WORKING PAPER

Abril/2014

Scenarios and typology of water markets for Guadalquivir. CAP & TRADE Project Report

Authors: Berbel, J., Giannoccaro, G. y Gutiérrez, G.

Language: English

Project denomination: Water market scenarios for Southern Europe: new solutions for coping with increased water scarcity and drought risk

UNIVERSIDAD DE CÓRDOBA

Berbel, J. Giannoccaro, G. Gutierrez C.(2013) Scenarios and typology of water markets for Guadalquivir. CAP& TRADE Project Report.

Scenarios and typology of water markets for Guadalquivir

CAP& TRADE Project Report[1]

Authors: Berbel, J. Giannoccaro, G. Gutierrez C. *Universidad de Córdoba*

1. Objectives and structure of this deliverable

This deliverable aims to define scenarios that will be presented to different stakeholders in task #4.5 ‘Perception in several sites of Spain’ in order to get a result from the focus groups that will be held with the stakeholders and obtain a report that summarizes the perception on water markets by agents.

The deliverable will be focused in Guadalquivir case but the final section will draw general conclusions and questions for the other European case study.

The output of task #4.5 has been used as a discussion material in WP7 ‘National Advisory Group".

[1] Water Cap & Trade: Water Markets Scenarios for Southern Europe"

2. Existing practices and references

Gomez-Limon et al 2013 make a typology of irrigated areas in Guadalquivir that is going to be used as reference in our analysis. The total area of irrigated land maybe categorized in the followings typologies: C1-Traditional extensive crops; C2-Modernized irrigated schemes; C3-Olive; C4-Vegetables-traditional; C5-Rice.

Table 1: Irrigated farms typology (2008)

Crop	C1	C2	C3	C4	C5	ha
m3/ha	5,206	3,638	1,934	3,870	12,000	Total
Surface (ha)	38,735	310,719	406,713	51,365	34,524	842,052
Olive	12%	28%	89%	27%	0%	466,677
Cereals	16%	16%	3%	16%	0%	76,400
Cotton	23%	13%	1%	0%	1%	52,672
Vegetables	9%	6%	2%	23%	0%	43,563
Citrus	3%	11%	1%	1%	0%	38,712
Rice	1%	0%	0%	0%	94%	34,049
Industry	8%	8%	0%	1%	1%	29,830
Fruits	1%	4%	1%	8%	0%	19,809
Maize	13%	4%	0%	2%	0%	18,481
Rest	15%	10%	3%	21%	4%	61,859

Source: Gomez-Limon et al 2013 from AQUAVIR (2009) 'Inventario de Regadios, 2008'

Sample in Figure 1 summarizes large irrigation schemes in Guadalquivir that belongs mainly to cluster C2, (large irrigation schemes) sellers in the market have been the agents integrated in this cluster named: 'general modern irrigation', next section analyses the economy of this typology. Demand in a 'wet year for this typology is illustrated in figure 1, supply of water is around 5,000 m^3/ha (gross) that is the average water rights in the Draft Hydrological Plan 2010. As we can see in Figure 2, average gross use is below that figure, with 4.250 as the average consumption with the 'normal water dosis' that implies a certain level or deficit irrigation, theoretically some crops such as wheat, sunflower, olive that are irrigated at 30-60% Relative Irrigation Supply (RIS) may use full Etc (theoretical irrigation needs) but this is not done for reasons of profitability, low or zero value of marginal water in their production function and increase in risk of fungal diseases. So we have decided to keep the average real water dosis for those crops that maybe adapted to deficit.

The potential typology of markets existing in Guadalquivir is illustrated in table 2.

Table 2: Potential Types Water Markets in Guadalquivir

Class	Seller	Buyer	Market type Leasing (yearly)	 Land water rights
Intra basin	Low value crops	High value crops	Existing Scarce/neligible	Linked to land (No water trade)
	Low value crops	Industry	No	In operation
	Low value crops	Urban	Unlikely in future	Unlikely
Inter basin	Agriculture	Agriculture + Urban	Frequent	Operative
PWB	Water savings/Other	High value crops	Possible	Possible

Source: own elaboration

Table 3 summarised the markets to be researched. The future scenario development will focus either in existing active markets with the following products and typologies:

- Scale and instruments: Water bank, intra-basin and interbasin
- Products can be traded: Spot (lease), Permanent, Options

Table 3: Typology of markets in Guadalquivir to be analysed

	Range	Seller	Buyer	**Leasing**	**Perma-nent**	**Options**	Notes
A	Intra-basin	Agriculture	Agriculture	X			Very relevant for future reallocation
B	Intra-basin	Agriculture	Industry		X		Already operating for new energy power plants
C	Intra-basin (PWB)	Agriculture	Agriculture	X	X		PWB may ease the start up of markets
D	Inter-basin	Agriculture	Agric + Urban	X	X	X	Already operating, options not observed in Guadalquivir

Observed typology

<u>Type 'D'</u> is the best documented case as the analysis of observed behaviour in the period 2006-2011 in Guadalquivir is based in the analysis presented in Berbel and Mesa (2007) on the existence of an open water market in the basin around the inter-basin transfer Negratin-Almanzora. Table 4 illustrates the operations in Spain, with detail of the Guadalquivir operations where the Buyer has been 'Aguas de Almanzora'.

Table 4: Water trade in Guadalquivir 2006-2008

Seller (2006)	Buyer	Volume (m^3)
Aguas del Almanzora SA	Aguas del Almanzora SA	8.479.673
	Total Spain 2006	75.048.408
Seller (2007)		
Various	Aguas del Almanzora SA	35.315.378
	Total Spain 2007	102.393.891

Fuente: DGA, MIMAM, 2008

In this typology there are two types of water rights traded:

- Long term acquisition obtained by buying land in rice growing area by Aguas de Almanzora
- The same buyer has also bought water in an annual basis using the Negratin-Almanzora transfer infrastructure the years 2005-2008 with a total volume of 50GL and an average price of 0.18€/m3.
- The trade of options has not been observed yet.

Price for most operations in Guadalquivir has been around 0.18 euro per m^3 and sellers have been either the rice growing area (2006) or the large irrigation schemes in Medium Valley that will be analyzed in the next section.

In this river basin there have been some operations of water leasing where buyer was city of Seville and sellers farmers from 'Comunidad del El Viar' (see Camacho et al, 2006). This type of trade is very unlikely that will happen again as the new normative and technical environment with the new institutional and technical settings that are mainly:

- Hydrological Plan 2010
- Improved urban supply infrastructure (new dams and network connections)
- Drought Management Plan
- Improved urban water management
- User priorities defined in the Water Law

So that we conclude trade between agriculture and urban (domestic use) should be exceptional and it will be very unlikely that cities need to resort to buy water rights from farmers in the near future, so that it has been decided to skip this typology of markets.

Type A and C

They are quite similar, as the seller is agriculture (low value, short term non used water) and the buyers high value crops inside the basin. Difference is that in the first case trade is made between agents without public support through banks. Water banks can be seen as a way to reduce transaction cost and increase the speed of adoption of the markets in the basin.

Type 'B': Energy generation plants demand has been very active in the last five years and according recent data (Oct 2011) the demand of water for energy is summarized in the next table for the present and estimated for the near future.

Table 5: Water demand for energy generation (renewable) in Guadalquivir

Total power (MW)	**2010**	**2015**	**2020**	**2027**
Thermo-solar Andalusia	447,9	1 100,0	1 800,0	3 000,0
Thermo-solar CLM	1,0	17,0	17,0	17,0
Biomass	140,0	230,0	350,0	350,0
Total MW	**588,9**	**1 347,0**	**2 167,0**	**3 367,0**
Demand (hm^3/year)	**2010**	**2015**	**2020**	**2027**
Thermo-solar Andalucía	18,0	25-30	40-60	66-100
Thermo-solar CLM	0,03	0,6	0,6	0,6
Biomass	1,8	2,9	4,5	4,5
Total hm^3	**19,8**	**28,5-33,5**	**45-65**	**75-105**

Source: own elaboration form P.H. Guadalquivir data and published reports

The already operating plants consuming 19.8 hm^3 gives an average price in the range of annualized price of 0.12-0.30 euro/m^3-year.

A relevant technical question is that there is a change of characteristics as the demand for industry gets a level of guarantee similar to urban (99.8%) against the existing guarantee for agriculture (around 76%) . This conversion from low to high guarantee has a conversion coefficient K = 0.8 x 0.8 = 0.64. The first factor in the formula accounts for the reduction of return flows and second for the increase in guarantee.

3. Scenarios for case study: Summary of demand scenario

3.1 Potential demand

The potential demand of water is composed of various actors:

a) Interbasin transfer, limited by the capacity of channel and pumping capacity to a volume of 50 hm^3.
b) Intrabasin transfer to undersupplied irrigated olive, there are around 100.000 ha of olive grove irrigated with 1.000 m3/ha that maybe irrigated with 1,500 m3/ha that is considered a satisfactory doses still under deficit irrigation scheme. This implies 100.000 x 500 m3/ha = 50 hm^3
c) Energy generation plants demand, the scenario according recent data (Oct 2011) is summarized in the table 5

Actual demand is covered by the operations approved by the government, through a permanent trade of water rights that are converted from irrigation (average 6.000 m^3/ha) to industrial use, by changing the water rights quota to 2/3 of original agricultural use. According to our scenario, in the next 15 years around 25-45 hm^3 will be necessary to satisfy energy generation, thus 37-67 hm^3 irrigation assigned should be traded either permanently or temporary (lease)

d) Others, some high value crops irrigated (flowers, greenhouse) based upon over exploited aquifers may be interested in buying temporal or permanent water rights, but the demand of this crops is reduced and maybe integrated either in the intra-basin intensive olive demand or the inter-basin for greenhouse demand.

The possible long term demand is summarized in the table 6.

Table 6: Estimated potential demand of water rights

Sector	**hm^3**	**observed price (€/m^3)**	**Notes**
Inter-basin transfer	50,0	0,18	Possible increase to 60 hm^3
Energy (intra-basin)	50,0	0,12-0,30 (*)	Median equivalent irrigated water rights (37-67hm^3)
Others (intra-basin)	50,0	0,18	Only an operation 0.15 hm^3 observed in 2010

(*) Price is own estimation based in observed price of leasing and buying of irrigated land for thermo-solar plants

3.2 Potential supply

Sellers of water would be cluster #1 (traditional extensive), #2 (modernized) and #5 (rice). Volume offered will depend upon price, so that a supply curve is developed.

A generic linear programming model for farm-level analysis was used to assess the likely uptake of water selling activity at different market price under the assumption of a profit maximising decision maker. The model can be calibrated to represent any particular farm situation, in terms of basic resource endowments, to simulate representative farm situations. The model has been used in various studies, .to analyse the economic impacts of policy (i.e. water policy, agricultural policy) on farm businesses, particularly relating to how water use may change. The model incorporates all major cropping activities carried out on farms belong to the Guadalquivir river basin and can thus be calibrated for all mainstream farming types. The objective function of the model is to maximise the overall farm gross margin (revenue minus variable costs) in a single year (water selling revenue is therefore represented as annual equivalent values) within the constraints of available resources such as land and water. In addition agronomic and structural constraints that farmers usually face in the farming activity are implemented. In this first attempt, other resource availability such as family and hired labour is assumed not to limit farmer's decision at least under the short period assumption.

Gross margins are not explicitly entered into the model for conventional crops, but are implicit from the variable costs involved in production, relating for example to seeds, fertilizer, and herbicides, and the revenue based on the yield and the prices received. For the purposes of this exercise, water selling is included in the model as an extra activity available to the farmer. At begins this market option does have an explicit value. The model proceeds through a number of runs with the objective of maximizing the whole farm gross margin, even the water selling option. With each run of the model, the marketable price of water selling is gradually increased, and the effect of this on the amount of water allocated to each irrigated crops, as well as to water market option is observed. Having identified the price that is necessary to bring about a certain level of uptake, the water supplying curve is built up.

The allocation of water in the model is determined simply by the irrigated crop's gross margin. Since the water market activity is an annual 'spot' activity, the framework analysis refers to the short time horizon, in which changes in fixed costs do not occur. In addition, it is considered likely that for most farmers the establishment of selling activity will be undertaken by contractors which will be endorsed by the Irrigation board community (i.e. Comunidad de Regantes), and this is reflected in the model where these activities make no call on the transaction costs.

It was decided not to attempt explicitly to consider risk within the model. Alongside this changing regulatory framework is the perceived institutional risk associated with market contracts. The approach taken, therefore, is to abstract from these likely risks and examine theoretical uptake under the assumption that these barriers had effectively been tackled through policy intervention.

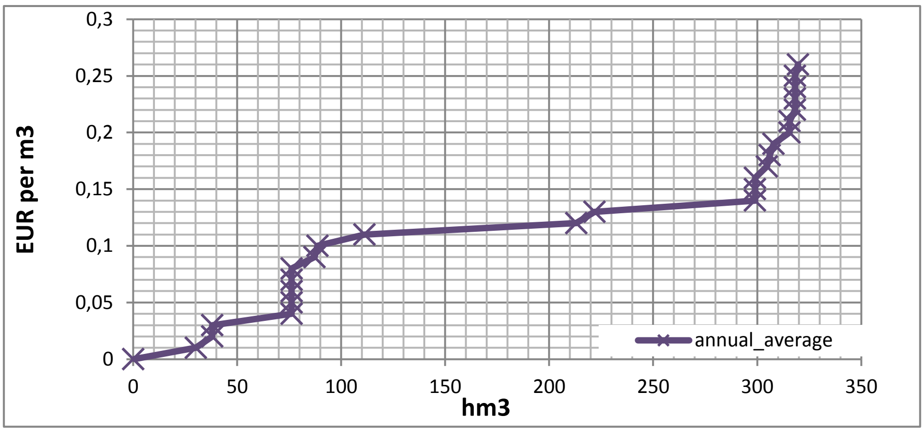
The model here was used to predict uptake of water selling activity (in terms of water volume) at different marketable prices across two of the major 'seller' farm types within the Guadalquivir basin (i.e. traditional extensive and modernized mixed farms). The most usually crops are winter cereal (durum wheat), general field crops, traditional and intensive olive grove systems, and citrus.

The two representative farm types are distinguished in the model principally on the basis of the number of hectares of different land types available for different crops. Beside that the annual yields, water allotments and water field use are distinguished in the model according to the mentioned farm types.

With an increase in agricultural commodity prices over the past few years, farmers were achieving higher gross margins for a number of conventional crops. A typical gross margin for winter wheat, for example, increased in the range of 1.4 times from 2005/2006 to 2006/2007. As a consequence, prices were based on a last two years rather than taking a weighted mean of prices over 3 years, as it was felt that doing so would not accurately reflect the price expectations of farmers. Indeed, prices, and input costs included in the model were updated using the two earlier years of each annual simulation.

According to the results it may be convenient to estimate a potential supply water curve (average inter-annual volume) for a 'standard year' that is developed in figure 1.

Figure 1 Potential supply water curve (average inter-annual volume) for an 'standard year'



We should remember that observed market 2006- 2007 (see Berbel and Mesa, 2007) has been reduced to a volume below 50 hm^3 for the observed traded price of 0.18 €/m^3.

Also we should note that volume traded in 2007-2008 that was around 35hm^3 according figure 1 had an opportunity cost estimated around 0.04 euro/m^3.

4. Conclusions and Questions

Once the scenarios for potential supply and potential demand are defined, the main conclusions from this case study are:

- Different demand and supply for the three water rights that may be traded:
    1. Seasonal
    2. Permanent
    3. Options.
- Seasonal demand is limited to years and seasons with resource limitations either drought or restricted local supply
- Permanent demand is open to changes in location (from low value, physical limiting conditions to high value products) and sectors (agriculture to industry)
- Options are scarcely traded but it should be convenient to study it as a potential tool.

The analysis of the potential trade and gains may be conducted mainly either by models or by direct questioning of agents (sellers, buyers and third parties). In any case the scenario of scarcity should be forced as the pre-condition for trade operation. This permanent or seasonal scarcity maybe forced by two means that may be used alternatively or simultaneously:

- Defining a **medium-long term climatic change conditions** where water resources and temperature force the scarcity environment in locations where there are not scarcity perception by farmers so that the market is not seen as a practical possibility.
- By **using the memory of the last droughts that farmers may have suffered** to induce artificially the natural conditions in case of farmer attitudes and interviews or by including water constraints in the models.

5. References

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