Water Management for Irrigation and Environment in a Water-Stressed Basin in South-West France: Charging is an Important Tool, but is it Sufficient?

Henri Tardieu
General Manager, Compagnie d'Aménagement des Coteaux de Gascogne (CACG)
Tarbes, France

Abstract

In France, the water management issue is no longer a question of developing stakeholders' participation or transferring State competence to user associations. As for the other countries with a complete and complex institutional framework, the point is to define clearly the role of each water management stakeholder and to answer both remaining questions:

1. *How to ensure sustainability of the investments by raising the price of water without discouraging economic development?*

2. *How to share water among users when resources are scarce?*

The general answer given to these questions relies on the two basic principles of a good water management leading to sustainable development:

1. *as it consumes more than 70 percent of the available water of low flow periods, irrigated agriculture must respect the other uses by limiting its demand to the allocated volume;*

2. *as it involves large and long-term public investments, irrigated agriculture must at least bear the "sustainability cost" of the upstream water resources.*

Such a general answer is of course largely case-specific and should be adjusted to each institutional framework.

France, like other Euro-Mediterranean countries, has a long history of water development, born from water scarcity and a constant search for the best agricultural use and the fairest sharing. A complex institutional structure has progressively been set up to develop private initiatives within a public service framework.

During the last century, Authorised User Associations (ASA) were developed. They were public establishments constituted by landowners for sharing the construction and management of irrigation systems.

In the 1950s, the State created, within more ambitious land use planning, the Regional Development Companies (SARs), public corporations with a "concession" from the State, to develop water resources and manage irrigation schemes in the southern regions of France. Well subsidised by the State at the beginning, the SARs now

cover their costs with the contributions of their customers. This management is now financially sustainable as it includes the provisions necessary to maintain the investments under concession. It nevertheless keeps the basic characteristics of a French public service: continuity, equity, sustainability, and transparency.

Finally, Basin Organisations were set up more recently, with a widened approach to include management and protection of the environment, to seek a global consensus on water management by using dialogue and financial incentives, while the State keeps the role of regulation.

After a short discussion about the stakeholders in French irrigation and water management, this paper addresses both socio-economic questions stated above, with a specific discussion of the case of the Neste system, a water-stressed basin in the south-west of France.

1. The key stakeholders in irrigation and water management in France

1.1 At the individual level: farmers

Farmers aim to satisfy the objectives they select for their household (to ensure a minimum revenue), their enterprise (to maximise profits, to minimise risks, and to improve the quality of the products) and their land (to be sustainable).

Each one freely chooses the crops to grow on the basis of advice from his profession with due consideration given to the market. He consequently optimises the management of the production factors, particularly the on-farm irrigation system.

The valorisation of water through irrigated agriculture varies, largely due to the heterogeneity of the production systems. The cost of irrigation water is generally relatively high in the Mediterranean regions, and implies high performances with high value-added crops.

The constraints of agricultural competitiveness make the irrigator very sensitive to the reliability of water supply and of course to its cost.

For each culture in a given cropping pattern, water value can be assessed; so the water demand is represented by the graph of water values per water volume. Such a graph shows how an irrigator reacts when the water price varies.

1.2 At the level of small systems: Authorised User Associations (ASA)

Gathering irrigators through an association which owns and/or manages common assets is the first and the oldest way to manage collective irrigation [Lesbats et al 1996]. These associations bring together the land-owners concerned with the irrigation system. They are self-managed structures, based on a legal framework developed since the 19th century, and have all the authority needed to carry out and to manage their irrigation system.

The statutes of Authorised User Associations (ASAs) are public; they confer on them the capacity to act for the public good, particularly in the matter of cost recovery, where they follow the rules of public accounting. Costs are shared in proportion to the involvement of each owner in the project area, generally as a function of his irrigated area.

These associations have a very long lifetime, since the properties are irrevocably engaged in the association. This long experience provides valuable references.

Initially, the collective participation of members is exemplary. They define their projects according to their needs and their means of fulfilling them. They personally ensure operation and minor maintenance. The apparent cost, corresponding only to monetary expenditure, is thus largely below the comprehensive cost of water.

But it sometimes happens that the necessary solidarity decreases and the ASA goes wrong by lack of involvement and lack of professionalism. Members are then concerned about the immediate balance of the accounts, and cut down the maintenance expenditure. This entails serious consequences in terms of quality and continuity of service.

To be assisted in all these approaches, and to preserve or re-establish the durability of their system, at the conception as well as at the management stage, ASAs have currently been calling for the help of the Administration. The ASA statutes indeed foresee that in case of bankruptcy of the ASA, the State representative has to replace the ASA President. Considering the State's other involvements, ASAs are now looking for professional advice, particularly on the part of the SARs (see below).

Such a complementary relationship between ASAs and a technically competent body can be organised at the start of the project so as to guarantee sustainable management. This is the case with the design and/or maintenance contracts offered by CACG, one of the SARs. These contracts can also evolve towards Public Service Delegation.

1.3 At the level of large systems: Regional Development Companies (SARs)

Created about 40 years ago, in the southern regions of France where water was proved to be a limiting factor to development, the SARs are characterised by the originality of their mission and statutes (Plantey et al.1996).

Their mission, defined by the concession contract with the State, deals with the implementation and operation of hydraulic projects necessary for the development of their region. Managing the conceded water resources, they ensure their conveyance to the centres of urban and industrial consumption, and the distribution in rural irrigated areas. For this purpose, they have all the rights and obligations of the owner of the works, but without the right to sell them.

Their statutes are those of private companies, implying rules of sound management and economic efficiency. The majority of the shareholders are public, and so is the governance: the local authorities (Départements[1] and Regions) have therefore control of the strategic resources in the name of the public good for all water users. The agricultural users are especially represented in the Board and participate therefore in governance as the SARs' private shareholders.

In accordance with the specifications of their concession contract, the action of the SARs is guided by the principles of sustainable management of a public service:

- Quality, continuity of water service;
- Equity when water is to be shared between users;
- Sustainability with adequate provisions for long term maintenance;
- Transparency of the management and accountability to the Board.

The SARs' continuous effort, with regard to innovation and professionalism, bears fruit: the system performances ensure, for a controlled cost, the best adequacy between resources and needs on the basis of integrated water management. Despite the relative scarcity of the resource in the French Mediterranean regions, water shortages or conflicts between users are no longer a major concern in the systems managed by the SARs (Tardieu and Plantey 1999).

When an exceptional crisis situation arises, high-tech equipment and well-tried methods in water sharing allow equitable management of the resource. This is typically the case of the Neste system managed by CACG.

1.4 At the level of large catchment basins

The Basin Committee, a sort of water parliament where users, local authorities and government are represented, is in charge of conservation of the water environment and of water management policy in one of the six French large catchment basins. It develops, in collaboration with the State Administration, the long-term water policy plan (SDAGE).

The Water Agencies are their executive body: taxes, collected in accordance with voted decisions of the Basin Committee, discourage polluters and consumers from polluting and consuming. This incentive to behave in a more responsible manner is coupled with a financial policy since the product of the taxes is allocated to financial aids for pollution abatement and for conservation/development of water resources. For irrigation particularly Water Agencies contribute to investments in modernisation and regulation, which are very important sources of water savings.

After 30 years the system based on the principles of solidarity and equity (the polluter pays and the consumer pays) is well accepted by public opinion. But the French Water Agencies are not to be misunderstood: they do not have direct responsibilities in water system management unlike the bodies described above.

[1] A Département is a local government unit.

1.5 At the State level

According to the terms of the 1992 Water Law, it is not the State's responsibility to ensure directly the operational management of water resources, except for very large rivers. Its authority should guarantee the respect of the necessary regulations of water uses, which are subject to previous authorisation. Elaboration and updating of the rules should be carried out in consensus with the members of the water community, so as to minimise the number of rule-breaker users.

Finally the State is the owner of large hydraulic works for irrigation purposes, precisely those which are delegated to the SARs by a concession contract. As a consequence, it supervises both the maintenance and the best use of the assets in order to meet all water demands.

Although this presentation of the French institutional framework in water management may be too simplified, we can nevertheless see an attempt to clarify the respective roles of different stakeholders:

- basin planning and financial policy: the Basin Committee seeks a consensus to reconcile all users, both among themselves and with the environment, in a global approach to water management using financial incentives.
- operational management: the SARs manage water resources by contracting with users, and ensure the sustainability of the assets; the ASAs have almost the same objectives but only for smaller irrigation systems.
- regulation and law enforcement: the State sets up regulation measures, keeping in mind both the necessary consensus and its own possibilities for applying them to all users.

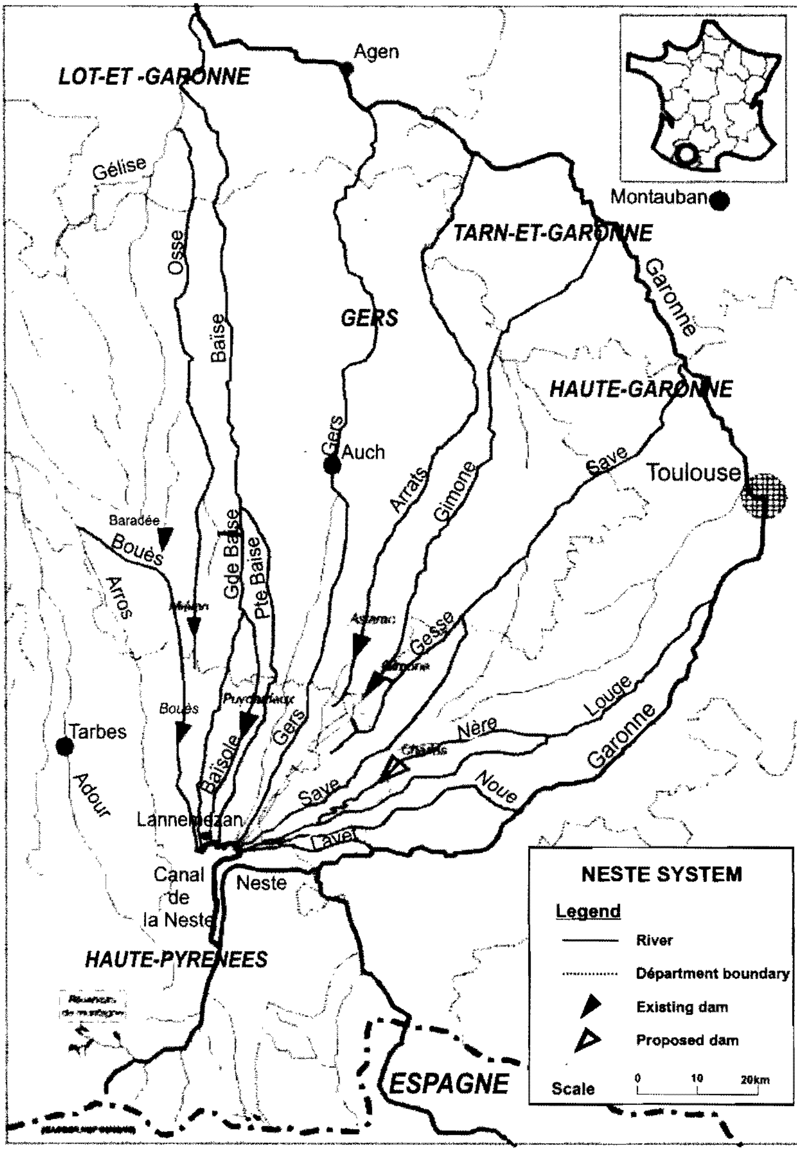
It is worth noting that the French water organisation is also characterised by a "public/private" mix. The freedom of the private initiative is balanced by the research of the public good. The economic efficiency of private management is associated with the sustainability of the public service.

2. The Neste system: an example of "controlled water management"

In the south-west of France, water management concerns several uses, among which, particularly for surface water, there are three important competing uses: irrigation, hydropower and minimum flow in the rivers.

As an example, water management in the Neste system is here described not only as a successful set of rules, consultation methods and high-tech controls, but also as a system facing a regulation problem due to a water supply below the water demand. The specific features of the water management agency—the Compagnie

Figure 1: Map of the Neste basin



d'Aménagement des Coteaux de Gascogne (CACG), one of the SARs—are described as preconditions of the success of "controlled water management": the institutional originality of the SARs with public missions and private management, their joint experience in regional development and water management, their capacity in maintenance and asset conservation, and finally the good practices they follow in pricing water as an economic tool together with a quota system.

Economic analysis of the water value in each use, particularly for irrigation in the specific context of irrigated agriculture and land development, may clarify the allocation of water and validate the regulation tools used in "controlled water management."

2.1 Presentation of the Neste system

In 1990, after a deep crisis, with conflicts between users due to a water-scarce situation, a new management method was set up (Tardieu 1991). In operation for 10 years, it can be described as follows with its successes and limitations:

Location: A 10,000 km^2 basin located in the south-west of France with 650 mm of rainfall, where irrigation is necessary for most kinds of agricultural production, and surface water is the only resource for urban and industrial uses because of lack of groundwater: recharged rivers (1,300 km) are the common resource for every user.

Water users:

- fish, wildlife and tourism need 250 Mm^3/year to strengthen low flows[2];
- 200,000 inhabitants consume 13 Mm^3/year;
- 51,000 irrigated hectares (28,000 l/s subscribed by 3,000 irrigators) consume 70 (average) to 95 Mm^3/year (dry years);
- a 10,000 hectares waiting list without irrigation contract (equivalent to 6,000 l/s).

Water resources:

- the Neste Canal (a State concession to CACG) which diverts 250 Mm^3 of the natural flow of the river Neste;
- stored resources: 100 Mm^3, of which 48 Mm^3 are stored in hydroelectric mountain reservoirs and 52 Mm^3 in CACG lakes (also State concessions).

[2] Mm^3 = million (10^6) cubic meters.

Types of withdrawal:

- individual withdrawals (14,500 l/s subscribed through "conventions de restitution", or "pour-back contracts";
- collective withdrawals by ASAs or CACG (State-conceded) irrigation networks (13,500 l/s).

Monitoring and remote control:

- resources: 200 river flow meters, 40 dam and canal gates, and 150 pumping stations under remote control;
- demand: 1,500 individual water meters (checked 3 to 4 times a year), 6,000 meters on collective networks, 150 pumping stations under continuous monitoring

Resource-demand balancing:

- The balance is ensured with a failure rate of 1 in 4 (years). For a more comfortable balance, the additional resource needed is 43 Mm^3 for the waiting list, and 7 Mm^3 to reduce the failure rate.

2.2 Management rules: the contract, individual and collective

Each user signs with CACG a water contract called "convention de restitution" guaranteeing that his/her withdrawal is balanced out by an equivalent upstream recharge. The contract states a maximum diversion flow and a subscribed volume (the "quota") with a 2-tier price (2-step): the first price is a function of the subscribed flow (Francs 320 per l/s)[3], the second price is a function of the volume consumed over and above the quota. (F 0.63 per m^3 above the 4,000 m^3/l/s quota).

Thus there are two limits on the abstraction of water by the user: a rate limit, and a volume limit. If the authorised flow rate is Q litres per second, the volume quota for the year is 4,000 m^3. (This means in effect that the user may abstract water for 1,110 hours before the quota is exceeded.) The extra payment required by those who exceed their volume quota is F 0.63 per m^3. The price step is thus large. By paying F 320 the user becomes entitled to take up to 4,000 m^3, so if the full quota is taken its average price per m^3 is F 0.08. If the quota is exceeded by the user, the marginal price for taking more water rises immediately to F 0.63.

In reality, the user will often take less than the quota, particularly during rainy years. In that case the payment of F 320 remains, so in effect the average price paid per m^3 is more than F 0.08, which is the minimum possible. Over a long period, the average price actually paid is close to F 0.12 per m^3.

[3] 1 Franc = about 12.6 US cents (October 2000).

The contract also fixes penalties for the user (in case of withdrawing above the subscribed flow, or lack of water meter) and for CACG (in case of quota reduction).

As demand exceeds resources even when dams are full, the Neste Commission, which brings together all water stakeholders from the five Départements involved, decided to start a "waiting list" of applicants. All rejected applications are registered in a withdrawal file freely accessible (6,000 l/s to date). Newly created resources and contract resignations allow a few new applications to be met annually, according to priority rules (young farmers) or to seniority on the waiting list. All the yearly contracts get a collective withdrawal authorisation in each of the five Départements.

When dams are not full or when it is anticipated that the Neste river flow will decrease, the Neste Commission meets before the irrigation season to decide on a quota reduction. The choice of the meeting date is the result of a compromise between the possibility of making a sound hydrological forecast and the possibility for farmers to adjust cropping patterns or inputs.

During the irrigation period, water meters are checked; if the quota seems likely to be entirely used, a warning letter is sent by CACG to the irrigator. Quota overrides are billed at the end of the season. Besides, CACG which is also in charge of the resource management activates its computerised remote control (RIO software): tactical water management in order to save water transferred from the remote-controlled dams (checked every three hours); strategic water management in order to optimise water allocation between irrigation and river wildlife with the objective of emptying the reservoirs by the end of the low flow period with a failure rate of 1 in 10 (weekly check).

After the irrigation season, water management performance is assessed in terms of respect or improvement of minimum wildlife flows, respect of volumes subscribed by irrigators and water savings throughout the system:

- Since 1990, when the system was first put in operation, failures to maintain wildlife minimum flows have been rare: One to two days per year over a few kilometres, as compared to the drying up of several dozens of kilometres over several weeks in 1989.

- However, irrigators' quotas have been reduced in 4 years out of 10 (although one of these reductions was later cancelled). The ultimate solution, when a crisis cannot be solved by quotas—imposition of the authority of the state, through intervention by the Prefect of the Department—has not been applied, except for substituting (in 3 years out of 10) a simple interdiction instead of the economic incentive for staying within the allocated quota.

- As to water savings throughout the system, it can be said, after using the RIO software for 10 years, that these amount to over 20 percent of the managed volume.

2.3 Successes and problems of the system: can a limited supply be regulated?

In the Neste system both principles of good water management are respected:

- Water is shared in such a way that fish and wildlife are preserved all along the 1,300 km of recharged rivers and that irrigators are delivered their contracted volumes;

- CACG, on behalf of the "conceding" State which bills the cost of the service, gets the financial means to cover at least the "sustainability cost" and guarantee the maintenance of the invested assets (F 3,000 million in current prices).

This is an obvious progress in comparison with the two "wrong practices" of the previous period: daily interdictions by the Prefect, which irrigators were circumventing by over-investing in pumping capacities, thus worsening subsequent crises; and the inability to charge for the "resource" part of the water service, thus leading to asset jeopardy.

One direct positive consequence is that irrigators are driven to saving water and optimising their cropping patterns, through a sound and sustainable incentive far more valuable than any media campaign. It also induces a renewed interest on the part of advice and research networks towards quota optimisation, in terms of cropping patterns or input selection (Balas 1993).

But a fundamental question remains which concerns "spatial development"[3]: what about the waiting list's demand, if water resource creation is hampered by procedure problems as well as limitations of public funds? One solution is sometimes envisaged: to reduce definitively all quotas of current irrigators, in order to let in the new applicants. This bad solution, which addresses issues of equity, economic efficiency, social acceptance and technical and agricultural management, has been discussed in a special paper (Tardieu 1999) and is summarised in section 4.

3. How to charge for balancing the irrigation costs without threatening economic development?

Whichever institutional framework one chooses, irrigation's main challenge is to cover the <u>full cost</u> of water used, by <u>raising the water price</u>.

The point is, for most irrigation systems being managed by government agencies, that public subsidies are now limited by Budget constraints. Such subsidies may consist in financing the operating personnel, heavy maintenance or rehabilitation costs, or in under-pricing the energy, etc. For us Europeans, the commitment "user pays for water" will be the basis of the new European Water Directive. Some targeted and transparent subsidies will still be acceptable, on the condition that they will be gradually phased out. This objective of an irrigation system breaking even thanks to adapted water charges is not impossible to reach: it is already the case in several regions of France.

However, the economic and social consequences of water price rises can be serious, as shown by the following examples of likely risks:

- Overall reduction in the country's agricultural production, making it impossible to reach the goal frequently assigned to irrigation, i.e. to secure food self-sufficiency. This consequence may be accepted if the country can maintain its "food sovereignty" [FAO-NGO 1996]. A regular increase in the price of water has recently been started in Tunisia, except for cereals, for which water charges have been kept constant.

- Higher food prices for urban consumers, which induces larger food imports and some losses of internal market shares for irrigating farmers. This has already been verified in various African countries.

- Lower agricultural income, hence increased rural poverty and population migration towards towns. Even if the irrigating farmers are not the most vulnerable in economic terms—since they can use a wider range of crops—the economic development of rural populations must remain irrigation's fundamental objective.

On the other hand, the "true prices" process can also entail some benefits:

- a new respect for water, which improves management efficiency;

- an incentive to choose the most profitable crops and to maximise comparative advantages;

- a means to know which assets have to be maintained, and which investments have to be done.

So, this price adjustment process has to be conducted with great care, taking into account the economic consequences on production: this is done by analysing the "water value" of irrigation for the farmer, i.e. the additional added value per water unit (m^3) offered by irrigated crops as compared with rain-fed.

3.1 Full cost and "sustainability cost"

Before tackling this issue, it is worth restating the definition of the full cost of water from the point of view of the agency responsible for water resource acquisition and distribution.

The full cost of water includes:

- operating costs: staff, energy, daily upkeep;

- investment-linked costs: depreciation and/or maintenance/renewal, financial costs of the initial investment.

A water price set at this level secures a balanced budget for the managing agency without any subsidies. In France, this price is about 1 F/m^3 for the large irrigation schemes, where water charges are based on the full cost of water with the first investment partially subsidised.

However, the cost of major headworks (reservoirs, transfer canals) is generally not included. The rationale for such under-charging is based on the consideration that these works are both strategic and multi-purpose and that they were created for the sake of regional development at a time when economies were more state-backed and more protected. Today, countries where such infrastructure is paid for by water users instead of taxpayers are rare. Nevertheless, it is the objective that has been set for irrigation, notably in France, with a transition period allowing a smooth evolution of production systems.

During that phase, water charges are meant to cover what will be called the <u>sustainability cost</u> of water, something that, in the case of heavy, long-life investments, is very different from the full cost:

- *sustainability cost = operating cost* + maintenance and sustainable renewal cost; or
- *sustainability cost = full cost* – financial cost of initial investment

With a water price set at the sustainability cost level, no new investment is possible; but budget constraints are met, and sustainable operation and maintenance ensured without having to resort to public funding.

As a very simplified example, here are the different costs, added to the water distribution cost, generated by the water resource infrastructure. This is the case of the Neste system: actual annual costs of a reservoir dam feeding a river (investment cost 10 F/m^3 with a quasi-infinite life duration).

Table 1: Calculation of sustainability cost and full cost, in the Neste system

Units: F/m^3

Operation and daily upkeep	0.05	
Maintenance / Renewal (0.5% x investment cost)	0.05	
Sustainability cost		0.10
Financial cost (Long-term interest rate : 5%)	0.50	
Full cost		0.60

A water price covering the sustainability cost of 0.10 F/m^3 is socially acceptable and, after the necessary public funding of the initial investment, prevents the need for further subsidies.

This transition phase, in the pricing policy is adopted in France: irrigation distribution costs are charged usually around 1 F/ m^3, i.e. at full cost pricing whereas the irrigator's share of the water resource costs is charged more around 0.10 F/m^3, i.e. at sustainability cost pricing.

3.2 Water Strategic Value

On the basis of the existing farming infrastructure, the strategic value (*Vs*) corresponds to the optimum combination between irrigated and non-irrigated crops, with a given cropping pattern:

Strategic Value: $$Vs = \frac{VAI - VANI}{VI}$$

where

VAI = Value Added from Irrigated crops (before deducting the cost of water);

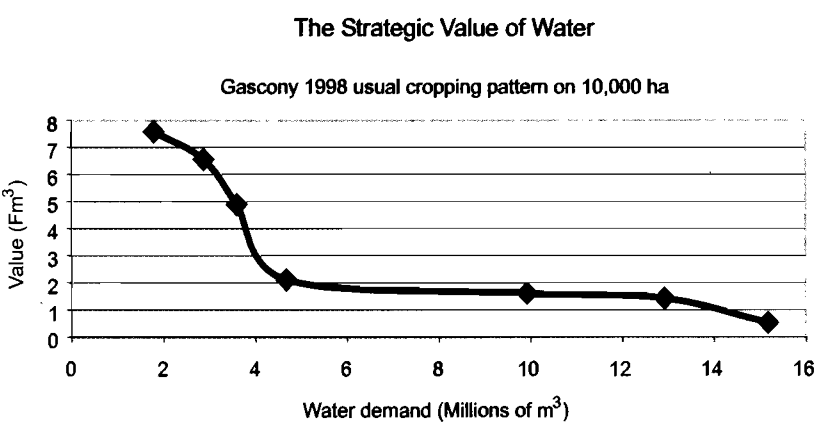
VANI = Value Added from Non-Irrigated crops (rain-fed crops) which could be cultivated instead of Irrigated crops

VI = Volume of water allocated to Irrigation

This value[5] reflects strategic choices made by the farmer at a point in time when he can still modify his cropping pattern, and adjust his irrigation practice to a variable allocated water volume. It is the result of a decision taken once or twice a year and it should at least cover the cost of irrigation (not included in *VAI*) for it to be profitable.

The strategic values of irrigated crops in any region can then be related to the areas of those crops and hence to their water consumption. By arranging these various crops in decreasing order of their strategic values, we can obtain a graphical relationship between crop value and water demand, as shown in figure 2.

Figure 2: Effect of water quantity on water value



[5]See also Molden et al. 1998.

The following remarks can be made on the Vs formula presented above:

- Variations in the crop price (domestic or world price) can lead to a change in value that rules out irrigation, or on the contrary to a stronger water demand; this is particularly the case for cereals, whose water valuation is relatively feeble but which call for large volumes of water.

- Changes in the yield or added value of a given rainfed crop can paradoxically entail changes in irrigation water demand. For instance, a specific subsidy to rainfed durum ("hard" wheat) makes it an alternative to irrigated maize in the driest parts of southern France. On the other hand, the probable diminishing profitability of cattle breeding (because of the coming reform of the Common Agricultural Policy of the European Union) will increase water demand for irrigated cereals; the improvement of rainfed crops in Sahelian Africa may lead to reserving irrigation for high added-value crops, such as vegetables or fruits.

- Improving irrigation effectiveness, thus diminishing the formula's denominator, increases water value and may make irrigation profitable; this is often the case with the flood irrigation of meadows, economically unthinkable in water-scarce areas but quite sound, if carefully conducted, in a mixed farming system.

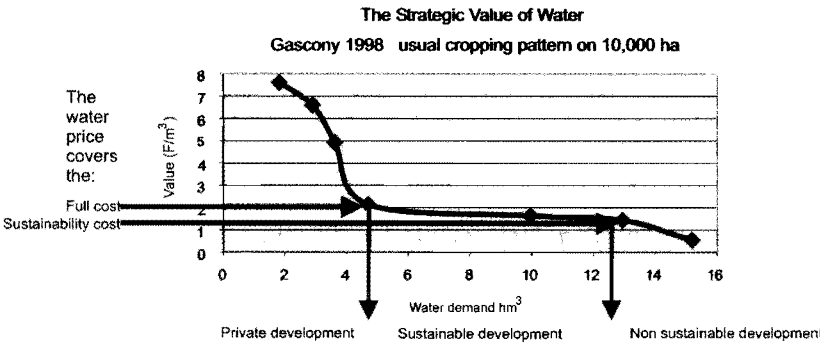
3.3 Water's Strategic Value, price and budget constraints

By comparing the *strategic values* of water for the farmer and its *comprehensive cost,* it is easy to know the average price that will balance the irrigation manager's budget.

The problem for the irrigation agency, and for the State which is often backing it, is the following: water price rises, which help to balance its budget, have a negative effect on water sales and, hence, a tendency to raise the costs of each m^3 sold since irrigation costs are mostly fixed ones (depreciation, financial, and maintenance costs). This is a vicious circle leading inevitably to the collapse of the system. That is why, in a now-transparent management environment, the State may find it interesting to keep on financing intensification or modernisation investments, thus boosting irrigated agriculture and increasing its own chances of recouping heavy *sunk costs.*

The concept of *sustainability cost* as described above is essential, for it constitutes the lowest price the State can accept. If the water price does not cover the sustainability cost and exceeds the Strategic Value of water for farmers (for at least one given existing crop), this means that a long-term public subsidy through water charges will be necessary to maintain that irrigated crop in the country or region considered. The opening up of agricultural markets and the new transparency in world trade will make this practice impossible in the future.

Figure 3: Sustainable allocation of water



Note: In this example, the price of 1.10/Fm³ based on sustainability cost includes the costs of the upstream dam and the distribution system, whereas on a full-cost basis this price would be about 2F/m³.

On the other hand, it does not seem economically sound to dismantle entire sectors of irrigated agriculture on the principle that the *full cost* of water should be covered... at all costs! This would mean that today's irrigators would have to pay for investments which will also be used by future generations, thus justifying a certain amount of public subsidies to help start up the economic development process.

So, when embarking on the true-price process in irrigation, it is essential to have a good understanding of *strategic values* of water to be able to derive demand curves by farm types and by region. Economic data on irrigated crops are not always available. This is one negative consequence of the disappearance of public irrigation agencies: the overall regulation of irrigation investments and of agricultural production requires States to allocate some funds to data collection and processing that "privatised" agencies can no longer afford. It should not be forgotten that economic references to be looked at also concern rain-fed crops, so as to be in a position to correctly appraise water value by comparison between alternative agro-economic systems.

4. Is water pricing useful for controlling water allocations?

The points made above assume that an essential pre-requisite has been met: the clear identification of the economic agents who buy and sell irrigation water, and can also measure the traded economic good. This is an often heavy but always decisive task, which precedes and accompanies the true-price process in irrigation: going away from the idea that water is a free gift from the State, towards the concept of an irrigation water "service" to a "client" farmer. The critical point of how this transfer should be conducted is the subject of many workshops. Let it just be said that, wherever water is scarce, it is very tempting to use the newly established economic links between "supplier" and "customer" to try to regulate water management through prices.

Indeed, after the beneficial disengagement of the State from direct management of irrigation schemes, some think that the regulation of water management can also be taken care of solely by price mechanisms. To what extent is such price-based regulation reliable?

Water allocation regulation consists in inciting each economic agent to respect the volume of water allocated by the public authority. Is the pricing of water sufficient to avoid crises in scarce water systems? Can it settle intersectoral disputes between competing uses? Can it improve water distribution between farmers?

4.1 Quotas and pricing: instruments for allocation regulation

In water-scarce regions, water quotas are—more or less clearly—allocated to farmers, by sub-basin or by region. For the public authority, the problem is to ensure that these allocations are respected. The answer is usually of the law enforcement type, forbidding off-takes and suing trespassers. This type of regulation generates economic inefficiency and, sometimes, corruption. Therefore, it is highly tempting to use the price of water to avoid disputes between users, provided that all participants have been identified and the service billed has been clearly defined.

From analysis of the marginal value of water (marginal value is defined here as the value of the additional production that is brought about by one additional m^3 of water applied during the irrigation period), a method of water pricing can be derived with a view to attempting such regulation. It will necessarily be step-pricing, i.e. a discontinuous series of price levels, increasing with water demand. The higher price step, which will counteract the marginal value, must be higher than the lower price step, which itself is calculated to cover at least the sustainability cost and also to secure the farmer's income.

The fairly simple system set up in the Neste system consists of:

- an allocated quota, priced at a fixed total which is the same whether the user takes it all or takes less;
- an over-consumption price, for using more water than the quota.

The overall volume quota must be compatible with the limited resources allocated to irrigation as opposed to other competing uses. For a given existing irrigated area there exists a corresponding volume quota per hectare, which has to be regulated with a price step high enough to deter over-consumption.

But efficient regulation is based on understandable and practical water charges, within a freely negotiated contract: bills are useless if they cannot be recovered. Too high over-consumption prices can only lead to jeopardised contracts and then to legal prosecutions, which is precisely the regulation mode to be avoided.

The Neste system example shows that a price step between average price and over-consumption price exceeding 0.60 or 0.80 F/m^3 would not be socially acceptable at present. This approach provides useful strategic guidelines for fixing the volume quota per hectare. In consideration of the marginal value graph, this highest price step clarifies the concept of socially acceptable minimum quota. If the quota is too far below the optimum needs (less than 80% of those needs) the system does not work in a dry year: then, crisis can be frequent, with stalled contracts and prosecution by the public authorities.

4.2 Best practices in water pricing and water resources development

Stemming from this discussion, three basic ideas can be emphasised:

- Water *step-pricing* can help to regulate the allocation system if the quota and the *over-consumption price* are set in consideration of the *marginal value* of water and the social acceptability of the water charge.

- *Quotas* that are too low compared to the crop need cannot be regulated by pricing, and lead to economic inefficiency linked to enforcing inapplicable rules. The quest for equity at all costs in a system with limited resources leads to the same result.

- Increasing water resources in a tight system makes it possible, over and above the direct economic benefits, to rebuild collective regulation based on a sound *quota + price contract* which will leave each farmer free to manage his irrigation efficiently according to his own water value function.

Such an effort to adapt the strategy of water pricing, together with the investments needed to create new water resources, is necessary to help farmers face open market competition: guaranteed and clearly contracted water supply, full responsibility in irrigation management without public intervention.

But it is clear that such a system of price regulation can only work smoothly within a narrow range of economic variables, water price and water value. And it is the State's responsibility not only to identify this range but also to be ready to lay down rules on economically "offside" behaviours (high water value crops, exceptional water shortages, and irrational collective wastage). Only this type of strong State makes it possible for the managing agency to make efficient and economic use of price regulation.

The main advantage of such regulation is to give back to farmers the freedom to optimise their choice of crops and their management of irrigated or non-irrigated agriculture, this optimisation being more and more complex in the context of competitive world markets.

One prerequisite to the efficiency of this economic approach lies in the identification of the relevant agents (managing agency, individual farmers, water user groups), the clear content of their contract relations (water price, allocated water volume), and the capacity to measure the traded economic good (water meters). It is indeed a move towards water markets (Kosciusko-Morizet et al. 1998). But analysis of the value of irrigation water—particularly its marginal value—shows that it would be unwise to go further along this line, especially when it comes to free bidding for water quotas, given, on the one hand, the disproportion between the marginal value and the socially acceptable price of water and, on the other hand, the necessary equity in the sharing of a highly socially-valued good, this feeling of equity being necessary for water pricing to be efficient.

5. Conclusion and lessons learned

The role of service-oriented organisations in irrigation and water management is now largely accepted as a prerequisite for implementing good control of water allocation and ensuring the sustainability of economic development (Malano et al. 1999). The transfer of management to water users' associations under control of an integrated basin authority is one possible solution, frequently described but too recent to be completely convincing. In fact this type of solution often leaves unanswered the two important questions raised at the beginning of this paper, i.e. how to balance the budget by raising the water price and how to reach a fair sharing of scarce water among users. If water management is transferred to water users' associations, the process must be implemented carefully. The main idea is to develop "self-management without abandonment" by transferring to socially strong users' associations responsibilities adapted to their capacity, while keeping a tight partnership with a professional water manager.

French history of irrigation management emphasises the efficiency of some other solutions, such as management by the SARs, mixed public-private companies linked to the Government by concession contracts. With the experience of such management, we can propose two recommendations in the very difficult debate on water pricing and allocation:

- Firstly, it is recommended that a cautious but firm move towards Sustainability Cost Pricing; that is, charging the necessary amount to ensure the sustainability of the assets—i.e. operation, maintenance and renewal costs, or what has been called Sustainability Cost earlier in this paper—but not trying to recoup the full financial cost of initial investment or of the most recent rehabilitation. To correspond exactly to sustainability, the price charged must cover all costs incurred in delivering each drop of water from the dam to the crop. At this level of cost recovery, there is no further need of current subsidies for staff, for repairs, for energy or for future rehabilitation: the subsidies' "vicious circle" is broken. Such development is sustainable, even though it is not designed to recover the initial investment.

- Secondly, it is recommended to use step pricing, based on water metering, in order to facilitate control of the allocations in a fair and transparent water sharing system. In case of water scarcity the implementation of a joint quota system is necessary due to the high marginal value of water during the irrigation period. The collective regulation has to be based on a sound quota + price contract with the service provider, which will leave each farmer free to manage his irrigation efficiently according to his own water value function. But in a "closing" basin, the development of new resources must also be implemented in order to ensure the governability of the system. The success of controlled water management, as developed in the Neste system has been founded on joint-management of demand and resources, with the implementation of necessary new reservoirs during the last 10 years. In France it is now very difficult to take such decisions. The transfer of experience in water management can be based on such methods, if governance, after the period of "decision without consultation," avoids the current tendency towards "consultation without decision."

Bibliography

Balas, B.; and J.M. Deumier. 1993. De l'entrée parcellaire à une stratégie globale dans la gestion de l'irrigation. Aménagement et Nature n° 3.

Boussard. 1993. L'irrigation en France: une approche économique. Académie d'Agriculture.

Briscoe J. 1997. Managing water as an economic good: Rule for reformers. In: M. Kay, T. Franks and L. Smith (eds.): Water: Economics, management, and demand. London, E. & F. Spon.

Conférence Euroméditerranéenne sur la gestion de l'eau (1996). Atelier 1. Gestion de l'eau pour une agriculture durable. Actes: www: oieau.fr.

FAO. 1996. Food production: the critical role of water.

FAO. 1996. NGO consultation on the world food summit. Rome.

Hurand P. 1995. La nouvelle PAC et l'irrigation des grandes cultures. Académie d'Agriculture France, 81, n° 7, pp 35–49.

Hurand, P.; and H. Tardieu. 1998. Gestion de la demande en eau dans un contexte de ressource limitée. In: Traité d'irrigation J.R. Tiercelin, coordonateur. Tec & Doc, Chap. 12, pp 882–899.

Irrimieux – Gleizes, Cl. 1999. Gestion collective d'une ressource connue: des « droits de l'eau » à la gestion collective de l'eau.

Kosciusko-Morizet, N.; H. Lamotte; and V. Richard. 1998. Que peut-on attendre de la mise en place de quotas individuels échangeables de prélèvement sur la ressource en eau en France? L'exemple de l'agriculture irriguée. Colloque SFER-CEMAGREF-ORSTOM Montpellier.

Lesbats, R.; H. Tardieu; and M. Héritier. 1996. Associations d'irrigants dans le sud ouest de la France,et leur relations avec la CACG. Question 46–1, paper R-107, ICID Congress, Cairo.

Malano, H.; and P. Van Hofwegen. 1999. Management of irrigation and drainage systems. A Service approach. A.A.Balkema/Rotterdam/Brookfield.

Meinzen-Dick, R. Valuing the multiple uses of irrigation water. Environment and Production Technology Division, International Food Policy. Research Institute, Washington D.C., USA.

Molden D. J.; R. Sakthivadival; C. J. Perry; C. de Fraiture; and W. H. Kloezen. 1998. Indicators for comparing performance of irrigated agricultural systems. Research Report 20. Colombo, Sri Lanka: International Water Management Institute.

Montginoul, M.; and T. Rieu. 1996. Instruments de gestion de l'eau en France: exemple de la Charente. Ingénieries - EAT (8), pp 3–12.

Plantey, J.; H. Tardieu; M. Mesny; J.P. Nicol; Th. Rieu; and J. Verdier. 1996. Gestion de l'eau pour l'agriculture en France: durabilité socio-économique et implication des usagers. www:afeid.montpellier.cemagref.fr.

Point, P. 1995. Eléments pour l'évaluation économique des bénéfices du SDAGE du Bassin Adour-Garonne. BIPE Conseil.

Rieu, T.; and M. Montginoul. 1996. Instruments économiques et gestion de l'eau d'irrigation en France. La Houille Blanche (8), pp 47–54.

Strosser, P. 1997. Analysing alternative policy instruments for the irrigation sector—An assessment of the potential for water market development in the Chishtian Sub-division. Wageningen Agricultural University, Wageningen.

Tardieu, H. 1991. Gestion de l'eau en Gascogne: la CACG, instrument technique et lieu de concertation. POUR n° 127–128 L'Harmattan.

Tardieu, H. 1999. La valeur de l'eau en agriculture irriguée: une information économique nécessaire pour mieux réguler la gestion de l'eau et des productions agricoles dans un marché ouvert. Symposium, ICID Congress, Granada.

Tardieu, H.; and J. Plantey. 1999. Balanced and sustainable water management: The unique experience of the regional development agencies in Southern France. ICID Journal 1999/1 issue.

Villocel, A. 1998. Une Société d'Aménagement Régional (SAR), opérateur de gestion de l'eau. SHF Colloque Chambéry.