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SUMMARY - In order to approach the management of a resource such as water, one must first of all consider the institutional framework which affects the resource, together with the underlying ownership structure. The different institutional frameworks and their corresponding regulations imply different resource allocations whose efficiency and equity will need to be considered, besides their effects on the sustainability of the resource over time. Once the conceptual framework has been explored, water management in Spain will be analysed.

Key words: Water management, regulation, institutions.

RESUME *- "Gestion et problématique de l'eau". La problématique qui dérive de la gestion d'une ressource comme l'eau, requiert en premier lieu la considération d'un cadre institutionnel qui affecte cette ressource, ainsi que la structure de la propriété sous-jacente. Les différents cadres institutionnels et leurs régulations correspondantes conduisent à différentes assignations de la ressource dont l'efficacité et l'équité seront nécessaires à considérer ainsi que leurs effets sur la durabilité de la ressource dans le temps. Après la révision d'une structure conceptuelle, on procède à une analyse de la gestion de l'eau en Espagne.*

Mots-clés *: Gestion de l'eau, régulation, institutions.*

Introduction

Water is a renewable resource also called "flow resource", although this would not be the case of the fossil aquifers where water has been stored for hundreds or thousands of years.

Unlike other flow resources, water can be stored, transported, even re-used and recycled and therefore it has always been considered to be yet another production factor. Only in recent times has the economy begun to discuss trade-offs between instream and offstream uses, that is, to value the non-consumptive uses of water. Some economists are trying to value the non-consumptive uses of water (i.e. instream flow values as: water quality enhacement, improvement of fish and wildlife habitat, recreation, etc.) using new techniques such as the contingent valuation method and others.

A resource can be exploited within the framework of different institutional and property structures. Many theories on collective action are very pessimistic about its practical viability in the use of common property resources (e.g. *the prisoner's dilemma*, Hardin's *the tragedy of commons* and Olson's *the logic of collective action*,

etc.), since the equilibrium solution in all of these theories is that no-one respects the rules and the whole group uses the resource without limit until it is over-exploited. In view of these conclusions, some schools defend the implementation of full property rights (private property on the resource) and others defend the implementation of an outside authority with full rights (State) as the only way to avoid disaster.

However, evidence shows that many resources have continued to be viable until the present date, managed within the framework of a communal institution, together with the fact that many resources have disappeared or becoming privatized because the extractor, holding ownership of the resource, had no incentive to maximize the present value of the total extractions over time. He was not concerned about the resource property rights of future generations.

The conditions which must be present for a resource to be sustainable would be the following:

(i) The entitlement to the resource must be defined and the boundaries clearly stipulated (restricted use).

(ii) The use of the resource, by entitlement holders, must be well regulated and sanctioned either in a pre-agreed manner or by law.

This regulation implies that the users ought to have a certain insight or information regarding the sustainable yield of the hydric system or resource in question, so that the total extractions, or use are limited. Quantities or quotas are allocated to each user provided that they are compatible with the sustainable yield.

The existence of communal goods nowadays implies the maturity and experience of the "resource owners". They have considered the future values of the resource and have adapted its use to the self-sustainable yield of the system throughout history.

Efficient allocation of scarce hydrologic resources

A given allocation of resources is economically efficient, if, and only if, no individual improves his situation without worsening that of another (Pareto optimum). Another optimality criterion, much more widely used in practice (since it is less strict) is the Hicks-Kaldor criterion, which acts as the basis for the cost-benefit analysis. This definition affirms that an allocation A is efficient compared with allocation B if, and only if, those who benefit from shifting B to A can fully compensate those who lose out, and still obtain some profit (a necessary condition for the Pareto optimum). The problem lies in the fact that the majority of economic analyses do not demand "an actual" compensation for those who lose out, but they rely on the existence of a "theoretical" possibility to compensate. Economists often ignore the distribution aspects of the collective action whose responsibility, they feel, lies with the institutional structure, or rather on the politicians, leaving aside the analytical aspects derived from equity and the conclusions of the Welfare Theory.

One must not forget, as Bromley (1992) points out, that the institutional and legal structure is based on a "Status Quo" of ownership structure and it is the latter which finally determines which costs must be calculated and who ought to pay the compensations. The laws which arise from established interests, stipulate what is correct, the compensations to be paid to those jeopardized by a certain action, if and when they are covered by the property rights, since the party who is not protected by the property structure is the party who pays all the costs.

The Pareto optimum and of course the Hicks-Kaldor optimum are necessary for social optimality, however they are not enough, since, in order to maximize social welfare, the efficiency and equity criteria must be jointly considered.

The allocation of hydraulic resources can be made through alternative mechanisms. The water markets, which assume the privatization of the resource, are examples of such a mechanism and those based on common property, public trust and public property are others. The latter are normally publicly managed through a central agency of users, or by the government, subject to a particular regulation.

Water Markets

Many authors estimate that the allocation of water through market and trade processes is much more efficient than any of its alternatives. The literature written on privatization of resources points out the probable advantages of trade through the market instead of bureaucratic control and allocation.

The positive aspects quoted are:

(i) Their flexibility for the re-allocation of part of water availability for more valuable uses, according to variations in economic conditions, climate, demographic situation etc. and at a low cost.

(ii) They guarantee the security of water ownership as well as fair trading for the buyer and seller since transactions are voluntary.

(iii) The potential users are more likely to take the opportunity cost of water into consideration due to the market price signals.

(iv) Water is transferred from low value uses (normally agriculture) to higher value uses (industry and urban areas) when the differences in water value are high enough to compensate the operation. In consequence, an efficient market will tend to equal the marginal values of water among all possible uses (agriculture, industry, urban, etc.)

The negative aspects of these markets must also be pointed out:

(i) High transaction costs due to: the physical separation of buyers and sellers which makes it difficult for them to locate each other; and the lack of a clear definition of property rights or *usufruct* (right to use, not to ownership).

Water ownership rights are only clearly limited through a definition which includes the water quota that belongs to each owner, the amount of water transferred to the market, its distribution over time, quality and site of transfer-application. The changes of any of these characteristics may affect other owners and/or users of water downstream. The existence of rules of negotiation and norms on the aforementioned aspects helps to create a more transparent market, to avoid uncertainties and possible law-suits. Those derived from price negotiation, financing, compliance with state norms etc.

Transaction costs are heterogeneous and, so, they imply differentiated water prices in each area of the market. This means that the market transactions do not equal the marginal values of water; however, regarding this point, Saliba (1992) states that the high transaction costs, in spite of affecting the levels of market trade, do not necessarily imply inefficiency.

(ii) They do not reflect all opportunity costs, either because they ignore the negative external effects or because of the geographical boundaries of the market (basin, sub-basin), since values of use outside this geographical framework are unknown.

(iii) They do not guarantee justice concerning third parties negatively affected. (e.g. those who lose employment due to the disappearance of irrigated agriculture in the farms which sell their rights to water). The market processes, functioning within an initial distribution of rights on water, cannot solve properly these questions of equity.

There exist 3 types of effects on third parties which are not normally considered:

- The change in return flows.
- The change in the level of ground waters.
- The change in water quality.

Many times, their identification and quantification would raise both transaction and compensation costs making operation unviable;

(iv) Public values generated by no-consumptive uses of water (recreation, water quality enhacement, improvement of fish and wildlife habitat, preservation of the aesthetics of riparian areas and power generation) may be underestimated since the laws of many states do not consider instream flow benefits (Colby, 1990).

The nucleus of the questions of market equity lies in the tension between individual and collective interests and in the fact that those who do not have bargaining power hardly influence the market results.

To summarize, according to the references to be found in the literature (Saliba, 1992), the water markets seem to be relatively efficient in the allocation of water between municipal, industrial and agricultural uses. However, the non-market use of water and the effects on third parties are rarely considered. Only if the participants in water markets are obliged to recognize all the values and the effects on third parties, social benefits of transactions will outweigh the social costs.

Allocation based on "non-market" institutions

As previously mentioned, there are different institutional frameworks to allocate water apart from the market: (i) The communal framework, in which the entitlement of the resource is held by the community of users. This entitlement must be perfectly designated and the management of water must be well regulated and sanctioned to guarantee sustainability (the right to use the resource must be exclusive to members of the community and equal among them, although not necessarily the volume consumed by each one). (ii) The public framework, in which case the entitlement is held by the Adminstration (whether state, regional or local). They in turn would delegate the management and regulation of the resource in a central agency who is covered by the legal sanctioning power. (iii) The public trust which is a mixture of the two former since in this case, the entitlement is still communal but the management of the resource has been entrusted to the public authorities whose action must safeguard the interests of the resource owners.

The range of institutional structures and their variants can be quite wide, nevertheless, throughout this analysis, we will concentrate on the public allocation because it is normally applied today in Spain.

The positive aspects which are quoted in the public allocation are:

(i) Of an ideological type. Among these can be mentioned:

- Avoiding the commercialization of the access to such a basic and necessary resource for life as water.

- A greater security and control of the water supply than through the "market laws".

(ii) Greater sensitivity towards welfare issues since public authorities are more inclined to consider the following aspects than the private bodies:

- Equity of distribution.
- Possible negative external factors to third party users (e.g. quantity and quality of the resource).
- Public values of the resource generated by the non-consumptive use and water quality.

(iii) All values of use are considered (among different users, geographical boundaries, negative external factors etc.).

The negative aspects of this type of assignation are:

(i) Its inferior efficiency to allocate. Very often the price of water does not reflect the scarcity of the resource but its amount is established by political criteria and therefore water is not re-allocated from uses of lesser value to uses of greater value.

Or rather, the allocation of water based on priorities either politically or administratively determined may infringe the basic economic principle that resources are allocated to uses where the value of the marginal product is higher.

(ii) The management results very often are not measured by benefits obtained but based on technical or political criteria where, given water supply problems, technical solutions are preferred instead of the re-allocation of water from marginal users. Therefore expensive projects are drawn up, whose budgets are rarely respected, and are conferred to the beneficiaries for a fraction of their real cost. Furthermore, a greater danger exists of political clientism and permeability of pressure groups.

(iii) The administrative allocation of water based on priorities, can also lead to results contrary to the social objectives even though these are clearly formulated. Consequently, government action is not always a guarantee of social welfare.

To sum up, it is necessary to point out that there is no perfect allocative alternative since, a priori, one cannot take for granted that either the state regulation or private ownership can internalize all the continuum of social/private costs and benefits, and function properly in general terms.

Besides, both types of allocation systems (market and administrative control) are expensive if one wants them to be efficient since both require detailed information on: the quantities and qualities of the resource, the pattern of its use, the communication of this information among the users and finally the implementation of a sanctioning regulation and an effective control of the consumption.

One must also add, that both methods of allocation incur problems when measuring the value of the non-consumptive uses and the changes in water quality. This type of issues are more difficult to value than water for consumption, (irrigation, urban and industrial supply, etc.) and therefore information is out of balance, leading to the favouring of the water uses with easily obtainable values and forgetting the others.

The problem of transferring water between basins

As McDonnell and Howe (1992) point out, a transfer of water between basins must fulfill 3 conditions to be economically suitable: (i) the water supply must be the cheapest and dependable for the user; (ii) its benefits must exceed all costs incurred; (iii) no-one must be worse off. One of these costs comes from the necessary protection of the water original areas. Water forms part of an area's nature and as such must benefit people living in this area (just as with other natural resources such as minerals, timber, etc.). As a consequence, safeguard measures must be established to protect the future development, or water potential, in the exporting area.

Losses in the original water producing areas normally take four main forms: (i) present and future losses of net income due to the derivations and cutting down of consumptive uses resulting from the transfer; (ii) present and future losses of income and values generated by non-consumptive uses; (iii) losses of income in activities linked to those which are direct consumers of water [e.g. chain reaction: ∇ water $\Rightarrow$ ∇ irrigated land $\Rightarrow$ ∇ livestock and ∇ agro-industry]; (iv) indirect losses suffered by society as a whole in the original area (e.g. loss of public services, emigration, etc.).

The schemes used to protect the areas of origin are normally those mentioned below or even a combination:

(i) Prohibition or strong restriction (e.g. restrictions according to certain volumes of water flow, need to accredit the public interest of the transfer, etc.).

(ii) Norms which assign, either directly or indirectly, some part of the water for its future use in the area of origin. The following must be mentioned:

- Recovery or permanent priority. All the export rights of water are conditioned through the concession to users in the original area of the right to recover the exported water whenever this is necessary for the development of the original area.

- Reserve. A specific part of water is allocated for exclusive use of the original area and it is only permitted the export of surplus water. Surplus water is the quantity that exceeds the water needs at present or in a reasonably foreseeable future to satisfy all the beneficiary uses in the area of origin.

- Assessment. The transfers between basins must be evaluated taking into consideration certain general regulations or "public interest". The authority responsible must make a cost-benefit analysis in order to ensure that the benefits derived from the awarding of the concession are superior to the costs derived from the refusal.

(iii) Compensation. Tries to improve the situation of the basin of origin offering benefits which at least refund the costs incurred by the transfer (e.g. create a fund which can be used to provide water for future users of exporting areas at a reasonable cost).

Water management in Spain

Historical Background

The Royal Decree of 14-3-1846 strongly modified the previous legislation, doing away with private ownership of waters and demanding royal authorization for any use or benefit of river water.

Previously to this law, the arid and humid areas of Spain were managed under different water rules and institutions. Whilst the "humid" Spain and Castille upheld the system of riparian rights, similar to other North-European countries, in the arid areas such as Valencia, Murcia and Zaragoza, the legal regime assumed that all running water came under the control of the Administration. It was this last philosophy which finally prevailed in this and posterior spanish laws.

The Royal Decree of 12-8-1849 widened the public domain of all running water, the only water to remain private being water extracted from wells on private land. The Water Act of 1866, continued with this philosophy of water being a public resource, which finally also prevailed in the Water Act of 1879 in spite of some of the changes inspired by individualist principles. The Water Act of 1879, in force until 1985, established concessions of public waters for irrigation and was of great relevance in the development of the irrigation in our country.

The last Water Act of 2-8-1985 imposes as a new feature, the inclusion of ground waters in public domain, meaning that those discovering wells on private land lost their rights to take ownership.

Present Situation

According to the Water Act 29/1985 of 2 August, the owner of an estate can take advantage of pluvial waters running over his land and still waters within the limits of his land as well as water from springs and ground waters located on the property. However, the total annual volume extracted from the latter must not exceed 7,000 m^3.

Any other private use of water requires administrative concession to be granted; such concessions are granted taken into consideration the joint rational exploitation of the surface and ground resources.

Table 1. Exploitation of ground waters in different hydrographic basins

Basin	No. wells	Recharge hm^3 $year^{-1}$	Pumping hm^3 $year^{-1}$
Norte	15,200	2,975	51
Duero	34,000	1,875	353
Tajo	7,200	1,645	164
Guadiana	30,000	754	771
Guadalquivir	30,000	2,315	450
Sur	5,400	1,160	424
Segura	4,200	486	470
Jucar	12,700	3,505	1,440
Ebro	4,000	2,923	209
Pirineo		1,036	447
Baleares		585	283
Canarias		609	411
Total	142,700	19,868	5,493

Source: MOPU (1990). Plan hidrológico. Síntesis de la documentación básica. Madrid

Spain has 1,015 reservoirs (only those of more than 15 m height and capacity over 100,000 m^3 are considered) with a storage capacity of 52,934 hm^3, although according to data obtained there are thousands of small reservoirs, watering holes and ponds used almost exclusively for agricultural purposes and that are not included in the inventories.

The hydrographic basins with greater reservoir volumes are the Tajo, Guadiana, Guadalquivir, Duero and Ebro respectively. According to data from the Registro de Aguas Públicas y Catálogo de Aguas Privadas de las Cuencas, there are 142,700 wells in Spain from which 5,493 hm^3 $year^{-1}$ is extracted. As we can see from Table 1, the recharge volumes (including the infiltration of rainfall, seepage from rivers and

return flows from irrigation systems) are greater than the extractions. Apart from the case of the Guadiana Basin where pumping is slighter greater than recharge.

Nevertheless, the fact that this data is taken as a whole does not allow us to discern the problems of local underground aquifer over-exploitation. Some areas of the Balearic Islands and Andalucía were subjected to special regimes for the discovery of wells and exploitation of ground waters previous to the Water Law coming into force. In addition to that, the Royal Decree 2618/1986 of 24 December, on hearing the declarations of the hydrographic confederations of the Guadiana, Guadalquivir and south of Spain affirmed that the underground aquifers of Campo de Dalias, Zona de Nijar, Zona Húercas-Overa and Pulpí, Zona del Bajo Andarax (located in Almería, Andalucía) were all over-exploited, together with the western coast of the province of Huelva.

Interaction of different institutional structures in solving the problem of over-exploitation of the Campo de Dalias aquifer

Before the Water Act of 1985 was passed, the exploitation of underground waters was private in our Country. As users did not know the recharge rate of the aquifer and there were not clear regulations about extractions, well owners had incentives for overexploiting them while their marginal profits exceeded their marginal costs.

But once the problem was noticed several measures were taken to solve it. Naredo *et al.* 1993, show us the type of solutions that are being applied to avoid the marine intrusion in this aquifer. The Administration, users and some private bodies such as the Caja Rural de Almeria and the Experimental Station "Las Palmerillas" are cooperating most successfully in this question.

Public and private organizations have contributed their joint efforts working towards the successful reduction of water consumption. This is how the Instituto Geológico y Minero and the Servicio Geológico de la Dirección General de Obras Hidráulicas sounded the warning about the problems of over exploiting aquifers and of marine intrusion. This triggered the change in attitude of both farmers and irrigation communities and also the Central and Autonomous Administrations (fundamentally the Institute Andaluz de Reforma Agraria), which took up a series of measures both legally (prohibition of new irrigation systems) and also in the improvement of the irrigation water distribution network. The latter is useful as an example: the water distribution system is fully piped and controlled through meters as far as the farms, presently administered by the Comunidad de Regantes Sol Poniente, of approximately 2,000 hectares of irrigated land of the Sector VI of the Campo de Dalías. One must likewise point out that the action of the irrigation communities as true vehicles to collectively manage for the farmers the extraction and distribution of water has avoided the "war of the wells" and facilitates the good state of repair of the hydraulic infrastructures, minimizing losses along the network.

Supply and demand of water. Are water transfers necessary?

Table 2 shows us the demands for water from different sectors in each basin. One can observe that the agricultural activity demands almost 80% of the total consumptive needs, particularly the Ebro Basin has a high agricultural demand, 8 times more than the urban and industrial demands put together. The only exception to this generalized trend is that of the Northern Basin where its industrial and urban uses are greater than the agricultural demands.

Table 2. Water demand for different uses according to the hydrographic basins (hm^3 $year^{-1}$)

Basins	Urban	Industrial	Agriculture
Norte	601	684	673
Duero†	214	-	3,375
Tajo†	573	161	2,119
Guadiana	126	138	2,052
Guadalquivir	687	476	2,996
Sur†	275	-	704
Segura†	193	-	1,861
Jucar	499	107	2,535
Ebro	545	324	6,683
Pirineo†	959	-	348
Baleares†	96	-	276
Canarias†	121	-	687
Total	4,889	1,890	24,309

†Industrial demand is added to urban demand. Demands for hydroelectricity, cooling systems for power stations have not been considered.

In recent years, agricultural needs for water have increased considerably due to numerous private irrigation programmes which (encouraged by the financial advantages given) are creating more new irrigated lands than the Administration. The water used in these new irrigation systems almost always comes from underground aquifers which are not always renewable, are not easy to manage and predict. As a consequence, problems of sustainability may arise in the medium or long term, unless the Administration carries out a detailed study of these systems and regulates them appropriately in order to lead users towards a sustainable management of the resources.On the other hand, the increase in non-consumptive demands such as ecological and recreational uses are often incorporated in the demands attributed to agriculture.

Table 3 indicates the deficits and surpluses of water in each basin. Although taken as a group, surpluses are greater than deficits, this is rather misleading because there are remarkable deficits in some basins (Guadalquivir, Sur, Segura, Gawkier and also the Balearic and Canary Islands). This manifests the possible need for controversial

water transfers between basins. The original areas of water surpluses are very hesitant when it comes to the possibility of their losing this scarce natural resource in favour of "national interest" without the guarantee of sufficient compensation (it being a publicly owned resource).

Table 3. Volumes of deficits and surpluses of water by basins† (hm^3 $year^{-1}$)

Basins	Resources	Demand	Surplus	Deficit
Norte y Galicia	4,967	1,958	3,009	-
Duero	9,269	3,589	5,680	-
Tajo	6,233	2,853	3,380	-
Guadiana	2,385	2,316	69	-
Guadalquivir	3,255	4,159	-	904
Sur	861	979	-	118
Segura	700	2,054	-	1,354
Jucar	2,564	3,141	-	577
Ebro	9,337	7,552	1,785	-
Pirineo	1,358	1,307	51	-
Baleares	312	372	-	60
Canarias	496	808	-	312
Total	41,737	31,088	13,974	3,325

†Other demands and water quality aspects have not been considered

The problem of water allocation

The Water Act stipulates that the Hydrological Basin Plans must fix an order of priorities on granting water concessions, taking into consideration the demands for protection and conservation of the resource and its surroundings. However, and whilst these Basin Plans are being elaborated, the Law stipulates the following order of general priorities:

(i) Supply for the population, including a necessary amount for low-consumption industries in towns and those connected to the urban network.

(ii) Irrigation and agricultural uses.

(iii) Industrial uses for the production of electrical energy.

(iv) Other industrial uses not included in previous sections.

(v) Aquaculture.

(vi) Recreational uses.

(vii) Navigation and water transport.

(viii) Other uses.

At this stage we could ask ourselves how this order of priorities has come about, whether based on strictly political criteria or whether it is a case of re-allocating the water from uses of lesser value towards those of greater value. The truth is that at first sight, there does not seem to be an intention towards the re-allocation towards more efficient uses, nor is there much priority given to those non-consumption and ecological uses of the resource.

In the first place, one must say that in order to carry out an efficient allocation of water, the water prices ought to be indicative of the scarcity of the resource. This does not happen at the moment, since the water prices only contemplate costs derived from the distribution and management of the resource. Fortunately, the hydrological basin plans will serve to fix new water prices more in accordance with the deficit or surplus situations of each basin.

The lack of competitivity of many Spanish irrigated lands and particularly those specialized in intensive inland crops (cereals, oil seeds, beetroot, etc.) ought to be serious and unbiased food for thought regarding the future re-orientation possibilities.

These productions, majority productions in many basins, are demanding considerable volumes of water (partly due to the fact that the low price water policy does not encourage an efficient management of the irrigation systems, nor does it encourage a capitalization towards systems which save water) and on the other hand, they are gaining a very small remuneration since they are surplus crops. This situation does not appear to be sustainable in the long term, especially if the water price policy is modified, since these crops will not longer be profitable.

If alternatives to this type of production were to be found and if a technological change were to be encouraged towards more efficient irrigation systems in water use, part of the water could possibly be released towards other consumption uses (industry, towns, etc.) and for other non-consumptive uses. This, at the same time, could mitigate the need for water transfers from surplus basins to deficit basins which always creates friction and unease both between regions and also towards the Central Administration.

Conclusions

There are not perfect allocation structures. It is true that market, if clearly defined and regulated, may allocate water among consumptive uses more efficiently than other institutions; however, we have seen that it does not consider equity criteria and either negative externalities. Water allocation by public institutions may be more sensitive to the general interest and so to the equity criteria but it falls shorter with the resource allocation efficiency.

Water allocation is under the control of public institutions in Spain. It is evident that water allocation among different uses is not efficient in our country: prices do not reflect the scarcity and the water is not re-allocated towards the greatest value uses. However, public institutions, becoming aware of this problem, are trying to correct this sort of disequilibriums.

With regard to the interregional water transfers, they should only be done in the case they are the lower cost supply alternative and benefits are higher than costs (compensation of the original areas and costs of infrastructure included). Nevertheless, there is the impression that is too early to talk about transfers when there is much to do in terms of reallocation towards higher marginal value uses in our country.

Either market allocation systems or the public one are expensive if they are required to be efficient because both need very detailed information about the quantity and quality of the resource, its use, control, etc.

Generally speaking, the richer and technologically advanced a country is, the better the resource allocation system works, independent of the type of the system, because it may be supported by information collecting and data systems that allow it a more precise and scientific management of the resource.

The recent experience in Campo Dalias (Almería) proves that public control over underground water may be very efficient to solve an aquifers'over-exploitation when it is developed over consistent scientific bases and in an appropriate and cooperative manner.

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