nitrates Directive include the Seine River where the nitrates load at the mouth has doubled in the last thirty years, the Po River where nitrate trends are increasing, and the Thames River where nitrate pollution remains unabated. The only country in the European Union showing substantial abatement of nitrates pollution is Denmark, which has applied command and control and stakeholders' cooperation rather than water pricing.

The European Commission recognises somehow the difficulties of using irrigation water pricing alone in the fitness check of the WFD, by including the objective of enabling discussions with stakeholders. Stakeholders' cooperation turns out to be the inescapable driver for achieving the collective action of sustainable management of basins, where economic instruments are only ancillary tools in irrigation. This institutional cooperation seems to be essential to achieve the 'good ecological status' of all water bodies pursued by the WFD.

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