

# **Water Demand Alternatives to the Spanish National Hydrologic Plan**



## **Executive Summary**

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This brochure summarizes the Working Document 02/4, *Las Alternativas de Gestión de Demanda al Plan Hidrológico Nacional*, prepared by José Albiac-Murillo, Javier Tapia-Barcones and Anika Meyer from the Agricultural Economics Department of the Servicio de Investigación Agroalimentaria (Government of Aragón, Spain), and Javier Uche-Marcuello and Antonio Valero-Capilla from CIRCE (University of Zaragoza, Spain). The ideas and opinions in this document are the responsibility of the authors and not those of the Government of Aragón or the University of Zaragoza.

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## Main Results

Water demand management and supply policy

The Ebro inter-basin transfer is the consequence of the supply policy proposed by the National Hydrological Plan (NHP) approved by the Spanish Parliament. The transfer diverts 1,100 hm<sup>3</sup> from the Ebro up to a distance of 850 km. This study investigates various water demand and supply alternatives under discussion to solve the water scarcity problems in the basins of Levante: banning aquifer overexploitation, increasing water prices, water desalinization, and external transfers from the Ebro. The analysis of agricultural water demand for the counties of Levante (provinces of Castellón, Valencia, Alicante, Murcia and Almería) shows that a demand management policy with more elevated prices than those currently in place solves water scarcity, without need for external transfers which would deteriorate the ecological functionality of the Ebro source basin and prolong the current unsustainability of the Júcar, Segura and Sur receiving basins.

Demand scenarios considered

The effects on the agricultural sector of the demand management alternatives to water scarcity, have been examined by two scenarios. In the first scenario, a strategy is analyzed in which aquifer overexploitation is prohibited. In the second scenario, a price raise is considered in order to calculate the price of water that balances the global water demand placed on the basins of Levante with the available water resources of those basins.

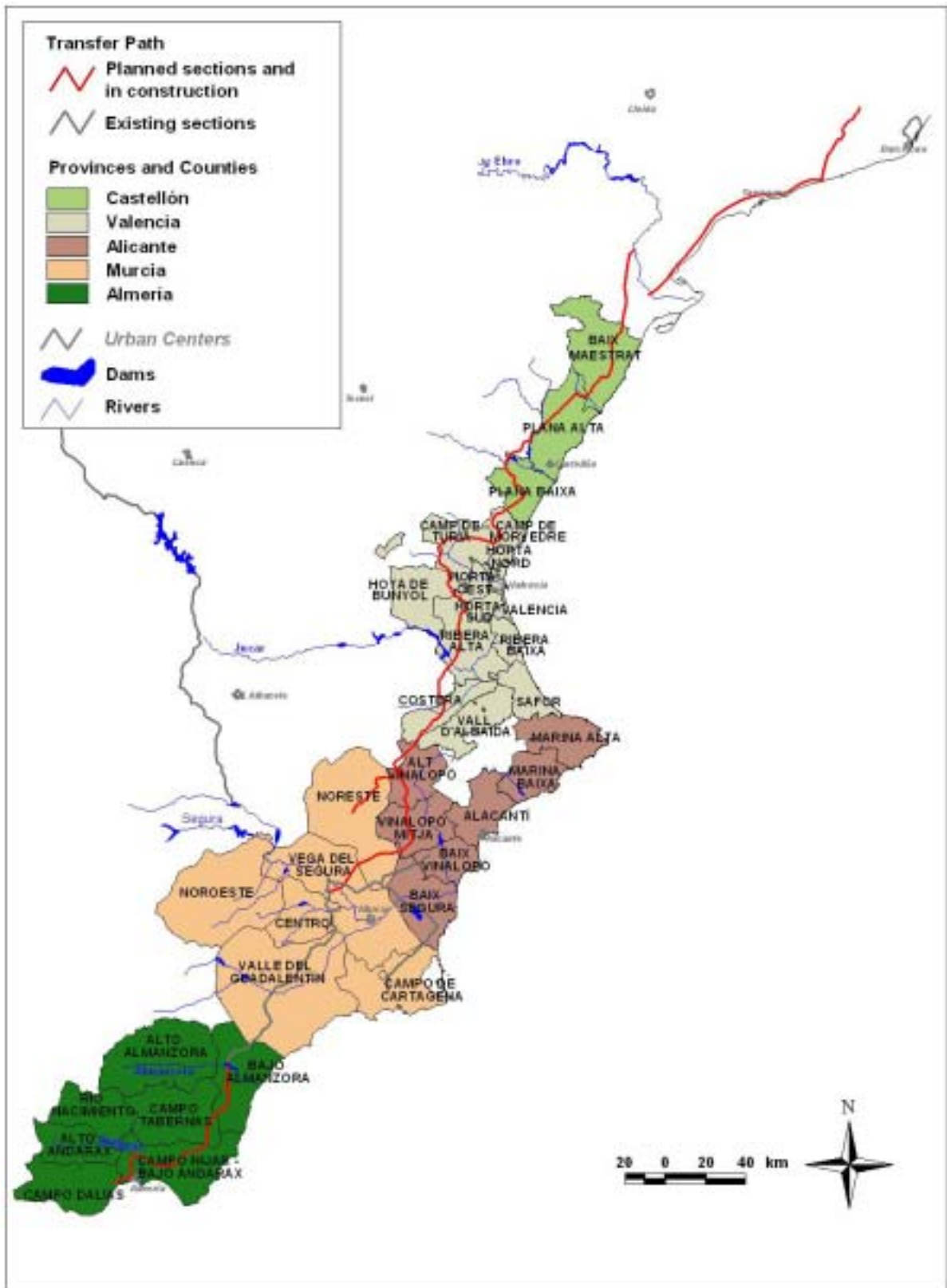
Increases up to 0.18 €/m<sup>3</sup> in the price of water solves the water shortage in Levante

The impact on agriculture of increases up to 0.18 €/m<sup>3</sup> in the price of water (1€=0.95USD), is small on the final agricultural production (-6%), although more significant on farmers net income with a loss of 30 percent. The reduction in agricultural water demand substitutes for the water transfer allocations from the Ebro River assigned by the NHP for agricultural and environmental uses, and more than half of its allocation towards industrial and urban use. The remainder allocation can be covered by desalinization, since in the coastal counties of Levante the effective agricultural water demand reaches almost 300 hm<sup>3</sup>.

Incoherence of the allotments assigned by the NHP

The viability of diverting water from the Ebro as proposed by the NHP has been examined simulating the cost of diverted water, with prices ranging from 0.19 €/m<sup>3</sup> in the Northern counties to 0.75 €/m<sup>3</sup> in Southern counties. This

Map of the Water Transfer Channel System



simulation defines the available demand for transferred water that can be absorbed by the Levante counties at the high prices of diverted water or *effective demand*. Results show that the allocation that the NHP assigns to agricultural and environmental uses in the Segura basin greatly surpasses the *effective demand* of water at this price, which farmers from the Segura basin will not be able to pay. Therefore farmers will continue aquifer overexploitation.

### **Sustainability of the National Hydrological Plan**

The concept of sustainability is linked to the increase of human well being with respect to time, and is based on the idea of non-diminution of various kinds of capital: capital created by man, natural capital and human and social capital. Sustainability applied to hydrologic resources implies the protection of the natural capital formed by the water systems that maintain the ecological functioning of basins. The Ebro and Levante basins have experienced a grave degradation in ecological functioning during the second half of the twentieth century. Today, the key problem in the Ebro and Levante basins is stopping the degradation of natural capital and restoring the functionalities of the hydrologic systems, to which end the NHP must guarantee actions that do not provoke more degradation, and what is more, insure the improvement of the functional integrity of those systems.

The concept of sustainability

The NHP proposes to transfer water from the Ebro basin to Levante basins, and the essential question is to identify the elements of natural capital that this transfer deteriorates, and if there exist preferable alternatives from the economic and environmental point of view. The critical elements that can be identified in the Ebro basin are the decreasing water volume in the Ebro Valley in recent decades due to increased water consumption, and the progressive degradation of water quality. This degradation is a consequence of point source urban and industrial pollution, non-point source pollution from agricultural activities, and the scarcity of water volume in certain sections of the river. Another negative consequence comes out of the fact that the transfer would require increased regulation by new dams to meet the pluriannual periods of drought, which would mean a greater degradation in the ecological functioning of the basin. Finally, the transfer of water would deteriorate the Ebro Delta due to the reduction in water

Identification of those elements of natural capital deteriorated by the transfer project

volume causing a more aggressive penetration of saline water, and additional lack of sediments deposition.

The new focus of the European Union Water Directive

The European Union has passed the Water Framework Directive which adopts a new focus on water policy based on the management of demand, full recovery costs including environmental costs, and the establishment of standards on water flow and contaminants. The Directive promotes the use of economic tools as opposed to an increase in the availability of water resources in order to avoid waste and reduce environmental degradation.

Demand management alternative

The demand management alternative proposed in this study follows the criterion of the Water Framework Directive. A moderate increase in water prices of some 0.12 or 0.18 €/m<sup>3</sup> in the Levante basins, rebalances water supply and demand avoiding external transfers. At present, the price of water is no more than 0.03 €/m<sup>3</sup> in almost all of the Júcar counties and in some of the Segura counties, and the price only reaches 0.15 €/m<sup>3</sup> in several South basin counties of the Almería province where water scarcity is severe. These low prices foster wastefulness in a market in which the resource is rationed and has a quota assigned by the water administration. Agricultural water prices could be maintained below prices paid by other users, but the scarcity of water in Levante has to be resolved with prices higher than 0.12 €/m<sup>3</sup>. This will free up sufficient demand so as to resolve the scarcity, with a negative effect on farmers rent that may be compensated. This policy of demand management is the one studied here, and is economically and environmentally preferable to the supply policy of water transfers from the Ebro.

### **Elimination of the Overexploitation of Aquifers**

Effects of banning aquifer overexploitation

The elimination of the overexploitation of aquifers reduces the availability of water for agriculture, and the effects are concentrated in the counties where aquifers are located. In the Júcar and Segura basins the reduction of available water and cultivated acreage especially affects the less profitable crops. But in the South basin, the reduction of water and cultivated acreage affects very profitable crops, since in the counties of the South basin there is no possibility for

abandoning crops of low profitability. Losses are quite elevated in the South and less in Segura and Júcar; in the South the income and net profit of farmers falls one half, in Segura it falls 20 percent and in Júcar less than 5 percent. The consequences of this scenario show that nearly 70 percent of the losses of net profit, that's 204 million € of 306 in losses, occur in Almería (South basin) due to the abandonment of high-profit green house crops.

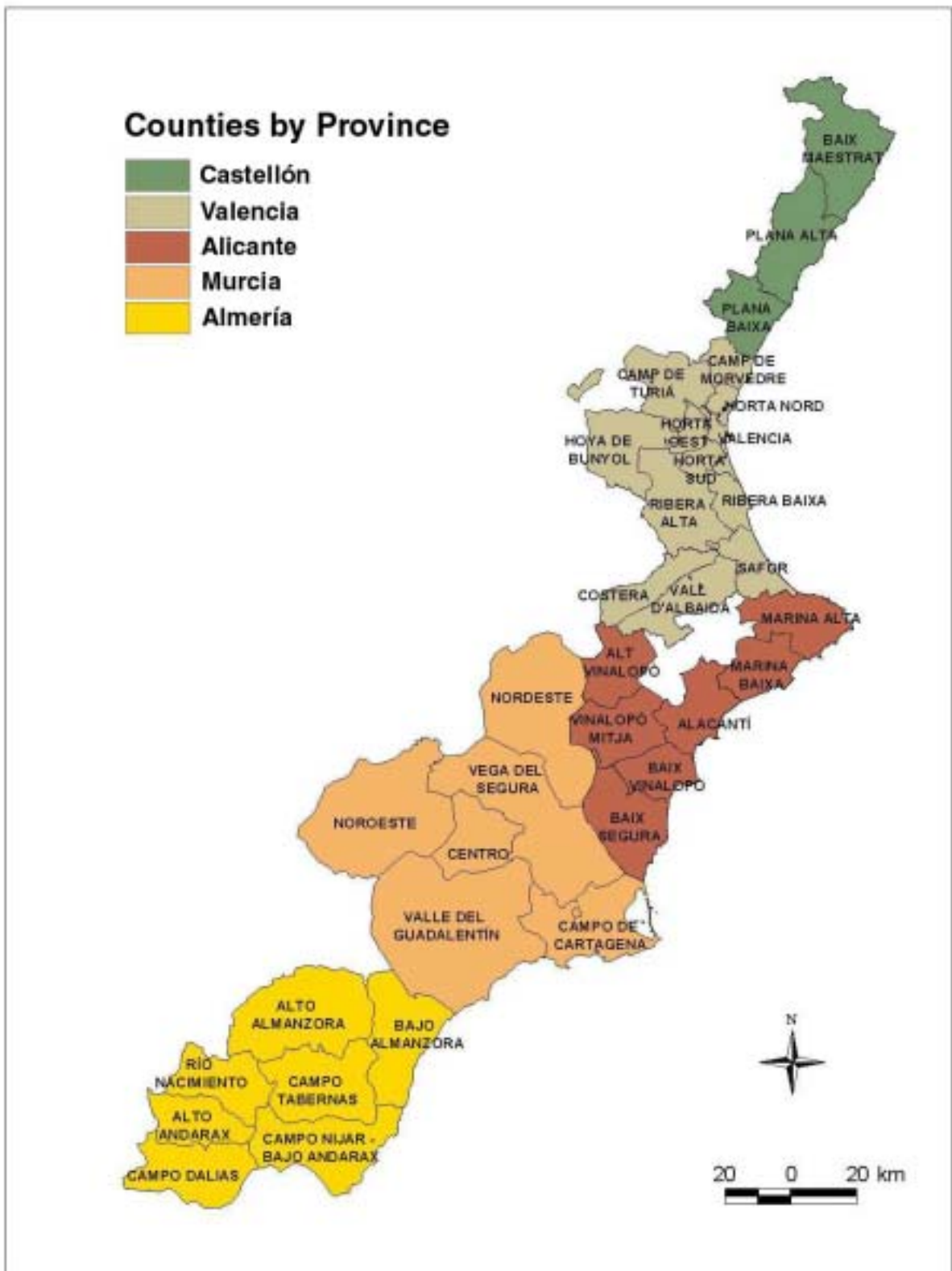
#### Location of losses

The counties that have the greatest losses in Almería are those which have very profitable crops, and in Segura those which bear the greatest reduction of available water: Campo Dalías, Bajo Almanzora and Campo Níjar-Bajo Andarax in Almería, and Valle del Guadalentín and Nordeste in Murcia. In Campo Dalías income and net profit fall 378 and 180 mill €, and in Valle del Guadalentín they fall 103 and 44 mill € respectively.

#### Recommendations

If the measure of demand management chosen to solve the scarcity in Levante is that of prohibiting overexploitation of aquifers without external transfers, then mechanisms should be established to transfer water between counties in the interior of the South, Segura and Júcar basins, such that farmer losses are minimized. In the South Confederation these management measures should permit the reassignment of water from western counties to the eastern basin, or from counties of neighboring basins. The quantity of water from the transfer envisaged by NHP to solve aquifer overexploitation and guarantee irrigation in the South basin is only 58 hm<sup>3</sup>, which is insufficient even to avoid the current overexploitation that reaches 71 hm<sup>3</sup>. In contrast, the quantities proposed by the NHP for transfers into the Júcar and Segura basins are much more generous. Even if the proposed transfers are carried out, the overexploitation of aquifers in Almería will not be solved. In any case, to resolve this problem it will be necessary to introduce additional measures of demand management that rebalance availabilities and uses.

Map of Levante counties by province



## Increase in the Price of Water and Reduction of External Transfers

Strategy of price increases

The rise in the price of water for agricultural use, is a demand management instrument in line with the new Water Framework Directive of the European Union, a measure which solves the Levante scarcity problem at a lower economic and environmental cost to society, freeing up water resources by abandoning the irrigation of less profitable crops, and rebalancing the global supply and demand of water.

Increase of 0.12 €/m<sup>3</sup>

With an increase in water prices in the Levante basins of 0.12 €/m<sup>3</sup>, the agricultural demand for water reduces to 441 hm<sup>3</sup>, with a fall of 4 percent in income and of 21 percent in net profit for the farmers, due to the lowering of irrigated cereal and woody crops acreage that are less profitable. The impact on net profit is much greater in the Segura and Júcar basins, at 23 and 30 percent, than in Almería, at 6 percent. The reduction of 441 hm<sup>3</sup> in water demand is inferior but close to the agricultural and environmental allotment from the Ebro water transfer project of 561 hm<sup>3</sup>. With this increase in the price of irrigation water, the volume of water freed up from agricultural uses would reduce the need for expanding water supply in the Levante basins to 379 hm<sup>3</sup>, of which 120 hm<sup>3</sup> would be destined to agricultural and environmental use and 259 hm<sup>3</sup> to urban and industrial use. This water supply expansion of 379 hm<sup>3</sup> is significantly less than the figure of 820 hm<sup>3</sup> currently proposed by the NHP, and the cost to farmers of this solution would not be too high, estimated as a 4 percent fall in income and 21 percent loss in net profit. The loss of 294 million € in net annual profit is a measure of the compensation that could be offered by the Spanish and European Union administrations, or by other water users, so that the farmers would voluntarily accept the raise in water prices.

Increase of 0.18 €/m<sup>3</sup>

A raise in water prices of 0.18 €/m<sup>3</sup> reduces the demand for agricultural water by 703 hm<sup>3</sup> in the Levante basins, with a global fall of 6 percent in income and 30 percent in the net profit for farmers, who would abandon the irrigated cultivation of cereals and reduce the cultivation of woody crops. The fall in net income is greater in Júcar (-44%) than in Segura (-31%) due to the greater specialization in Segura on more profitable vegetables, and the elevated

consumption of more expensive water in Júcar, while the drop in income is moderated in South (-8%). The water demand contraction of 703 hm<sup>3</sup> approximates the 820 hm<sup>3</sup> of transferred water that the NHP assigns to the three basins for urban and industrial use (259 hm<sup>3</sup>) plus that due to prevent aquifer overexploitation plus the irrigation guarantee (561 hm<sup>3</sup>). This raise in prices provokes a fall in demand of 325 hm<sup>3</sup> in Júcar, 327 hm<sup>3</sup> in Segura and 51 hm<sup>3</sup> in South, which almost covers the amounts of the water transfer designated for urban, industrial, agricultural and environmental use of 300 hm<sup>3</sup> in Júcar, 420 hm<sup>3</sup> in Segura and 100 hm<sup>3</sup> in South. Transferring the excess from Júcar to Segura, there remains a deficit of only 68 hm<sup>3</sup> in Segura and 49 hm<sup>3</sup> in South, which could be resolved with measures such as desalinization and the improvement of irrigation efficiency.

The price raise alternative deserves consideration

This demand management approach of increasing water prices in Levante by 0.18 €/m<sup>3</sup> solves the water shortage by balancing supply and demand of water without the need of the enormous investment in diverting the Ebro and transferring the water. This measure should be seriously considered as an alternative to the water transfer from the Ebro by those responsible for making decisions in the autonomous (state) governments of the Ebro Valley, in the Spanish government and in the European Union, and by political and pressure groups. The cost to Levante farmers of this proposal is given by their income and net profit reduction: the fall in income is only 6 percent, but the fall in net profit is sizeable attaining 30 percent. The necessary compensation so that farmers voluntarily accept this raise in prices is given by the 423 million € of yearly net profit they lose, and could be paid by the administration or by other groups of water users. This compensation is an alternative to society for not making the water transfer investment diverting the Ebro. The construction costs in diverting the Ebro exceed 6 billion € and if invested in some other fashion, could produce an annual profit greater than 423 million €

Higher prices coupled with desalinization solve water scarcity

Desalinization of sea water is a measure complementary to water prices increases that expands supply, making unnecessary the water transfer from the Ebro. The cost of desalinization is 0.52 €/m<sup>3</sup>, and the effective water demand at this price in the coastal counties from Safor to Campo Dalías is 287 hm<sup>3</sup>.

Desalinization cost is lower than the cost of transferred water in the Southern Levante counties of Valle del Guadalentín (0,56), Bajo Almanzora (0,66), Campo Níjar (0,75) and Campo Dalías (0,75). Desalinization coupled with an increase of 0.12 €/m<sup>3</sup> in water prices balances water supply and demand in Levante. The effective demand for desalinization is 287 hm<sup>3</sup>, and the reduction in water demand if water prices increase 0.12 €/m<sup>3</sup> is 441 hm<sup>3</sup>. Both sum 728 hm<sup>3</sup>, a quantity very close to the Ebro water transfer allocation of 820 hm<sup>3</sup> for all uses.

### **Inconsistency in the transfer allocations assigned by the NHP**

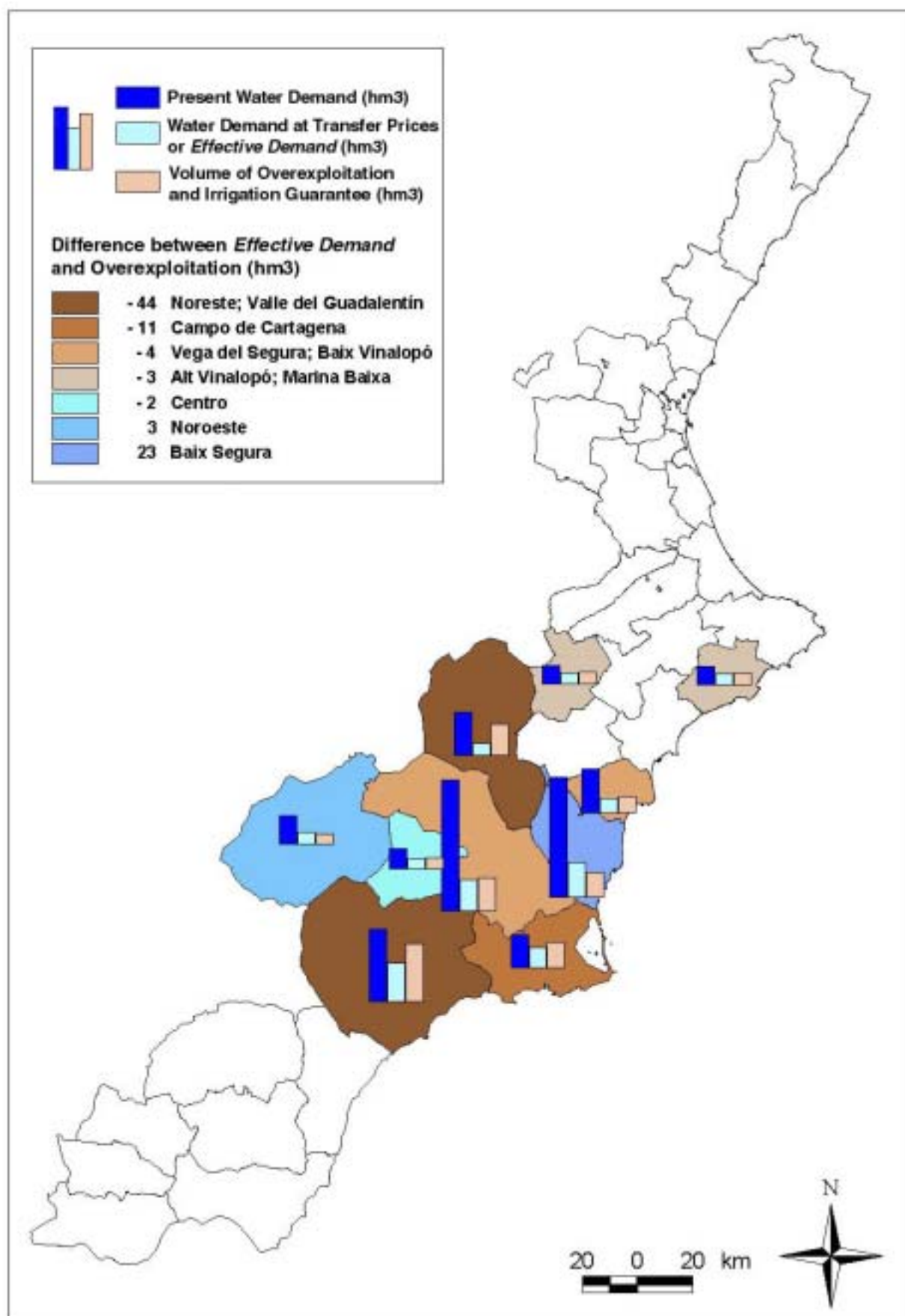
The diverted water will have high costs which depend on the distance from the Ebro river, with a range of prices between 0.19 €/m<sup>3</sup> in Baix Maestrat county and 0.75 €/m<sup>3</sup> in Campo Dalías county. These prices are well above the low prices of around 0.03-0.09 €/m<sup>3</sup> that farmers pay now, and these elevated water prices will only pay for themselves in counties with high profit crops. The volume of diverted water that the Levante counties can absorb at this price is 863 hm<sup>3</sup> in Júcar, 215 hm<sup>3</sup> in Segura and 112 hm<sup>3</sup> in South. These quantities contrast with the water transfer allocated for agricultural and environmental use proposed by NHP, which is 141 hm<sup>3</sup> in Júcar, 362 hm<sup>3</sup> in Segura and 58 hm<sup>3</sup> in South. Thus, *in the Segura basin there is a significant problem of inconsistency in the NHP proposed transfer*, since this basin can only absorb 215 hm<sup>3</sup> of water destined to agricultural use at the water transfer price, which doesn't cover the NHP assignment of 362 hm<sup>3</sup> to end the overexploitation of aquifers and to meet the irrigation guarantee.

Severe problem of inconsistency in the Segura basin

Inconsistency in certain counties of the Júcar basin

In the Júcar basin, the global agricultural water demand at the water transfer price is greater than the NHP assignment for agriculture and environment, however this is also inconsistent with the NHP proposal because there are several counties in which the volume of aquifer overexploitation is similar or greater than the agricultural demand at the water transfer price, or the *effective demand*, in the province of Alicante. The farmers in these regions will not be able to pay for the same volume of transferred water as is now overexploited, which means the overexploitation will continue. The map shows the counties where water transfer *effective demand* is lower than overexploitation.

Map of Differences between Effective Demand and Overexploitation



The inconsistency of the NHP reinforces the superiority of demand management

Consequently, the proposal of the NHP does not eliminate overexploitation of aquifers by farmers in the Segura and Júcar basins, as they will not be able to pay the elevated price of diverted water. This incoherence in the NHP demonstrates the superiority of demand management policies that use price raises as against increasing the supply of water with its enormous cost to society. The management of demand is superior as much from the economic supply and demand analysis point of view as it is from the sustainability point of view previously mentioned.

### **Comparison of Results with the National Hydrological Plan**

The evaluation procedures of the NHP are not very rigorous

The National Hydrological Plan examines the effects of the water transfer on net profit, final agricultural production and agricultural employment, in the Levante irrigation area. Two aspects are evaluated: the elimination of aquifer overexploitation and the improvement of irrigation guarantee (water available when needed). The procedure used in the NHP lacks rigor, since it starts with the volume of water to be transferred from the Ebro without justifying the quantity. This transfer volume figure is then divided by a standard irrigation assignment per hectare, and in this way the affected surface area is calculated. From the affected surface area, the NHP estimates the net income by multiplying this surface area by a representative net income per hectare.

Procedures in this study incorporate much more information

The procedure used in the NHP is excessively simple and poorly supported, and thus the results are approximate in the best of cases. The procedure used in this study yields much greater precision by incorporating the surface area of each crop by county, meteorological information for calculating both crop irrigation needs and the irrigation water demand, technical information about yields and costs, and information about irrigation systems.

#### **Net Income**

The NHP underestimates the impact of scarcity in Levante and does not detect the large losses in Almería

The NHP estimates as 222 million € the sum of losses in net income for the elimination of aquifer overexploitation (210 million €) and for lack of irrigation guarantee (12 million €). In this study, the loss of net income due to the elimination of aquifer overexploitation and lack of irrigation guarantee in the three

basins has been valued at 385 million € which is distributed between losses of 29 million € in Júcar, 95 million € in Segura and 261 million € in Almería.

Notably, more than 70 percent of the losses occur in Almería, due to the enormous net profit derived from greenhouse crops. Nevertheless, the NHP assigns only 58 hm<sup>3</sup> to Almería for overexploitation of aquifers and irrigation guarantee of the total of 543 hm<sup>3</sup> of water transferred for this use in Levante. The allotment for Almería of 58 hm<sup>3</sup> doesn't even cover the overexploitation of aquifers of its counties, which is 71 hm<sup>3</sup>. Clearly, *this water transfer project has no economic justification based on the Levante agriculture*. Almería is the zone where the elimination of the overexploitation of aquifers has the greatest economic impact, and in spite of easily being able to pay the high price of diverted water, doesn't receive a sufficient share so as to eliminate the overexploitation. At the same time, Segura receives 362 hm<sup>3</sup> for agricultural and environmental uses, 136 hm<sup>3</sup> higher than the overexploitation in the basin, and 142 hm<sup>3</sup> higher than their ability to pay. Segura farmers cannot pay the price of transferred water since they do not have sufficiently lucrative crops in their counties.

The economic justification for the NHP is not based on the agricultural reality in Levante

Unlike the National Hydrological Plan, the study carried out allows the break down of final agricultural production and net profit losses between the Comunidad Valenciana (Castellón, Valencia and Alicante provinces), Comunidad de Murcia (Murcia province) and Almería province. In the Comunidad Valenciana, final agricultural production (FAP) and net income are 1.7 and 0.8 billion € and the losses are 76 and 31 million € respectively. In Murcia FAP and net income are 1.0 and 0.4 billion € with losses of 242 and 93 million € respectively. Finally, Almería has a FAP of 1.0 billion € and a net income of 0.5 billion € and the losses are 539 and 261 million € respectively.

The NHP does not break down economic losses by province

## Labor

Employment in Murcia has been estimated as 47,000 AWU (agricultural work unit, equal to a man-year of work) for all crops, while the NHP estimates that direct employment in Murcia in 1997 was 48,346. The NHP doesn't give

Nor does the NHP break down job losses by province

figures for the employment reduction in Murcia that results from elimination of aquifer overexploitation, which are calculated as 11,200 AWU in this study. In the Comunidad Valenciana (Castellón, Valencia and Alicante provinces) labor is equal to 88,800 AWU for all crops, and the reduction in jobs when the overexploitation is eliminated is 5,100 AWU, while Almería employs 33,900 AWU, with a fall of 17,200 AWU for halting overexploitation.

The NHP points out that in the Segura basin Hydrological Plan there are 76,000 agricultural jobs in the Segura basin, that without the water transfer project would fall to 52,000 (-24,000) and with the project would grow to 102,000 jobs (+26,000). It is difficult to comprehend where this labor growth comes from, since according to the NHP the fall in net profit will be 210 million € when the aquifer overexploitation is eliminated, which could in turn provoke a fall in 24,000 jobs, while the growth in net profits from irrigation guarantee is reckoned to be 12 million € and it is doubtful that this increase would generate 26,000 jobs.

The evaluation of job expansion due to the water project is dubious

In the study carried out, the number of jobs in the Murcia and Alicante counties of the Segura basin are estimated at 59,600 AWU, and if one adds the irrigation acreage of Castilla-la Mancha and Andalucía regions (also in the Segura basin), the estimate reaches 82,000 AWU, which approaches the figure of 76,000 jobs estimated in the Segura basin Hydrological Plan. This present study evaluates the fall in employment in the counties of Murcia and Alicante in the Segura basin due to the elimination of overexploitation as 20,800 AWU, which is below the loss of 24,000 indicated in the NHP.

The NHP overestimates job losses that result from stopping aquifer overexploitation

### **Final Considerations**

The analysis of the impact of alternative solutions to the water scarcity in Levante shows that the *ban on aquifer overexploitation* as a strategy of demand management without expanding water supply causes a fall of 20 percent in the final agricultural production and net profit in the Levante basins. This alternative would be especially damaging for Almería, while the negative effects would be less in Segura and Júcar. The extent of the impact of this alternative depends on the reassignment of water among the zones where there is scarcity.

The ban on overexploitation of aquifers would be very negative for Almería

Water demand scenarios in Levante and NHP allocation (hm<sup>3</sup>).

	Júcar basin	Segura basin	South basin	Total Levante
Water Demand Reduction for Agricultural Use...				
...by banning aquifer overexploitation.	157	226	71	454
...by increasing the price by 0.12 €/m <sup>3</sup>	141	263	37	441
...by increasing the price by 0.18 €/m <sup>3</sup>	325	327	51	703
NHP Allocation				
all uses	300	420	100	820
agricultural and environmental use	141	362	58	561
urban and industrial use	159	58	42	259
Effective Demand of Water for Agricultural Use...				
...at prices for transferred water (0.19 to 0.75 €/m <sup>3</sup> )	863	215	112	899

The second demand alternative considered is that of an *increase in the price of irrigation water*. This measure serves to balance the global supply and demand for water in the Levante basins, and follows the criteria of the new Water Framework Directive of the European Union. Water prices for agricultural use can continue to be less than those for other uses, but the scarcity should be solved by a reasonable increase in prices, which frees up water resources sufficiently, with an impact that should not be excessive for farmers and for which they can be compensated. This demand management policy is preferable for society, and is the one defended by this study as it has a lower economic and environmental cost than the policy of expanding the supply through transfers from the Ebro Valley.

An increase of 0.12 €/m<sup>3</sup> in irrigation water price reduces the water demand to a figure that covers the NHP allotment for aquifer overexploitation for Segura and Júcar basins, and part of the irrigation guarantee in Segura, for which the water transfer would be reduced to 379 hm<sup>3</sup>. Of this figure, 120 hm<sup>3</sup> would be destined for agricultural use and 259 hm<sup>3</sup> for urban and industrial use. This solution has a not too excessive cost for farmers of around 4 percent of their income and 21 percent of their net profit. The loss of 294 million € of net annual profit is a measure of the compensation that could be offered by the administration so that farmers voluntarily accept the rise in water prices. The regional (state) administrations of the conceding basin should negotiate this

Demand management by increasing water prices avoids scarcity with a much lower economic and environmental cost than the water transfer project

An increase of 0.12 €/m<sup>3</sup> reduces the size of the water project to 379 hm<sup>3</sup> with a cost to farmers of 294 million €

alternative with the central government, an alternative which reduces the need for additional water in Levante from 820 to 379 hm<sup>3</sup>.

An increase of 0.18 €m<sup>3</sup> eliminates water scarcity in Levante at a cost of 423 million € for farmers

An increase of 0.18 €m<sup>3</sup> in the price of irrigation water reduces water demand by 703 hm<sup>3</sup>, a volume close to the 820 hm<sup>3</sup> allocated by the NHP to the three basins for all uses. This reassignment of demand, covers the needs of the three basins by balancing the use and availability of water, with a deficit of only 68 hm<sup>3</sup> in Segura and 49 hm<sup>3</sup> in South, which could be resolved employing desalinization and improving irrigation efficiency.

The action of raising prices 0.18 €m<sup>3</sup> should be seriously considered by public administration heads, political groups and lobbyists as an alternative to the enormous investment in the Ebro water transfer project. The social cost of this measure is not excessive compared with the water transfer social costs, and represents a drop of 6 percent in income and 30 percent in net profit for farmers which can be compensated for the losses. The necessary compensation so that Levante farmers voluntarily accept the raise in prices is 423 million €, equal to their net annual income lost. This amount could be paid by the administration and other water use groups, so that the society doesn't carry out the investment of more than a 6 billion € in the water transfer project. These funds could be designated to alternative investments having greater profitability. The increase in water prices that reduces demand, can be coupled with an expansion of supply through desalinization, in order to balance supply and demand in Levante without recourse to water from the Ebro.

The water transfer project does not solve aquifer overexploitation in Segura nor in some counties of Júcar for lack of sufficient *effective demand* for transferred water

Another criticism of the NHP water transfer proposal comes as a consequence of the *inconsistency in the county assignments of transferred water proposed by the NHP*. At the elevated price of diverted water, farmers in the Segura basin cannot absorb the allotment for agricultural and environmental use fixed by the NHP, nor can farmers absorb their allotment in some counties of Alicante province in the Júcar basin (See map in page 10). The problem is that the *effective demand* of water at transfer prices is inferior to the aquifer overexploitation in these counties. Consequently, with the proposal of the NHP, aquifer overexploitation cannot be eliminated in Segura and in some of the Júcar

counties, since farmers cannot pay the elevated price of diverted water. The incoherence of the NHP proposal is an additional argument demonstrating the superiority of water demand management policies over and against the policy of increasing supply of the NHP.

Subsidy of transferred water is feasible, but very costly for nonagricultural users in Segura.

This incoherence of the NHP could be resolved by *subsidizing the price of transferred water destined for agricultural use*, charging higher prices to other user groups, thus assuring the survival of the less profitable agricultural activities. The option to subsidize diverted water for agricultural use would be costly for the non-agrarian water users of Segura. In Segura, if a surcharge is placed on the water transfer allotment destined to urban and industrial use, in order to subsidize the allotment for agricultural and environmental use, the surcharge would come to 168 million € or  $2.90 \text{ €/m}^3$  to be added to the cost of transferred water. Another more workable alternative would be to establish the surcharge on the actual urban and industrial use in the Murcia region and on the transfer allotment destined to urban and industrial use, which implies a surcharge for this group of users of about  $0.68 \text{ €/m}^3$  and resulting in a final price of  $1.54 \text{ €/m}^3$ . In order to maintain the present low water prices that farmers pay in all Levante counties, the subsidy to transferred water amounts to 264 million €

Political and social officials from the donating basin should avoid subsidizing of the transferred water

This option is frankly unjustifiable as much from the economic perspective as from the environmental and territorial balance point of view, since non-profitable agricultural activities would be maintained in an unsustainable framework, diverting water resources that compromise the ecological functioning of the donating basin and selling out its future. Political and social watchdogs from the donating basin should make sure that this option does not occur.

A rational water policy should avoid supply solutions and be oriented towards demand solutions

The alternatives that have been presented in this study are: *the ban of aquifer overexploitation, an increase in the price of water by  $0.12 \text{ €/m}^3$  with a remaining excess demand of  $379 \text{ hm}^3$ , an increase in the price of water by  $0.18 \text{ €/m}^3$  which balances demand and supply, and the NHP alternative of water transfers of  $820 \text{ hm}^3$  with a required subsidy to farmers of 264 million € to maintain the present low prices*. These alternatives must be carefully examined to determine a rational policy what will not be oriented towards the traditional policy

of supply with enormous investments in external transfers to basins to augment the supply of subsidized water, but rather should be oriented towards measures of water demand management coupled with local desalinization. The more elevated water prices would reflect the scarcity of the resources, but prices can not escalate excessively and losses to farmers must be compensated. Otherwise, an excessive burden on agricultural activity will be met by social opposition and make the measures fail.

The best option for society is being blocked by the decision taken by the Government. However, a compromise solution is needed

The best option for society would be to compensate farmers for higher water prices around  $0.18 \text{ €/m}^3$ , in order to balance water use in Levante without resorting to the Ebro, for the economic, environmental and territorial equilibrium reasons that have been expressed here. But looking at the firm decision of the Central Government to expand water supply, a compromise solution between the policy of increasing water supply and the policy of demand management would consist in a smaller increase of  $0.12 \text{ €/m}^3$  in the price of water coupled with desalinization in the coastal counties, since the *effective demand* for desalinized water is close to  $300 \text{ hm}^3$ . This solution would reduce water demand with a moderate effect on farmers income and net profit, and does not preclude subsidizing desalinization.

More elevated water prices allow farmers to internalize in their private activities the social cost of providing water resources

A demand management strategy is preferable, because it guarantees the relief of pressure on aquifers coming from agricultural use without needing to establish unfeasible strict controls on wells and extractions. The higher water prices for agricultural use would incorporate information about the scarcity of the resource and profitability of use. The existing communities of irrigators should carry out the supervision of water payments, such that the demand of surface water as well as the extraction and payment of subterranean water in farmer's exploitations is controlled. Farmers would respond to higher prices approaching the sum of economic costs of water and environmental costs, internalizing in their private production activities the social costs of the current externalities embodied in the provision of water resources and in aquifer depletion.

A final question on the water transfer not examined here is the "Tragedy of the Commons" aspect of public water transfers in Spain. Since public transferred

Risk of a “Tragedy of the Commons” outcome

water is assigned in proportion to existing irrigation acreage, the strategy that farmers follow is to expand irrigation acreage in order to get a larger share of transferred water, so when water finally arrives the scarcity is much more acute than before the transfer. This problem already occurred thirty years ago in Levante with the Tajo-Segura water transfer.