

## **Economic assessment of water in Mediterranean regions**

### **Irrigation systems in Catalonia**

Ignasi Aldomà Buixadé, University of Lleida

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#### **Abstract**

Universal concern for the environment, the resolve expressed by governments in the EU Water Framework Directive 2000/60/CE, and social conflicts arising from lack of water in the Mediterranean basin all determine the need for a new approach to irrigation. The planning and management of the water cycle call for irrigation to be reconsidered within a new framework in which management policies related to demand should replace those related to offer, which consist of extending irrigated surfaces with no concern for the social and economic context. From this new perspective, it should be easier to find a rational way out from current traditional irrigation, anchored in inefficient irrigation systems, while plans and projects for new irrigation systems need to be improved, corrected and adapted.

As a kind of prelude to conflicts which may become the norm in the Mediterranean basin, a serious drought episode took place in the spring of 2008, bringing restrictions in water supply to the metropolitan area of Barcelona. The clash of water-related interests among the different users, territories and social groups involved was raised. The debate was particularly acrimonious as regards the agricultural use of water in irrigation because farmers competing directly with urban uses see their irrigation rights being restricted or taken away, while irrigators from more distant basins (the Ebro basin) are opposed to diverting agricultural resources for urban consumption. Stemming from this conflict, stirred up in urban media forums, there is a stigma attached to agricultural irrigation and to agriculture itself for squandering water. This does not help understand the real situation, or find solutions to structural shortfalls and to drought episodes which would appear to be becoming more frequent.

Without addressing here the solutions to conflicts over priority in water use and the full extent of the advisability of diverting water (requiring a more specific reflection), it is worth making a prior assessment of the economic and social interest of agriculture in present-day irrigation. Although irrigated lands currently suffer from the general economic and social difficulties of agriculture, irrigation has played a decisive role in industrial development and urban transformation. It does not seem, therefore, that irrigation should be underestimated and this is why it needs to be restored and brought up to date. The requirements and difficulties that the irrigators themselves face to manage their water efficiently must then be detected. The improvement of irrigation projects and plans can help, at the same time, to meet urban demands and enhance water cycle management as a whole (I. Aldomà, 2006).

#### ***Increase in agricultural productivity and income faced with doubts about profitability***

In the first place, it needs to be recognized that irrigators, economic stakeholders from the agricultural sector in general, and the Government itself, are making an effort to implement and restore irrigation with the aim of the wider use of more modern and efficient irrigation techniques. For example, the National Irrigation Plan of the Government of Catalonia has forecast for 2020 the

modernization of 260,000 of the 310,000 hectares of currently irrigated land, and has plans to irrigate an additional 135,000 hectares. Meanwhile, the 2001 Spanish National Irrigation Plan has forecast 240,000 hectares of new irrigated lands for 2008 and the improvement of the already existing 3,344,000 hectares (I. Grau Roca, 2008; MAPA, 2001). As usual, irrigation projects are slow and costly and the plan's deadlines have not been met, but the projects have gone ahead.

Agricultural irrigation has not stopped expanding in the last few decades, whether due to public initiative or, in many cases, to private initiative. Official plans and prospects point to still further growth. There are several reasons, three of which should be highlighted:

1. In the race for increased productivity in agriculture, non-irrigated land has more and more disadvantages, and bringing in water from the outside has become almost essential. Even without changing crops, a small supply of water at times of water stress leads to large increases in yields and/or stable annual production.
2. Even small external inputs of water with a supply guarantee (generally called backup irrigation with resources of around 1,500 m<sup>3</sup>/ha) not only increase yields, but enable production to be diversified and the introduction, in particular, of intensive productions (such as the cherry, the plum and other early fruit and vegetable crops).
3. In addition to the beneficial effects on yields, modern on-demand irrigation systems can reduce costs by significantly reducing the time dedicated to irrigation, and by streamlining farm work like fertilisation and treatments applied to certain areas via the irrigation system.

Irrigation is a guarantee of improved profits from farm lands, and of a general increase in productivity in the agricultural sector. However, this is irrigation's first great contradiction: the economic results do not quite justify all the investment in irrigation, at least from a financial standpoint. Internal rates of return on investments in irrigation are low, with a few exceptions related to highly intensive greenhouse farming and fruit and vegetable farming. Expected differences in profitability between one crop and another are well known:

- Conversions aimed at intensive fruit and vegetable farming in the Mediterranean basin produce the best results, and in fact we can see how these conversions have been made directly by private initiative, either by owners (industrialists or wholesalers) who transform large expanses or by farmers' associations (the case of small irrigation schemes in the Segre).
- When dealing with investments in irrigation systems with few changes in previous non-irrigated production and, above all, when the change is to extensive irrigation, economic results are insignificant and may even mean losses when the price of the cubic metre of water increases (nearly 0.1 €/m<sup>3</sup>). It is not unusual for Treasury contributions to gain importance in this type of operation, both when making the investment and to cover general expenditures.

According to the results of feasibility studies, some of the current irrigation operations are particularly questionable and will be even more so if the per unit incomes of crops tend to decrease in the future, as they have been doing over the last few decades, or if the Single Payment Scheme (SPS), especially noteworthy in extensive farming, is curtailed or disappears (J. Fernández, P. Arrojo, 2000; E. Calvo, M. L. Feijoo, M. Mema, J. Albiac, 1999). However, in the 20 to 30 years in which feasibility studies have been carried out, many variables which could make farm revenue increase have been overlooked, despite the fact that the net results per hectare, upon which the economic assessment of irrigation is based, could fall. Size increases, production changes and the restoration of the agricultural business fabric permit hope for higher revenues in the future, as has been the case in the past. From this more general perspective, the change from non-irrigated to irrigated farming or the improvement of traditional irrigation systems leads to better results, even though doubts persist about more extensive production options.

Be that as it may, expectations of higher productivity and farm revenues reinforce the pressure to obtain water from rivers and aquifers, and more so if threats of a decrease in average rainfall and an increase in periods of drought are confirmed. The Administration, for its part, has boosted the pressure on demand for water with subsidies and new projects and irrigation schemes that continue with the out-dated nineteenth-century conception of water as a free, never-ending resource, in the hope of preserving the country's political clients (L. Díaz, 2002). Meanwhile, water scarcity has become part of everyday life in the small basins on the Mediterranean, and this situation may move inland to certain over-exploited sub-basins.

### ***Adaptation to the agro-food and biomass production chain***

Beyond agricultural results, irrigation should be measured by its effect on the entire food chain and on society, and in this respect, we can only highlight the lack of cost-profit analyses that would lead to better assessment and planning of irrigation projects. For years the production of agricultural raw materials has been impossible to understand without considering the entire agro-food and production chain, and this fact is still misunderstood in irrigation projects, in two ways in particular:

- The increase in productivity in the agricultural sector caused by irrigation is spreading to the input supply, the transformation and distribution industries, so that stakeholders from outside the agrarian sector will receive most of the added value generated.
- On the other hand, processes of vertical integration among the chain's stakeholders blur the margins of the agricultural enterprise itself and mean that stakeholders (who combine raw material production with transformation and/or distribution) approach irrigation systems with an extraordinary advantage.

While the second aspect is related, above all, to the transformation of agricultural structures, which will now be analysed, the first leads to two consequences that change the objectives and traditional results of the creation of new irrigation systems, or their improvement:

- The profits from irrigating land may basically end up in the hands of stakeholders outside the agricultural raw material production sector. It will be difficult for them to escape the grasp of falling revenues imposed by the industrial sectors from above (input manufacturing) and from below (transformation).
- Related to this, and even in the case of the vertical integration of production, the added value generated will also end up outside the irrigated area, having been moved to areas where the factories and headquarters of production and distribution industries are found, and meaning the effects of irrigated land on local development may be particularly meagre.

An irrigation project that does not involve the agricultural industry and does not take into account the location of factories and enterprises that will have to transform and commercialize agricultural production (and this is the general state of affairs) is a project that abandons local development. The free market certainly has an impact on policies of active industrial localization; but policies related to industrial zones, subsidies and tax incentives, among others, still play an important part and should be taken into account in projects of a minimum size. Despite the many doubts raised by this kind of reflection and the practical results, only the government of Navarra appears to be aware of these approaches in their irrigation policy (Riegos de Navarra, 2006).

Applying agro-industrial policy to irrigation is, on the other hand, essential if a minimum of production coherence is introduced to irrigation, to at least define the most viable crops in a specific area and obtain the best possible results from the operation. Prevision in farming matters, on which irrigation projects and plans are based, are no good if everything remains at the will of a changing market and the irrigator has to adapt to it. On the other hand, an agro-industrial policy can consolidate a farming system. Transformation industries can certainly not be expected to depend on more extensive local production in a context of internationalized markets; but proximity to the place

where agricultural raw materials are produced continues to influence the location of agricultural factories and the proximity of certain agro-industrial “clusters” to a potentially irrigated area can help guide future production.

In addition to an active agro-industrial policy, it must also be pointed out that the cost of agricultural inputs exerts a strong influence on the economic viability of the raw material production sector, and localization and stimulation policies in this field have a smaller margin of action. The rise in energy costs, for example, can seriously erode the economic margins obtained from irrigated farming systems, particularly the most extensive and mechanized ones, and very little can be done about that. In this context, cooperation among agricultural producers can play a significant role in reducing the costs of agricultural inputs.

### ***Irrigation and the significance of the modernization of agricultural production structures***

New irrigation systems were traditionally seen as leading to agricultural development and growth, or as the result of farmer obsession, and even today irrigation projects of some importance are justified by these social objectives, but nothing is further from the truth (A. Sumpsi, 2002). In general, the mechanization and capitalization of the agricultural sector have entailed a radical cutback in the number of farms and farm labourers in the sector, and the implementation of new irrigation systems, or the improvement of existing ones, has not changed this trend and may even have accentuated it:

- Both non-irrigated and irrigated farming are seriously outdated today and with no alternatives, so that their capacity to adapt to change is greatly reduced. The investments and technical requirements of irrigation will lead sooner or later to the abandonment of the more precarious farms, a fact that may be considered good from an economical standpoint, but is difficult to justify from a social one.
- Apart from socially unviable farms, others generate reduced working capital and/or are in a precarious financial situation so that investments and changes involved in irrigation systems may accelerate their closure, when social assessment is negative and economic assessment is already doubtful.

Except when dealing with farms included in one of the two previous cases, the cost and financial proposal of an irrigation operation, as well as its management, have a great impact on the transformation of production structures and this is barely taken into account in new irrigation schemes or improvements:

- At first, the cost of initial investments in a new irrigation system does not affect the future results of the farm (in any event, much less than what is currently spent on water) if the cost has an impact on the price of a cubic metre, or if good long-term financing exists. However, owners generally have to cope with high initial expenditures that complicate the continuity of working farms.
- A certain school of thought assumes that multiplying the price of non-irrigated land by three will fully pay the cost of implementing irrigation. But that does not take into account the productive economic framework in which farms must move, and the other expenses involved in the conversion or improvement of irrigation.
- Acting accordingly with the creation of speculative profits, the promoters of irrigation, the Administration in most cases, should try to collect or cushion the high added value generated by, for example, taxes or control mechanisms of the land market, such as the establishment of a minimum sale period, of the rights of pre-emption and buy-out, and others. If these interventions have any significance it is in changes to irrigation, where they will favour the productive economy; but these tools are rarely used. Independently of

whether the shift to larger, more industrial farms leads to a positive or negative assessment of new, up-to-date irrigation systems, the Public Administration promoting irrigation has simply stopped intervening in the planning of agricultural structures.

Government interventions in this field are carried out by means of land consolidation schemes that are infrastructural rather than structural. By adding plots of land and redrawing the land map, land consolidation, which is fully paid for the government and generally accompanies great irrigation transformation schemes, reduces the costs of initial investment and rationalizes subsequent agricultural exploitation. Structural changes resulting from land consolidation schemes certainly enhance productivity as much or more than the incorporation of irrigation and the effect could be studied in greater depth with accompanying structural measures. Land consolidation schemes could also be a means of land enrichment and diversity if they were implemented, but their strictly productivist purpose gives poor results from the viewpoint of the environment, landscape and heritage in general.

### ***Irrigation expansion accentuates water shortage and environmental problems***

If the Administration neglects to accompany new irrigation schemes with structural changes, the environmental situation will be the same or worse. However much some projects still avoid the issue, the intensification of agriculture that irrigation entails has considerably negative effects on the natural cycle and the environment in general, with more or less impact depending on each case (T. J. Trout, 2000).

- It removes increasingly important quantities of water from the natural cycle, affecting the continuity of natural wetland and marine ecosystems.
- It also increases the presence, in absolute and relative terms, of nitrates, phosphates, sulphates, heavy minerals and other polluting elements that imply a health risk and contribute to the impoverishment of ecosystems.
- It damages economic activities related to water in the lower parts of basins (fishing, navigation, irrigation and other forms of consumerism) in the aforementioned ways, and may soon be damaging the middle parts.
- All this in addition to environmental alterations caused by changes to crops and to the land consolidation map, which are those which have centred Public's reports.

In relation to these impacts, there is no doubt that modern systems of on-demand irrigation being implemented in newly-irrigated lands bring about substantial improvements. Apart from economic advantages, they have environmental advantages over the old blanket irrigation, because they use water on a plot of land more efficiently, and because they should lead to a reduction of fertilization and other treatments, and of pollution. For these reasons only the replacement of old blanket irrigation is essential, and some people have even stated that before creating new irrigation systems, it was well worth modernizing the old blanket ones. However, irrigation modernization is not simple (for social reasons and cost), nor does on-demand irrigation eliminate the aforementioned environmental and economic problems. We must bear in mind that the large blanket irrigation basins usually have great resource reuse so that the use of water is globally very efficient and can scarcely be improved. If cultivation is intensified with new on-demand irrigation systems and two annual harvests are obtained, for example, the savings achieved are cancelled out.

### ***Adaptation of irrigated land to water cycle requirements***

All in all, new irrigation systems and the modernization of existing ones only accentuate problems stemming from water scarcity and pollution, and confront society with the irreversible need for corrected tendencies and new irrigation concepts and proposals:

a) Research into irrigation techniques is well developed, but research and technical innovation in

the management of the water cycle as a whole and in large infrastructures is practically non-existent. Among other research subjects, the following should be approached:

- The use of age-old knowledge and infrastructures that make use of rain water and the water naturally present in the environment, generally spoilt and/or neglected in the face of easily available external surface water.
- The integration of groundwater in the management of large irrigation systems, which should also watch over the state of the aquifers themselves.
- The implementation of settling ponds and other sanitation systems to catch run-off water from irrigation can be made cost-effective in different ways and could be implemented through the land consolidation schemes.
- The integration of livestock and other uses in a global system of management, in which the general reuse of water should be looked at closely.

b) The availability of water changes in time and space and agriculture must eventually adapt to it, while attempting to solve environmental problems and limits:

- Knowledge and control of the water used is the first step and the majority of new irrigation systems permit this. The next step is to adjust the price of irrigation water to the real costs of obtaining and managing it, while environmental externalities are also incorporated (better real environmental costs), as determined and recommended by the Water Framework Directive 2000/60/CE (A. Argüelles Martín, 2006).
- If water is a scarce resource, priority must naturally be given to irrigators who consume less (within the communities of irrigators themselves), creating a decisive incentive for using it efficiently, incorporating modern irrigation systems and adjusting the production orientation.
- Taking advantage of already abundant experience in this area, water shortage administrators must move from restricting surface water use and /or regulating water resources depending on crop continuity (avoiding the death of trees) and their higher or lower sensitivity to water stress. The experiences of deficit irrigation systems also offer great possibilities for improvement in this matter (S. Minguet, 2006).
- From the perspective of water use efficiency, we need to think of agriculture adapted to the area's ecological potential and conditions, without losing sight of cost-effectiveness. From this standpoint, for example, crops in the Mediterranean area should be adapted to more favourable water availability in spring or autumn; only crops with an extremely high cost-effectiveness (intensive fruit and vegetable farming) can justify large water requirements in the height of summer.

c) The limitations of new irrigation systems and the need to adapt them to the demand do not only mean they should be conceived and managed to preserve the natural water cycle; a more general environmental assessment is needed instead. The impact on climate change and biodiversity has been necessarily introduced into irrigation system planning, and it has become particularly important to assess the expense and the energy balance. Energy costs can have a serious influence on the economic results of new, on-demand irrigation systems and it is now paradoxical that new pressure-irrigated lands are producing "energy crops" with a deficit energy balance (Institute for Diversification and Energy Saving, 2005).

### ***From irrigation organizations and projects to land organization and projects***

If the application of the Water Framework Directive is a sound way to begin to solve some of the aforementioned problems, it may not be enough nor the best way. Traditional experience in irrigation backs the usual cunning of farmers and irrigators when faced with changes, and up to now

this experience has shown how large investment in public irrigation projects have a low return in the end, and the State ends up forgetting the debts incurred by irrigators (T. Ruff, 2000). It is not easy to shift from a system organized on the hypothesis of a “surplus” resource (you simply build reservoirs) with an insignificant price to others that watch over every litre of water and ensure it is paid for. Acceptation and social consensus become essential, but are difficult to come to terms with unless the subject of irrigation and “irrigators” is opened to society as a whole and to other sectors of the economy.

- Large irrigation systems should be open to the other potential water users (livestock, industrial, domestic, leisure and environmental uses), which in an industrialized, urbanized environment end up being users in one way or another. Financing irrigation works could also be made easier in this way.
- In a society where the agricultural sector represents a small part of overall occupation and wealth, public investments and subsidies for irrigation should be fully specified and recognized by society as a whole.
- Similarly, and given that agricultural uses have lost the price battle against other uses (and this is especially true throughout the Mediterranean basin), exchange centres foreseen by the Water Law should limit transactions to meeting social needs and general economic interests. Exchanges should also be made with real consumption and not with concessions, while assessing effects on third parties (R. Huffaker, J. Hamilton, 2007).
- In any event, agriculture must continue to be an economically viable activity, and the price of water for irrigation cannot exceed a certain limit, which varies extremely according to crop and area.

Environmental demands on irrigation cannot be easily integrated with demands for economic viability in agriculture unless there is a more general, comprehensive perception of water use and the demands of agriculture and the inhabitants of a region as a whole. This is why substantial changes are called for in irrigation plans and projects, which do not generally make their irrigation justifications and objectives explicit and do not analyse with minimum rigour the social, economic and environmental impacts, or assess general viability, and consequently do not assess the diversity of possible alternatives to intervention either. Economic and social changes over the last decades have certainly made the assessment of investments in irrigation (from the most conventional to the most generic techniques) baseless because long-term results (twenty-five or more years in advance) have to be contemplated, making any forecast difficult. However, this does not exclude the need for these assessments and, above all, does not justify that projects are not compared or that current, on-going economic and social changes are not taken into account.

Changes in the planning and management of irrigated lands, in some cases already proposed to the Administration by those affected and by local inhabitants, would be desirable as part of a social response and to ensure the quality of the interventions (Vallbona Manifesto, 2007).

- Irrigation plans and projects should consider the agro-food chain, involving cooperatives, agricultural industries and services, and the economic and social development of a region as a whole. More than irrigation plans, comprehensive development plans are needed.
- If the Administration, for whatever reason, does not have the resources to make comprehensive plans and projects a reality, a more selective investment policy should be proposed, ensuring the global nature of the objectives and permitting and facilitating the free initiative of irrigators. The paternalism and clientelism shown by the Administration in irrigation matters have high additional costs and do not help adapt production structures.
- Beyond major hydraulic infrastructure, where intervention by the central hydraulic

administration is essential, the associations of irrigators, responsible for well delimited irrigated land expanses, are able to adapt both to the water distribution network and the social administration of irrigated land.

- However, water management supervision cannot depend, as now occurs, on associations of users who represent very specific irrigation interests and that have very restricted operational capacity, over the interests of associations of irrigators. Water management should involve irrigators, industrialists, town councils and other enterprises through associations of users, in which the competent Administration should also watch over the fulfilment of more general interests and the correct management of the entire cycle.
- Assuming that it is possible to broaden the current horizon of projects, irrigation plans and projects elude the Administration and strictly agrarian or pro-agrarian professionals. If other professionals and administrations are not incorporated into the irrigation plans, there will continue to be serious shortages.

The planning and management of the water cycle requires a reconsideration of irrigation in a new framework in which the current, typical interventions based on supply must be substituted by policies to manage demand. This is not only the result of a certain ecological will or of the Water Framework Directive, but responds to collective interest and to the need to manage a scarce resource over which different users and interests clash. From this new perspective, it should be easier to find a rational way out from current traditional irrigation policies anchored in inefficient irrigation systems, while plans and projects for new irrigation systems need to be improved, corrected and adapted.

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