Water Cap & Trade

WATER MARKETS SCENARIOS
FOR SOUTHERN EUROPE: NEW SOLUTIONS FOR COPING WITH INCREASING WATER SCARCITY AND DROUGHT RISK?

IWRM-NET

Final project report

July 2014

Contributing authors:
Berbel J., Bouscasse H., Calatrava J., A. Duponteil, Giannocarro G., Garrido A., Figureau C., Hérivaux C, Kervarec F., Montginoul M., Raggi M., Rey D., Rinaudo J-D, Vernier M., Viaggi D., M. Zavalloni

Coordination: Jean-Daniel Rinaudo

A project funded by :

ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale
GOBIERNO DE ESPAÑA
ONEMA Office national de l'eau et des milieux aquatiques
mid Un lugar para la ciencia y la tecnología

DISCLAIMER

This report was prepared within the framework of the IWRM-NET Funding Initiative. While reasonable care has been taken in preparing this publication to ensure that information is appropriate and valid it have to be considered that the views, conclusions and recommendations expressed herein are those of the authors and must not necessarily endorse the views of the IWRM-NET or the respective Funding bodies involved.

The intent of the research reports is to provide relevant information and to stimulate discussion of those having an interest in integrated water resource management (IWRM). The results and conclusions of all reports produced under the IWRM-Net Funding Initiative will be disseminated across the network to the appropriate audience (river basin managers, policy-makers, research funding bodies, universities, industries, and other stakeholders at all levels), and on the general IWRM-Net website (http://www.iwrm-net.eu).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF DELIVERABLES

Scientific publications

P1 Garrido A., Rey D. and Calatrava J. (2012b). "Water trading in Spain". In: de Stefano, L. and Llamas, M. R. (eds), Water, Agriculture and the Environment in Spain: can we square the circle? CRC Press, Botín Foundation, pp. 205-216.

P2 Garrido A., Calatrava J. and Rey D. (2013). La flexibilización del régimen de concesiones y el mercado de aguas en los usos de regadío. In: Embid A. (ed.), Usos del Agua (Concesiones, Autorizaciones y Mercados de Agua). Universidad de Zaragoza and Confederación Hidrográfica del Ebro. Thomson Reuters, pp. 177-197.

P3 Rey D., Garrido A. and Calatrava J. (forthcoming). The Water Markets in Spain: moving towards 21st century mechanisms and approaches with 20th century regulations. In: Water Markets for the 21st. Century: What Have We Learned? Easter W. and Huang Q. (eds.). Springer. In press.

P4 Rey D., Garrido A. and Calatrava J. (To be submitted). An innovative water sharing scheme for allocating water in inter-basin transfers: the case of the Tagus-Segura Transfer in Spain.

P5 Rey D., Calatrava J. and Garrido A. (submitted). Optimization of water procurement decisions in an irrigation district in Southeast Spain: the role of option contracts. *Australian Journal of Agricultural and Resource Economics*

P6 Rey D., Garrido A. and Calatrava J. (under review). Assessment of irrigators' preferences for different water supply risk management tools: option contract and insurance. *Environmental and Resource Economics*

P7 Rey, D. (2014). Water option contracts for reducing water supply risks: an application to the Tagus-Segura Transfer. *Doctoral Thesis*, defended on June 27, 2014. Co-supervised by Prof. A Garrido and Prof. Javier Calatrava. Universidad Politécnica de Madrid

P8 Figureau AG, Montginoul M & Rinaudo JD (in press). Scénarios de régulation décentralisée des prélèvements agricoles en eau souterraine : Une évaluation participative dans le bassin du Clain. *Economie Rurale*.

P9 Figureau AG, Montginoul M & Rinaudo JD (submitted). Decentralization and Economic Incentives to Manage Groundwater Withdrawals for Irrigation: from Theory to Practice. *Ecological Economics*

P10 Rinaudo JD, Calatrava J and Vernier de Byans, M (submitted). Tradable Water Saving Certificates to Improve Urban Water Use Efficiency: an ex-ante evaluation in a French case study. *Australian Journal of Agricultural and Resource Economics.*

P11 Rinaudo JD, Montginoul M, Varanda M, Bento S (2012). Envisionning innovative groundwater regulation policies. *Irrigation and Drainage* 61 (pp. 65-74) (http://onlinelibrary.wiley.com/doi/10.1002/ird.1661/full)

P12 Zavalloni M., Raggi M., and Viaggi D. (In press). Water Harvesting Catchments with Internal Water Reallocation: a Case Study in Emilia Romagna, Italy. *Journal of Water Supply: Research and Technology* - AQUA.

P13 Zavalloni M., Raggi M., and Viaggi D. (accepted), Water Trading with Multiple Water Source: A Case Study in the Reno Basin, Italy. ”Economics of Water Management in Agriculture“ edited by Bournaris T., Berbel J., Manos B, Viaggi D. Science Publisher

P14 Vollaro M., Zavalloni M., Raggi M., Viaggi, D. (accepted) "Adapting to Climate Change: the Social Perception of Voluntary Water Transfers in the Italian Context". *International Journal of Sustainable Agricultural Management and Informatics*.

P15 Giannoccaro, G., Castillo, M. and Berbel J. (submitted) An assessment of farmers' willingness to participate in water trading in Southern Spain. *Water Policy*

P16 G. Giannoccaro, V. Pedraza and J Berbel (2013). Analysis of Stakeholders' Attitudes towards Water Markets in Southern Spain. *Water*. 5, 1517-1532; doi:10.3390/w5041517

P17 Giannoccaro G., Pedraza V., Berbel J. (2012). *Análisis de las percepciones de agricultores y regantes sobre mercado de agua en la cunca del Guadalquivir*, in: El Agua en Andalucía, Retos y avances en el incio del milenio, a cura di López-Geta J.A., Ramos González G., Fernández Rubio R., Lorca Ferández D. Instituto geológico y minero de Espeña, Madrid pp.945-956. ISBN: 978-84-7840-863-4

P18 Castillo, M. Giannoccaro, G., Berbel J. (submitted). Determinants of farmers' participation in water allocation trading. A case study in Southern Spain. *Journal of Agricultural Economics*

P19 Giannoccaro G. and Berbel J. (submitted). Analytical Review of Mathematical Models of Water Markets. *Spanish Journal of Agricultural Research*

Conferences

Rey D., Garrido A., Calatrava J. (2013). Comparison of different water supply risk management tools for irrigators: option contracts and insurance. IX Spanish National Congress of Agricultural Economics, Castelldefels, 3-5th September 2013

Figureau AG, Montginoul M et Rinaudo JD. (2012) Autorégulation et incitations économiques pour gérer les eaux souterraines. Test dans le bassin du Clain. Oral presentation at : *6èmes journées de recherches en sciences sociales, INRA SFER CIRAD*, Toulouse : France (available at http://hal.ird.fr/hal-00780264/

Giannoccaro G., Pedraza V., Berbel J. (2012): “Barriers to water markets in agriculture. Analysis of Southern Spain stakeholder attitudes”. 1st AIEAA Conference – Towards a Sustainable Bio-economy: Economic Issues and Policy Challenges. Trento, 4-5 June 2012.

Vollaro M., Zavalloni M., Raggi M., and Viaggi D. (2013), Potential For Water Use Right Market Development In Italy: Social Acceptability In The Context Of Climate Change. Presented at the AIEAA Conference, Parma, 6-7 June 2013: "Between Crisis and Development: Which Role for the Bio-Economy".

Zavalloni M., Raggi M., and Viaggi D. (2013), Water Harvesting Catchments with Internal Water Reallocation: a Case Study in Emilia Romagna, Italy. Presented at the 3rd International IWA Conference on Water Economics, Statistics and Finance. 24-26 April 2013. Marbella, Spain.

Technical notes

	Author	Title
TN 1	D. Rey, A. Garrido, J. Calatrava	Literature review of WM around the world
TN 2	D. Rey, A. Garrido, J. Calatrava	Public water purchases and water banks
TN 3	D. Rey, A. Garrido, J. Calatrava	Option Contracts in Water Markets
TN 4	D. Rey, J Calatrava, A Garrido	Water market scenarios for Spain
TN 5	D. Rey, J Calatrava, A Garrido	Water market scenarios for the Tajo-Segura transfer and the Segura basin
TN 6	G. Giannoccaro, V Pedraza, J Berbel	Analysis of Southern Spain stakeholder attitudes towards water markets
TN 7	G. Giannoccaro, V Pedraza, J Berbel	A review of economic modeling approaches to simulate water trading in agriculture
TN 8	M. Montginoul (IRSTEA°	Lay perception of water markets: Lessons learnt from mini-debates with citizens
TN 9	Viaggi D., Zavalloni M., Calatrava J., et al.	Synthesis on transaction costs
TN10	F. Kervarec	Perception of water markets in the Marais Poitevin (France): methods, first results and feedback
TN 11	Calatrava, J. et al.	Synthesis report of water market scenarios
TN 12	G. Giannoccaro, V. Pedraza and J Berbel	Analysis of Stakeholders' Attitudes towards Water Markets in Southern Spain
TN 13	V. Pedraza, G. Giannoccaro, and J Berbel	Mathematical modelling in the context of water markets
TN 14	Giannoccaro G., Berbel J., Pedraza V.	Scenarios of water trading in the South of Spain
TN 15	F. Kervarec	Social acceptability and water markets: a short literature review
TN 16	Hérivaux C., Figureau AG, Rinaudo JD and Montginoul M	Scenario of groundwater trading within agriculture in France

Reports in national languages

	Author	Title
R1	Rinaudo J-D, Montginoul M., Hérivaux C. & Figureau	Quels instruments pour une gestion collective des prélèvements agricoles individuels en eau souterraine ? (2014) Rapport final. BRGM/RP-63259-

	A-G. (BRGM/IRSTEA)	FR, 86 p http://infoterre.brgm.fr/rapports/RP-63259-FR.pdf
R2	Figureau AG, Montginoul, M & Rinaudo J (BRGM/IRSTEA)	Gestion quantitative de l'eau d'irrigation en France : bilan de l'application de la loi sur l'eau et les milieux aquatiques de 2006, BRGM/RP-61626-FR, 50 p., 11 Ill., 3 enc., 1ann http://infoterre.brgm.fr/rapports/RP-61626-FR.pdf
R3	Campardon, M (IRSTEA)	Evolution de l'agriculture en plaine du Roussillon
R4	Montginoul M (IRSTEA)	Comment gérer les prélèvements d'eau effectués par les agriculteurs ? Résultats des ateliers de réflexion conduits avec des citoyens présents au Salon International de l'Agriculture 2012.
R5	S. Hernandez (ACTeon)	Représentations de l'eau et perception d'une gestion quantitative par les marchés : cas d'étuide sur le territoire du SAGE Bièvre-Valloire (France)
R6	H Bouscasse, A Duponteil ….	Modelling agricultural water markets in Marais Poitevin

Academic thesis

	Author	**Title & reference**
MSc.1	Duponteil A. MSc (Brgm)	Gérer la rareté de l'eau à l'aide de droits d'eau négociables : étude de faisabilité dans les Pyrénées-Orientales. *MSc. Thesis*. Defended 24 September 2010 at Rennes, **Agro Campus Ouest, Master POMAR.**
MSc.2	Vernier de Byans (Brgm) MSc	Les certificats d'économie d'eau potable échangeables comme option de gestion durable de la ressource en eau à l'horizon 2030 *MsC thesis*. Defended 11 sept 2012 at Rennes, **Agro Campus Ouest, Master POMAR.**
PhD.1	Rey, D (UPM) PhD	Water option contracts for reducing water supply risks: an application to the Tagus-Segura Transfer. *PhD thesis*. ***Universidad Politécnica de Madrid***. Defended June 27th, 2014

Technical notes and reports can be downloaded at:
http://www.capandtrade.acteon-environment.eu/

1 INTRODUCTION

1.1 PROJECT OVERVIEW

This report summarizes the main results of the 4 years "***Water Cap & Trade***" research project (2010-2014) funded under the IWRM net initiative. This project was designed and implemented by six research teams from Spain; Italy and France: University of Cordoba, Polytechnic University of Madrid, assisted by Polytechnic University of Cartagena (subcontractor), University of Bologna, Brgm (French Geological Survey), Irstea (National Research Institute for Science and Technology in Agriculture and Environment) and ACteon (consulting company).

The project main objective was to investigate if and how economic instruments aiming at reallocating water between users could be integrated into water management policy in the European context. The intention was to explore 1) the efficiency issue through economic modeling, 2) the acceptability issue through participatory approaches, 3) the institutional dimension through an analysis of transaction costs and 4) the policy implementation process, through policy simulation or policy exercises. By design, the project mainly looked at water markets from an economic perspective.

The project was based on several case studies in France, Italy and Spain. The number of case studies actually conducted is greater than initially planned, in particular in France (8 case studies instead of 2 initially planned) and Italy (2 instead of 1). Interactions with stakeholders, water planners and policy makers were significant in the three countries, either at local, regional or national level. A final conference organized in Paris in February 11th brought together experts from several EU countries for a very fruitful day.

From a scientific perspective, the production is satisfactory, with 18 papers published or submitted to peer-reviewed journals or edited books; 16 technical notes targeting a readership of practitioners and academic; 1 PhD dissertation and 2 MSc theses; and several reports in national languages targeting local / national stakeholders. The contributions are not only advancing research in economic modeling but also in interdisciplinary approaches of economic instruments. From the coordinator point of view, the main weakness lies in the limited integration of case studies' results, mainly due to lack of time and resources to conduct in depth comparative analyses. This comparative analysis and integration work should be done after the end of the project through the preparation of a joint publication.

From a policy perspective, the project results should contribute to the development of new visions of how water markets could be integrated into national water policies in Europe. Let us recall that, in its "Blue print to safeguard Europeans water"[1], the European Commission leaves open the possibility for using this instrument:

> "*water trading is another instrument, used mostly outside the EU, which could help to improve water efficiency and overcome water stress, if a sustainable overall cap for water use is implemented. Water trading entails relatively significant administrative costs and, in principle, only makes sense among water users in a defined river basin. Although it would not be helpful to set up such a system at EU level, the Commission proposes developing CIS guidance to help the development of water trading in the Member States that choose to employ it*"

One of the main contributions consists in showing the variety of instruments which hide behind the term "water market". It also shows that conditions required for establishing water markets are not

[1] http://ec.europa.eu/environment/water/water-framework/pdf/COM-2012-673final_EN_ACT-cov.pdf

met in a number of socio-economic and environmental contexts. However, where these conditions are met, their implementation could generate significant benefits for the society.

1.2 WORK-PROGRAM ADAPTATION

During the four years of the project, difficulties encountered as well as unforeseen opportunities leaded us to change the methodology and sometimes even the objectives of several work packages. The methodology and the work program were adapted by each team to better fit with local stakes and emerging research questions (*for more details, see interim report, October 2012*).

Contrary to what was proposed in the description of work, no common methodology was developed and systematically implemented in all case studies. Results obtained in case studies will thus be more difficult to compare at the end of the project than initially planned. This “loss” is however counterbalanced by the increased relevance of each case study and an increase spectrum of issues addressed in various environmental, economic and regulatory contexts.

During the first six months of the project, preliminary field work highlighted the need to dedicate more time and resources than initially planned to the analysis of the social perception of water markets and the identification of potential barriers to implementing this instrument. This was particularly clear in France and Italy where the concept of water market is strongly opposed on ethical grounds by stakeholders. In both countries, it has been extremely difficult to engage discussions with stakeholders on this issue. The difficulties are all the more pronounced in Italy where the issue is sometimes interfering with the debate on public-public partnership for the management of urban water utilities. In France, the team had to develop a specific approach to embed the discussion of water market within a wider context, considering water trading as one possibility amongst many others.

As a consequence, all partners agreed that the project should focus more on how markets should be set up to be attractive for policy makers and economic agents, rather than on the simulation of their economic potential using models. There is a need to be creative while designing scenarios, the discussion of simple WM scenarios would inevitably lead to rejection by stakeholders. The definition of applicable (and economically sound) scenarios of water market development scenarios should be one of the outputs of the project.

Partners also agreed that a lot of economic modeling had already been carried out to assess the potential of water markets. Models are for instance used to predict water sales and purchase curves, the intensity of trade, price levels and the total welfare gains. However, in cases where markets have actually been established afterwards (Spain), trade intensity has been much lower than predicted by economic models. There are evidences that economic agents refuse to engage into water trading for non-economic reasons which need to be investigated.

This has lead the consortium to put more efforts on the definition of finely tunes water market scenarios, implying more interactions with stakeholders (all parners), the selection of a greater number of case studies (Brgm and Irseta) and the implementation of new activities which were not planned initially. For instance, UCO has decided to conduct a survey with 200 farmers in the Guadalquivir basin, UNIBO is also planning to start such a survey with farmers of one irrigation board and Irstea has organized debates involving 110 citizens in Paris. This will automatically lead to reduced resources allocated to others tasks. Major proposed changes are described per parner in the following paragraphs.

1.3 REPORT OUTLINES

This report is organized as follows. Section 2 briefly defines what we mean by water markets; it presents an updated description of policy issues related to the development of water markets at the international and European levels, as well as in each of the three countries (France, Italy, Spain); it also recalls the main objectives of the project. Section 3 provides a summary of activities conducted and results obtained by each partners in each work-package. Finally, section 4 provides some policy recommendations.

Deliverables were not added in appendix to this report. They can be downloaded from the project web site at http://www.capandtrade.acteon-environment.eu/. For copyright reasons, publications are not downloadable, but they can be sent to funding agencies or to external evaluators on request.

2 POLICY ISSUES AND RESEARCH QUESTIONS

2.1 WHAT DO WE MEAN BY "WATER MARKETS"?

A water market can be defined as any institutional framework that allows two users to exchange water or water rights, voluntarily agreeing the conditions of the exchange. The fact that trading decisions are voluntary provide mutual benefits to market participants and, if no relevant market failures exist, results in an increase of the economic efficiency from the allocation of scarce water resources.

The fact that exchanges are agreed among private users does not mean that water markets imply a privatization of water supply and infrastructures. Water markets are tools that can help governments to solve the problem of reallocating water in scarcity periods rather than to privatize water resources. They can be adapted and integrated into very different water management institutional frameworks, from the most liberal to the most interventionists. In fact, Australia, Chile and The USA have long-active water markets of very different nature, with particular institutional settings and different degrees of market intervention and restrictions to trade.

The diversity of water markets around the world (USA, Chile, Australia, Spain, India, South Africa, Pakistan, etc.) illustrates the different forms that they can adopt. First, water markets can be differentiated in terms of the object of the transfer, be it water rights or water itself, and the type of water traded (surface or groundwater). They can also be distinguished depending on the length of contracts: short-term leases (agreement for a year or even a single water turn, as in India, Pakistan, and Marocco gravity irrigation systems), long-term leases (more than a year), permanent transfer of water rights and water supply option contracts.

Historically, exchanges between agricultural users have often been the first water markets to emerge in a given river basin or region. Around the world, agricultural water markets predominate with a large diversity of characteristics, from informal farmer-to-farmer exchanges to trading between irrigation districts in different basins. The benefits arise from water being transferred within the sector to higher-value agricultural systems. However, social and economic externalities may appear (e.g. farm abandonment, labour displacements, intensification of more polluting agricultural production). Most activity corresponds to water leases in spot markets, even in countries allowing for the exchange of water rights, such as Australia or the USA.

Similarly, trading may take place among users in different sectors (agriculture, urban uses, environmental uses, etc.). In most cases, inter-sector water markets involve water being transferred from agriculture to one of the other sectors, frequently to urban users. Water purchases from farmers are usually a cost-effective measure to increase water supply and/or water supply reliability for urban agencies, as shown by evidence from South-Western USA, where very active and increasing exchanges exist.

Contrarily to other countries, major water buyers in Spain are not urban but agriculture and the environment. Increasingly relevant in countries as Australia and Spain are the public purchases of water to comply with environmental demands, usually a less conflictive alternative to enforced reallocation. Each type of inter-sector trading has different implications in terms of potential efficiency gains, players and mechanisms, income distribution and environmental impacts.

Another major characteristic of a WM is its spatial extent (local, regional, intra-basin, inter-basin). The greater this is, the larger the number of potential trading partners and the potential gains-from-trade will be. However, at the same time, a greater spatial extension also increases the risk of environmental and third party effects.

This leads us to other relevant issue, namely the existence of restrictions to water trading. In most countries and states, trading is mostly restricted to users within a same basin. For example, inter-basin trading is forbidden in Australia, where strict provisions to limit the spatial extent of the exchanges exist. In Spain, it is exceptionally allowed and fairly controversial, especially if trading takes place between users in different political regions. Some USA states permit inter-basin trading, while in others there are very strict spatial restrictions. There are also restrictions to water crossing political boundaries: States (Australia, some USA states), regions (Spain) or even counties (California).

Restrictions to trade aim to protect public interest, to comply with environmental objectives (e.g. ecological river flows) or to prevent social impacts. They are stricter in the case of markets for water rights than for spot trading. For instance, in some countries it is not allowed to sell water rights out of the agricultural sector or even out of the irrigation district (e.g. the case of the Australian State of Victoria).

Water markets are poorly developed over the world as a groundwater management tool. In groundwater markets, trading involves abstraction rights and not water itself. Numerous examples of informal groundwater trading exist, especially in South Asia and Spain, but formal groundwater trading schemes are much less developed than markets for surface water. Numerous barriers hinder the development of groundwater markets: the limited spatial extent of aquifer boundaries (and thus of the market), the limited hydrological knowledge about many aquifers, the governance problems inherent to a common-pool resource, the homogeneity of marginal values across aquifer's users, or the complex third-party effects. Despite these, it is expected that groundwater trading will expand in the future in many areas of Australia and the USA, where several formal groundwater-trading schemes have been recently developed.

Water Banks are becoming the most used market mechanism in most mature markets (USA, Chile, Canada, Australia) with environmental protection as the main objective. Although a relatively new concept in Europe, there are a few experiences of public water banks in some Spanish basins. A Water Bank (WB) is a highly regulated institutional mechanism through which an administrative body (public or private) centralizes selling bids and purchase offers and produces a market-clearing price. It is not another type of water market but a mechanism for water markets to function. In a WB, exchanges take place following a pre-established process that is regulated and monitored by the Governments through some regulatory body.

2.2 CURRENT WATER POLICY ISSUES AND WATER MARKETS

At the international level

Australia, Chile and The USA have long-active water markets of very different nature and with particular institutional settings and different degrees of market intervention. Despite of these, there are similarities related to the problems in the definition and registration of water rights and their supply reliability, the predominant role of agriculture as the main water seller, the prevalence of temporary exchanges of water, the dispersion of prices and, in some cases, the increasing concern for the environmental impacts.

The system of water rights in Chile, although different from that in other countries, presents rights with different levels of reliability and thus a priority access to water resources exists depending on the attributes of the right hold by a user. In the case of Australia, one of the major problems is the over-allocation of water entitlements and the low reliability of a significant proportion of these, what causes that in very dry years the water allocated by entitlement is notably reduced. As in the other two countries, there is a wide variety of water rights in the USA (prior allocation, appropriative, riparian, groundwater, Federal Reserve rights), what results in an uneven access to water among

right-holders and in a notable price dispersion because of the different characteristics of the traded rights.

Despite of the free-market orientation of water trading, market activity in Chile is reduced. In fact, the 2005 Reform of the Chilean Water Code incorporates provisions to encourage the trading of non-used water rights. In Australia, trading of seasonal allocations predominate over trading of water rights because of the existing fees and restrictions to trade. However, the trade of entitlements is becoming significant (7 % of entitlements in 2009-2010).

All types of water markets can be found in the USA (permanent, one-year leases, leases for longer periods, water banks, option markets), although the most active ones are still the temporary or spot markets. However, market activity is not significant in relative terms but it is steadily increasing. Water trading in the USA is concentrated in the Western States, being California and Colorado the most active markets.

Chile has a free-market oriented legislation. The role of the government is mostly restricted to the initial allocation and registration of rights and to the allocation of water in specific public projects. Although the environment is considered as another water user, no provisions are made to restrict water trading based on its environmental impacts or on potential third-party effects. Australian Governmental bodies have a major role in the functioning of water markets, and even participate actively as buyers of both water rights and seasonal allocations for environmental purposes. Governmental intervention in US water markets is greater than in Chile although less than in Australia.

Restrictions to water trading of different natures exist in these countries. Australia has strict provisions to limit the spatial extent of the exchanges. In the USA, some States do not restrict exchanges among users or even basins, although in others there are very strict provisions to restrict the spatial extent of the exchanges. Although there are not specific provisions for environmental protection from water trading in the USA, nor in Chile, environmental uses are a major “purchaser”, especially in temporary markets. Apart of these, other relevant restrictions to water trading are the lack of information regarding the existing amount of rights in many areas of Chile and the USA, the thinness and resulting price dispersion of many markets in these two countries and the slower procedures for the authorization and registration of transactions in the USA when compared with Australia.

At the European level

At the EU level, only Spain has developed a regulatory framework to permit water trading. However, the EU considers that water trading could help to improve water efficiency and overcome water stress, if a sustainable overall cap for water use is implemented (EU, 2012). The EU assumes water trading only makes sense among water users in a defined river basin. Although it would not be helpful to set up such a system at EU level, the Commission proposes developing CIS guidance to help the development of water trading in the Member States that choose to employ it.

In Spain

In 1999 the Spanish Water Law was reformed to allow for the exchange of water concessions between users. The market regulation imposed many restrictions, and was built on the same definition of water rights set up in the 1985 Water Law, including the public nature of water resources. Until 2005, exchanges were rare. Due to the severe drought episode in all country, in 2005 water exchanges became more common; however, traded volumes represented less than 1% of all consumptive uses in one year (Garrido et al., 2012).

Two main types of exchanges can be differentiated: one involves two right-holders that voluntarily agree on specific terms of trade and jointly file a request in the Agency, or leased-out the water to which right-holders are entitled. The second way for exchanging water rights involves publicly run and administered water banks (Garrido and Calatrava, 2009). In both cases, the Basin Authority must approve the exchange and take into account the potential impacts on third parties (Albiac et al., 2006).

Since 2005, a number of exchanges have taken place in the Spanish water markets to alleviate the conditions of those basins where water scarcity was most severe (Segura and Andalusian Mediterranean Basins; Embid Irujo, 2010). Some of these exchanges were arranged through a Water Bank (or water exchange centre as it is called in the Spanish water law), and others between users in the same or in different river basins. Typically, a water exchange centre is set up to solve an environmental problem (Júcar, Guadiana and Segura). Their aim was to purchase water from irrigators to reduce the exploitation of groundwater bodies. There are only a few documented experiences of formal lease contracts between right-holders since the 1999 Reformed Water Act. In contrast with what was initially expected, many users have been reluctant to formally exchange their water or concessions (Garrido et al., 2012). In the case of inter-basin transfers, they will require the approval of the Ministry of Environment. Some exchanges have been arranged to transfer water from the Tagus to the Segura Basin (for irrigation districts and urban suppliers) using the Tagus-Segura Aqueduct.

Although the law allows temporary water exchanges, there are several barriers to water trade (legal, institutional and environmental barriers). In Garrido et al. (2012) these barriers are identified and analyzed. After several meetings with experts and market participants, there is a wide consensus that the Spanish water market system should be modified in order to facilitate and encourage exchanges, and to solve the current main problems: lack of transparency, rigidity of the users' priority system, a non well-developed legislation. Furthermore, there is also some rationale to change also the foundations on which water rights are based.

In Italy

In Italy water is publicly owned and water trade is not allowed. There has been no major change in the legal framework since the beginning of the project. However, the water referendum in 2011, though not directly connected to water markets, reinforced the positions against water privatization and provided a large concern about potential damages by private action in water management.
For this reason, it is not only difficult to study water markets in this moment die to the fact that there are no water markets in Italy, but also because it is difficult for the potential stakeholders to envisage any. However, claims for a need for higher flexibility have emerged and concerns for climate change are a growing, that could lead for an increasing interest for this issue.

In France

In France, as in many other EU countries, irrigation development has occurred in an institutional setting that placed no or few limits on water use, in particular concerning groundwater. Government agencies have issued water permits on a routine basis, generally without specifying any ceiling on water use. In several parts of France, this has resulted in low flow problems in rivers and declining water tables, with significant impacts on dependent rivers and ecosystems.

Until the mid-1990's, local authorities responded by establishing water restriction rules (irrigation bans) which were activated as soon as aquatic ecosystems were threatened by over-abstraction. This crisis management system is now being replaced by a structural approach based on a quota system. In river basins and aquifers considered as at risk of over-exploitation, hydrogeological studies are conducted to assess the total maximum volume that can be abstracted. This volume is then shared

among users, based on historical use. To solve the over-allocation problem, quotas are progressively being reduced, which triggers tensions and leads some farmers to develop additional water resources (tanks). There are, however, evidences that the current allocation of water is not efficient from an economic point of view (sleeping rights, inefficient irrigation technologies…) particularly in the agricultural sector. Following research conducted in the early 2000s (Strosser and Montginoul, 2001), the project team is therefore questioning whether establishing a system of tradable groundwater permits in agriculture would increase the economic efficiency of water use.

Implementing a groundwater trading scheme raises a number of issues in the French context, where water is culturally and legally considered as a national public trust. The first contribution of the case studies conducted as part of this project consists in identifying these issues and in proposing an institutional set up adapted to the French institutional context. We intent to show how market mechanisms can operate without creating full property rights, based on a public concession system, as already implemented in Spain. The potential role of government agencies will also be described, considering the issue of transaction and acceptability problems by farmers.

2.3 RESEARCH QUESTIONS CONCERNING WATER MARKETS

Five main research questions were clearly identified in the project proposal. The formulation of these questions has however evolved during the first half of the project. New issues have emerged and some of the questions raised have appeared difficult to answer (from a methodological point of view) or not so relevant in the case studies investigated. The following paragraphs provide an up-date of how our research questions are now defined.

Which trading mechanisms are feasible in the European context?

A review of the literature on water markets clearly shows that the term water market encompasses a huge variety of practices, ranging from very local informal exchange of irrigation water turns within irrigation systems to inter-regional and inter-sector trade of formal water property rights. Whereas most of this literature deals with water markets established in Northern America and Australia, very few papers report on real practices or experiments conducted in Europe – Spain set apart. As a consequence, no European model of water market spontaneously emerges from the literature. The first objective of the project is to investigate possible development of certain forms of water permits trading in the European context. The project more specifically investigate the following types of trading : (1) Groundwater trading (France, BRGM); (2) Option markets (UPM); (3) Inter-basin transfers in Guadalquivir-Andalusia (UCO) and Tagus-Segura basins (UPM); (4) Agricultural water markets (ACTeon, BRGM, UNIBO, UCO); and (5) Trading of Water saving certificates (BRGM –UPM).

What economic gains from establishing water trading mechanisms?

A second objective of the project is to assess whether the development of water trading would lead to increased welfare and productivity of water, as predicted by the economic theory. The analysis is based on economic modeling conducted in real case studies. This issue is investigated in several case studies: 1) Inter-basin option markets between the Segura and the Tagus river basins (UPM); 2) water trading between farmers in Marais Poitevin, France (ACTeon) and in Reno basin (Italy); 3) trading of water certificates between urban water utilities in southern France (Brgm). Work performed allows simulate the intensity of trade, price levels and economic gains from trade. Three case studies have already produced quantified results at this stage of the project (UPM, ACTEON and BRGM).

Is the development of water market impeded by socio-cultural factors?

In Europe, the idea of developing trading mechanisms for allocating water is triggering significant social and political opposition. The project intends to describe and analyze this constraint through a

detailed study of stakeholder's perception of water markets. This question is being addressed in several case studies using a variety of methods such as focus groups, semi-structured interviews, foresight seminars and quantitative surveys. The research focuses on the perception of markets by water users, water stakeholders but also ordinary citizens. The results will allow comparing differences in perception of water markets for different cultural and institutional setups within Europe.

What transaction costs for various water market scenarios

Establishing tradable (abstraction) water permits requires changing laws, institutions, information systems and sometimes even hydraulic infrastructure. All this might entail significant transaction costs that need to be assessed and compared with the gains from trading. The project initially intended to quantify these costs for several of the water trading scenarios. Preliminary research was conducted in the Segura basin to assess costs associated to existing transactions (UPM). It shows that it is extremely difficult to disentangle costs which are specifically related to transactions from other costs. UNIBO and UPM have jointly developed an analytical framework for assessing transaction costs for future water market scenarios and made an attempt to apply it to some water market scenarios. They concluded that ex-ante monetary evaluation of transaction costs will be difficult (if not impossible) when water market scenarios remain hypothetical.

How to phase the development of water markets in Europe

In France and Italy, water is considered as a common pool good allocated to users with a regime of administrative authorisation. Introducing water markets represents a real shift in paradigm that should be conducted at an appropriate rhythm. The project investigates how this transition should be conducted to minimize the risk of reform failure. This issue is currently being addressed by Brgm and Irstea through conducting policy exercises with stakeholders in different case studies. The policy exercise approach consists in exploring how water policy could develop in the 20 coming years considering the trading option (among other possibilities). The approach has been implemented in two case studies. It is yet unclear if a similar approach can be implemented in other countries (Italy, Spain).

3 ACTIVITIES AND MAIN RESULTS

3.1 OPPORTUNITIES FOR WATER TRADING (WP2)

3.1.1 Overview of activities

Lead	Contributors	
UPM	All partners	
Objectives: define water market scenarios adapted to each case study, considering inter-basin transfers (Tajo-Segura / Guadalquivir-Almanzora), intersectoral transfers (Marais Poitevin), agricultural water markets (Italy, French groundwater basin, Marais Poitevin, Bièvre valloire) and urban water markets (Hérault, France).		
Activities performed		
Partner	Description	Deliverable
UPM/UCO	Review of the literature on existing water markets	Short technical notes TN1, TN2, TN3
UPM	Analysis of existing water markets in Spain	Several publications P1 / P2 / P3
All partners	Water market scenario for specific case studies	For a synthesis see TN10. For other case studies, see: TN 14, TN16
UPM	Synthesis of water market case scenarios used in the different case studies	Technical Note TN 11

3.1.2 Analysis of existing water markets in Spain

Authors: D. Rey, A. Garrido, J. Calatrava.

The 1999 Reform of the Water Act of 1985 introduced the legal possibility of voluntary exchanges of public water rights (water concessions, as they are called in the Act). Initially, the formal trading activity was limited to a few isolated cases across the country (Garrido et al., 2012). The 2005-2008 drought gave rise to an increase in water exchanges that significantly improved the conditions in those areas where water scarcity was most severe. Since 2005 the water trading activity has been more frequent in Spain, although traded volumes in dry years represent less than 1% of all annual consumptive uses. Various water trading mechanisms were defined in the 1999 Reform, to which one more was added in 2012 to address problems of groundwater overexploitation. A specific market regulation in the Water Law of the Andalusian region enabled differentiated options to be used to exchange water in internal basins of the Andalusian region.

In parallel with formal trading operations, and going back at least three decades, informal water markets of a very different nature have evolved and developed extremely diverse and innovative mechanisms (Hernández-Mora and De Stefano, 2013), mainly in the Southeast of Spain and in the Canary Islands (whose water law is different from that in Iberian Spain). Some of the exchanges within this informal category eventually gave rise to formal agreements or adjudications. Still many others are in a legal limbo, but provide a wealth of services and water supply to otherwise thirsty users, showing that the regulatory framework in force is not sufficiently rich or encompassing to include the many market variants and approaches.

- **Water Market Legislation in Spain**

In Spain, there are public and private water rights. Public water rights are concessions granted by the Water Authorities for 30 to 75 years. According to the 1985 Water Act, rights can be granted to pump groundwater or divert water resources directly from surface water bodies. Water use rights are defined by the point of withdrawal, type of use, date of withdrawal (calendar), plots to be irrigated and irrigation technologies, usable volume or flow and return flows. The type of use, location, withdrawal prerequisites or return flow points cannot be changed without an explicit approval by the River Basin Agency (RBA). Rights differ in the priority of their access to water depending on the type of use (domestic, environmental, agricultural, hydropower or industrial). Holders of private groundwater rights, before the 1985 Law came into force, were given the choice of keeping their rights as a private right or else converting them into temporal water concessions. A vast majority (more than 80% of right holders according to Llamas et al., 2001) opted for the first option.

The differences between water rights and public rights are the following: public rights are use permits granted by the State for a duration of 30 years; they can be revoked, transformed, amended or interrupted by the Basin Agencies if conditions advise such decisions; their legal foundation stems from the 1985 Water Act, which declared all water resources to be part of the public domain; they are registered in a separate section of the section on private rights. Private rights, in contrast to public rights, have a longer maturity, existed before the 1985 Water Act came into force and are considered private property that can be sold, leased and form part of a company or cooperative assets. Maintaining the status of water rights requires that the technical conditions of use (depth and location of wells, power of pumps, pumped volume) not be altered.

Swapping private rights with a concession was in principle stimulated by the rigidity with which the former were defined. Since the legislators preferred to have most users under the public regimes, the Act preserved the private rights under the exact conditions established in the registry, forcing anyone wishing to change them to request a change to the public section and have it transformed into a concession. Unexpectedly to the legislators, most preferred to keep rights private.

The 1999 Reform of the Water Act introduced the legal possibility of voluntary exchanges of public water rights (concessions), but with many restrictions. Before this reform only private rights could be formally traded; water flows pumped from private wells could be leased, auctioned or sold.

The 1999 Reform identified only two ways to exchange public water use rights: i) right-holders that voluntarily agree on specific terms of trade and jointly file a request to the Agency, or lease-out for a number of years the water to which right-holders are entitled; ii) water bank operations (or water exchange centers, as they are called in the 1999 Reform of the Water Law). Users of private groundwater rights, individually or as firms or cooperatives, can sell, lease or rent pumped water, although such trading is subject to specific restrictions.

- **Conclusions**

Water trading is a tool to cope with water scarcity and to improve water use efficiency. As water availability in the Mediterranean region is expected to diminish because of climate change (among other reasons), markets will have greater importance in the coming years. Since the approval of the 1999 Reform, water markets have helped water users mainly during drought episodes. It is important to start thinking about water markets as a tool to be used in every circumstance and not only during drought periods.

As important as trying to improve and encourage water markets is there is also a need to achieve a fuller knowledge and understanding of how water is actually used in each Spanish basin and to control the effective use of this water while reviewing water concessions and increasing control of

illegal extractions. Better control of the existing water resources and their final destination will lead to a much more efficient use of water.

After reviewing the latest reforms in the water legislation in Spain, it is clear that water regulation should move towards a more flexible, agile and dynamic management system. But equally important is to think about the good ecological status of our water bodies and establish sustainable exploitation rates. Although it is difficult to try to serve all water demands and at the same time maintain a good ecological status for water resources, that is the path that should be followed.

The existence of informal water markets of a very different nature along the Mediterranean basins proves that there is a demand for the reallocation of water resources among users and for improving supply reliability. Not only that, but there is also a demand to manage differently quality graded waters and allow each user to meet their requirements at the least possible cost. This demand is not met within the current regulatory framework, which is too limited and lacks provisions to cope with extremely diverse, quality graded, poorly monitored groundwater users. There is clearly a need for a new improved regulatory framework that provides sufficient flexibility for users in the most water-stressed basins, while at the same time allowing for protection of the public interests. Our proposed reforms could help to make the market more flexible and to overcome most of the difficulties found in the current system.

- **References**

Garrido A., Rey D. and Calatrava J. (2012). "Water trading in Spain". In: de Stefano, L. and Llamas, M. R. (eds), Water, Agriculture and the Environment in Spain: can we square the circle? CRC Press, Botín Foundation, pp. 205-216.

Hernández-Mora N. and De Stefano L. (2013). Los mercados informales de agua en España: una primera aproximación. In: Embid A. (ed.), Usos del Agua Concesiones, Autorizaciones y Mercados del Agua. Thomson Reuters Aranzadi, Madrid, pp. 375-401.

Llamas M.R., Fornés J.M., Hernández-Mora N. and Martínez L. (2001). Aguas subterráneas: retos y oportunidades. Botín Foundation, Mundi-Prensa. Madrid, 529 p.

3.1.3 Synthesis of water market scenarios considered in the project

Author: J. calatrava

The water market scenarios considered by the six research teams of Water Cap & Trade cover a full range of existing and prospective institutional settings for water trading in Italy, France and Spain. Technical note 11 describes the most relevant aspects of these case scenarios and then briefly present each one separately. The following table 1.1 summarizes the main characteristics of the water trading scenarios considered in the different case studies.

- **Type of water resources subject to trade**

All the Italian and Spanish case studies focus on surface resources that are the main source of water supply for irrigation in these two countries. In the case of Spain, groundwater is of great importance for irrigation in several basins but their trading is quite restricted spatially and also lacks of an adequate regulatory framework. The most relevant cases of water trading is Spain are related to surface resources and the potential for innovative trading schemes is also greater for these resources. On the contrary, groundwater resources are the major interest of the French case studies and are also considered in one of the Italian case studies. Groundwater resources are the major source of water for irrigation in France.

- **Object of the transfer and length of the contract**

The presented case studies cover all types of water trading: the permanent exchange of surface water rights (the case of Italy and the Guadalquivir basin cases), the temporary lease of groundwater abstraction rights (the case of the Marais Poitevin), the outright selling of water volumes (the Guadalquivir and the five French groundwater trading cases), the use of water supply option contracts to secure water supply in scarcity periods (Tajo-Segura inter-basin option contract) and the trading of water saving certificates in southern France. In the majority of the proposed case studies, water exchanges are temporary, either because water volumes are exchanged or because water concession or groundwater rights are temporally leased for one or, in some cases, more that one year. In the Guadalquivir and the Italian case studies the option of permanent trading of water rights is also considered. Last, in the Tajo-Segura option contract case study, only water but not rights are exchanged. The option contract can be for a period of several years but the water is exchanged annually if the required predefined conditions prevail.

- **Spatial extent of water trading**

The spatial extent of water exchanges is a major restriction in most cases studies. Only two already existing cases of water trading between different basins are considered in Spain. Unlike in the Spanish cases, the remaining proposed scenarios consider water trading to take place at a local level and, in some cases, between users in the same sub-basin. This is explained by the concern for the environmental impacts of water trading but also by the physical restrictions to water trading because of the lack of transportation infrastructures.

- **Temporary restriction of market activity**

Trading activity is restricted to periods of scarcity in the two inter-basin case studies in Spain as this type of exchanges cannot only take place with the explicit authorisation of the Spanish Ministry's Council, which is only given in periods of drought emergency.

Trading is also restricted to drought periods in the case of trading between agricultural and urban and environmental users in the Marais Poitevin case study. In this case, trading would take place to guarantee urban supply and environmental demands in cases of scarcity.In all the other case studies no temporal restrictions are placed to the exchange of water, rights or saving certificates.

- **Sectorial extend of trading**

All the presented scenarios, except the urban water saving certificates one, consider the case of trading among agricultural users. The Tajo-Segura and the Marais Poitevin scenarios also contemplate trading from agricultural users both to urban users and for the maintenance of environmental flows, aquifers or wetlands. The Guadalquivir case study also includes the scenario of farmers selling water concessions to satisfy new emerging energy demands.

- **Market structure and trading mechanism**

All the case studies in Spain and Italy and several case studies in France (groundwater trading within agriculture) assume that water exchanges are agreed through bilateral agreements, whereas public Water Banks are the chosen option in the other French case studies (Water saving certificates and water trading in the Marais Poitevin) and in one of the Italian case studies.

Regarding the trading mechanism, private negotiation is the option chosen in all the case studies assuming that water exchanges are concurred through bilateral agreements among trading partners. The other case studies assume that the public water banks meet demands and supplies by bulletin Boards or Clearing House mechanisms. However, in the case of trading between agricultural and

urban and environmental users in the Marais Poitevin case study, trading would take place through public purchase offers from the Government.

- **Government role**

The government plays a major role in all case studies as it sets the legal framework for water trading and regulates the water exchanges. In the Italian and Spanish case studies it also owns the infrastructures used to transport the exchanged water resources. In some cases (Italy, Marais Poitevin) the Government also acts as a broker. The case study in Marais Poitevin also considers the option of the government acting as a water buyer by launching public purchase offers to cover for urban or environmental demands, similarly to some recent experiences in south and eastern Spain. In the case of the Tajo-Segura inter-basin option contract in Spain the Government would also act as a potential water seller.

			Tajo-Segura inter-basin option contract (Spain)	Agricultural groundwater trading (5 case studies, France)	Water Saving Certificates (France)	Water markets in the Guadalquivir basin (Spain)	Guadalquivir-Mediterranean inter-basin trading (Spain)	Water markets in Ravenna (Italy)	Water markets in Marais Poitevin (France)
Type of traded water resources	Surface water		X			X	X	X	
	Groundwater			X				X	X
Object of the transfer	Water right/entitlement					X	X	X	X
	Water volumes		X	X		X	X		
	Water saving certificates				X				
Length of contract	Non-permanent	Spot							
		Season		X					
		Annual		X		X	X	X	X
		Several years		X	X				
		Option contract	X						
	Permanent					X	X		
Spatial extent	Intra-basin	Local / District						X	X
		Regional							
		Sub-basin		X	X				X
		Basin			X	X			
	Inter-basin		X				X		
Temporary restrictions to trading	Only drought periods		X				X		X
	Permanent functioning			X	X	X		X	X
Sectorial extent of trading	Intra-sector	Agriculture	X	X		X	X	X	X
		Domestic			X				
		Other							
	Inter-sector	Agriculture to urban	X						X
		Agriculture to environment	X						X
		Agriculture to energy				X			
		Other							
Market structure	Bilateral agreements (brokered or not)		X	X		X	X	X	
	Water bank (public or private)				X			X	X
	Public purchases								
Trading mechanism	Private negotiation		X	X		X	X	X	
	Auctions								
	Bulletin Boards / Clearing House				X			X	X
	Public purchase offers								X
Government role	Sets legal framework and regulation		X	X	X	X	X	X	X
	Owns infrastructures		X			X	X	X	
	Broker							X	
	Water buyer								
	Water seller		X						

Table 1: Synthesis of water market scenarios considered in the project.

3.2 ECONOMIC MODELING ACTIVITIES (WP3)

3.2.1 Overview of activities

Lead	Contributors	
UPM	UPM / UPC	

Objectives: to model the functioning of water markets (equilibrium price, intensity of trade) in various contexts, using adapted modeling techniques.

Change in work program: the idea of developing a common modeling methodology was rapidly abandoned and specific models were developed. Three different types of models were developed in the Tajo Segura case study (instead on 1 in the initial description of work). Use of stated preference techniques in the Guadaquivir instead of mathematical programming (initial plan). Cost-minimization model developed in the Hérault case study (not planned initially).

Activities performed

Partner	Description	Deliverable
UCO	Review of existing modeling approaches to simulate water trading in agriculture	Technical note TN 13, P19
UPM / UPC	Three modeling exercises have been performed to evaluate an innovative option contract: 1) risk analysis of inter-basin trade regimes and management rules; 2) micro-economic modeling of agents' demand for option contracts and drought insurance; 3) water procurement least cost optimization model.	Publications P4, P5, P6, P7 PhD 1
ACTEON	Microeconomic modeling (linear programming) of farm water purchasing / selling decisions if water markets were established. Evaluation of economic gains and market activity.	Report R6
UNIBO	Microeconomic modeling of farm decisions using mathematical programming. Evaluation of economic gains.	Publication P12, P13
UCO	Simulating water trading using stated preference techniques: case study in the Guadalquivir basin	Publication P 15, P18 Technical Note T 12
BRGM / UPC	Development of a model to simulate the functioning of a market for water saving certificates in urban areas. Implementation in a southern France case study	Publication P10 MSc thesis Vernier de Byans (MSc 2)

3.2.2 Review of existing modeling approaches to simulate water trading in agriculture

A review of the literature was performed to identify economic modeling approaches which can be used to simulate the development of water trading (see technical note 13).

Given the specific features of water trade scenarios considered in the different case studies, it was not considered relevant to adopt a common methodology to be used in all case studies. Model chosen by the different teams are summarized in the table below.

Table 2: Summary of economic modelling approaches used to simulate water markets in the project.

Model type	Case study & partner	Water market scenario considered
Farm production choice modeling using mathematical programming	Marais Poitevin, France	Exchange of volumes of water (superficial, groundwater) between farmers
	Reno basin, Italy	Exchange of volumes among shareholders in small reservoirs
Stochastic modeling	Tagus-Segura inter-basin transfer	Option market between farmers located in the Tagus basin (sellers) and those of the Segura basin (buyers)
Farm production choice modeling based on stated willingness to pay and willingness to purchase	Guadalquivir basin, Spain	Exchanges between farmers considering various water scarcity levels and inter/intra basin exchanges
Urban supply optimization model	Hérault and Orb river basin, southern France	

3.2.3 Option markets (Tagus-Segura inter-basin transfer)

***Authors**: D. Rey, A. Garrido, J. Calatrava*

- **Context and objective**

The Segura Basin is the most water scarce basin in Spain, with a structural water deficit of 370 hm^3/ year (CHS, 2007). This deficit is covered with non-renewable groundwater pumping, treated water, desalinized water, and a deficit application of water to crops, which are subject to water stress conditions in many cases. In the 1970s the Tagus-Segura Transfer was approved with the aim of reducing this water deficit. It became operative in 1979, and on average has transferred 356 hm^3 per year. The variability of the transferred volumes from the Tagus Basin is caused by the monthly variations in the stored water in the *Entrepeñas-Buendía* reservoir (Upper Tagus Basin, Figure 1).

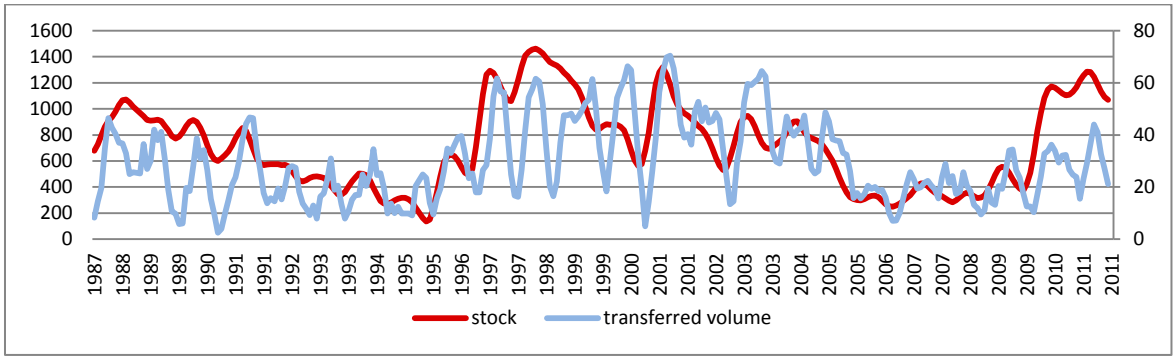

Figure 1: Moving average (4-months) of the monthly stored volume in *Entrepeñas-Buendía* (left axis) and the transferred volume to the Segura Basin (right axis) (hm^3).

As the urban uses have priority over irrigation, the risk that urban suppliers in the Segura Basin have to face is smaller. But, as they also depend on the resources from the Tagus Basin, they are affected when the transferred water is not enough to cover cities' demands (Figure 2).

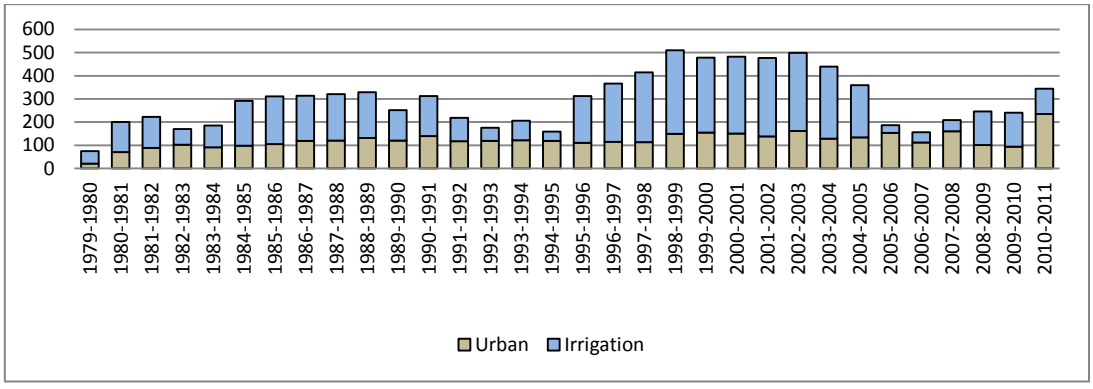

Figure 2: Transferred water volumes (hm3) used for irrigation and urban, 1978-2011. Tagus-Segura Transfer (Source: San Martín, 2011).

Irrigators in the Segura Basin are highly dependent on the water volumes that come from the Tagus through the Tagus-Segura Transfer. Besides, they have participated in the spot market during periods of drought. Thus, we have selected the Segura Basin as our case study in order to assess the current Spanish water market and to propose option contracts as a potential improvement. Option contracts have been evaluated from different points of view, in order to get broad idea of the benefits derived from the implementation of option contracts as a water trading mechanism in Spain.

- **Past trading experiences**

Reviewing the past water market experiences in Spain, there have been several exchanges between irrigation districts in the Tagus Basin and irrigation districts or urban water suppliers in the Segura basin, in those years when the volume transferred through the Tagus-Segura aqueduct is not enough to satisfy the water demands (Table 1). The sellers were over-supplied irrigation districts in the Tagus Basin. So, these agents could be the same than those involved in the water option contract. Likewise, after a meeting with the buying parts (SCRATS and MCT), they clearly expressed their interest in this type of contracts.

Table 3: Water trading between an irrigation district in the Tagus basin (seller) and another irrigation district or urban supplier in the Segura basin (buyer).

SEASON	BUYER	SELLER	VOLUME	STOCK[1]
2005/2006	SCRATS	Canal de Estremera	31.05 hm^3	320.4
2006/2007	MCT	Canal de Las Aves	46.5 hm^3	349.9
	SCRATS	Estremera	31.05 hm^3	349.9
2007/2008	SCRATS	Canal de Estremera	31.05 hm^3	332.3
	MCT	Canal Las Aves	36.9 hm^3	393.3
2008/2009	SCRATS	Canal de Estremera	31.05 hm^3	553.9

[1]Stock in the Entrepeñas-Buendía reservoirs at the moment of the transaction (hm3).

SCRATS (Central Association of the Irrigators' of the Tagus-Segura Aqueduct, Sindicato Central de Regantes del Acueducto Tajo-Segura,); Canal de Estremera (irrigation district in the Tagus Basin); MCT (Taibilla's Canals Commonwealth, Mancomunidad de Canales del Taibilla); Canal de las Aves (irrigation district in the Tagus Basin).

- **Result 1: An innovative option contract for allocating water in inter-basin transfers: the case of the Tagus-Segura transfer in Spain[2]**

Water volumes are annually transferred from the Tagus Basin to the Segura Basin to alleviate water scarcity problems in this region. The need to increase the statutory minimum environmental flow in the middle Tagus and to meet new urban demands has lead to the revision of the Transfer's management rules, which will cause a reduction of transferable volumes to the Segura Basin.

We evaluate the consequences of this change in the whole Tagus-Segura system, regarding the available water volume for irrigators in the Segura Basin, the resulting impact on environmental flows in the Tagus Basin, and the economic impacts on both basins. To minimize the consequences of such change on irrigators in the Segura Basin who depend on the transferred volumes, we propose a water option contract between both basins that represents an institutional innovation with respect to previous inter-basin spot market experiences. For the sellers, it would mean more stability in relation to the revenue flow that they will receive from the water trading activity. For both buyers and sellers, a multi-annual option contract would create an institutionally stable and secure means to transfer water resources, accordingly to rules with strong legal support. For option holders, no matter how adverse the water price movement might be, their loss is limited to the amount the paid for the options (Cui and Schreider, 2009).

Based on the draft of the new Tagus Basin Plan, we propose both a modification of the Transfer's management rule and an innovative two-tranche option contract. The main goal is to define this contract and evaluate it with respect to spot and non-market scenarios. Our proposal includes the following elements: an alternative management rule for the inter-basin transfer ensuring that

[2] Rey D., Garrido A. and Calatrava J. (To be submitted). An innovative water sharing scheme for allocating water in inter-basin transfers: the case of the Tagus-Segura Transfer in Spain.

environmental improvements in the Tagus are achieved, and the parametric definition of the contract.

The proposed option contract has two different components with different purposes. The first tranche is intended to protect Segura's irrigators in those years when the stock level in E-B is very low and thus the probability of receiving water through the TST based on the institutional management rule is low. The second tranche of the scheme would allow irrigators in the Segura Basin to have access to a higher water volume in those years when the stock level in the reservoir is high, as a compensation for the change in the Transfer's management rules.

Three different issues have been analysed for the considered scenarios: i) water availability for irrigators in the Segura Basin; ii) remaining stock in the E-B reservoir (Tagus Basin); and iii) economic impacts in the whole Tagus-Segura system.

Monte-Carlo simulations were performed in order to obtain the probability distribution functions (PDFs), for each scenario, of water availability both for irrigators in the Segura Basin (referring only to water resources from the Tagus Basin) and for the Tagus' headwaters reserves. We also obtained simulation results of the net benefit of the inter-basin operations. By comparing these PDFs, we can compare the impacts of different water trading mechanisms and transfer management rules on irrigators' water availability and on the economic performance of the whole system.

Our results show that the proposed option contract would reduce the impact of a change in the transfer's management rule and the supply risks in the recipient area. Thus, our proposal is meant to provide an improved market regime that meets both the environmental needs of the area-of-origin—the Tagus basin—, and the water demands of the Segura's users (Rey, 2014).

- **Result 2: Comparison of different water supply risk management tools for irrigators: option contracts and insurance**[3]

Irrigators must cope with the risk of not having enough water to meet crops' demands. There are different tools to manage this risk, including water markets and insurance. Given the choice, a farmer will use any of them when the expected utility change derived from the tool is positive. This work presents a theoretical assessment of a farmer's expected utility for two different water option contracts and a drought insurance policy. The conditions that determine farmer's preference for these instruments are analyzed and a numerical application to a water-stressed Spanish region is performed.

After obtaining farmer's theoretical preferences for the considered water supply risk management tools (drought insurance and option contract), the theoretical framework has been applied to obtain famer's WTP for these instruments and their tentative prices in the Campo de Cartagena irrigation district (Segura Basin). The obtained WTP values are consistent with previous work in the same area, and higher than the prices of these instruments, which highlights the feasibility of these mechanisms as water supply risk management tools for irrigators.

Results show that farmer's willingness to pay for the considered risk management tools are greater than the preliminarily estimated costs of the instruments. This suggests that option contracts and insurance may help farmers manage water supply availability risks.

[3] Rey D., Garrido A. and Calatrava J. (under review). Assessment of irrigators' preferences for different water supply risk management tools: option contract and insurance. *Environmental and Resource Economics.*

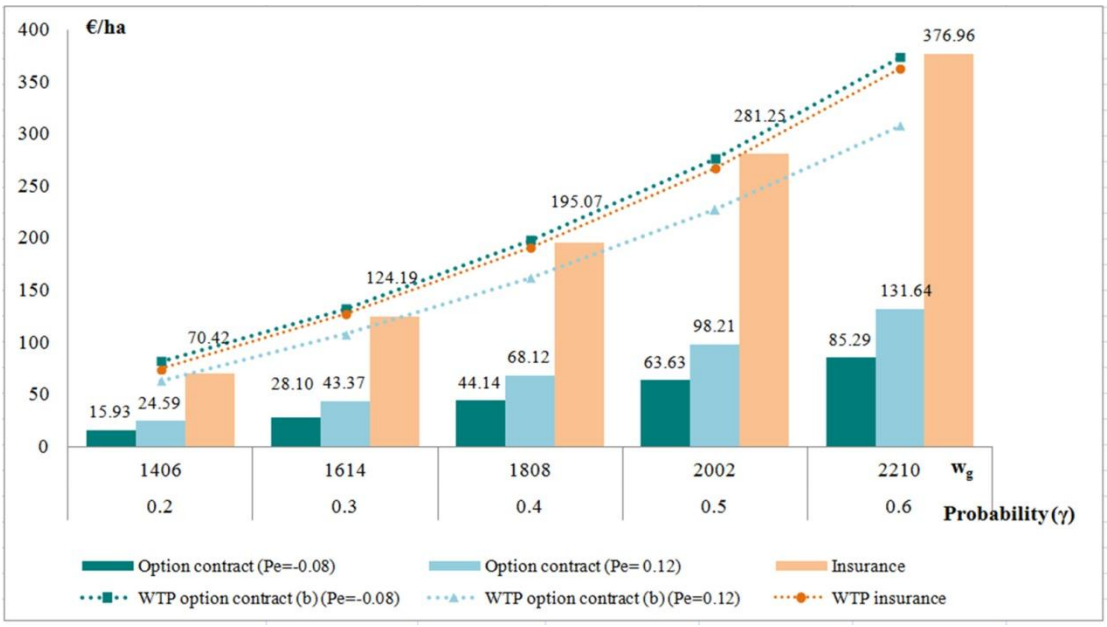

Figure 3: Prices (€/ha) for option contract and drought insurance, and WTP for these instruments for different guarantee levels (wg)[4]. Source: Rey (2014).

- **Result 3: Optimization of water procurement decisions in an irrigation district: the role of option contracts[5]**

Water supply instability is one of the main risks faced by irrigation districts. The optimization of the water procurement decisions is essential to increase supply reliability and reduce costs. The resource to temporary water markets, such as spot purchases or water supply option contracts can provide flexibility to this decision process. In this work, the potential interest of an option contract for an irrigation district in Southeast Spain that has access to different sources of water is analyzed. A two-stage stochastic recursive mathematical programming model is applied to simulate the water procurement decisions of a district in a context of water supply uncertainty and analyze the role that different option contracts may play to secure its water supply.

The Lorca irrigation district (Southeast Spain) is the case study. This irrigation district has access to nine different water sources, combining surface water, groundwater, desalinized water, water from the Tagus-Segura transfer, wastewater, etc.

The decisions regarding the signing and exercising of the option contract are carefully analyzed. Results indicate that the irrigation district would be willing to sign the proposed option contract in most cases, under realistic values of the option contract economic conditions. The contract's premium and optioned volume are the variables that have a greater impact on irrigation district's decisions.

[4] Parameters' values for the WTP curves: Absolute risk aversion level=0.001; marginal value of water, b = 0.7 €/m^3; parameter affecting the probability of exercise the option (a), Z=0.95.

[5] Rey D., Calatrava J. and Garrido A. (submitted). Optimization of water procurement decisions in an irrigation district in Southeast Spain: the role of option contracts. *Australian Journal of Agricultural and Resource Economics*

If the proposed option contract is added to the Lorca ID's water sources pool, average annual water availability is slightly increased due to the access to the optioned volumes. However, the major advantage of the option contract is its risk-reduction effect, as it reduces the variation coefficient of water availability and the probabilities of the left tails of the water availability probability distribution.

- **References**

CHS (2007). Estudio General sobre la Demarcación Hidrográfica del Segura (versión del 2 de julio de 2007). Confederación Hidrográfica del Segura, Murcia.

CHT (2008). Plan Especial de Sequía de la Cuenca Hidrográfica del Tajo. Confederación Hidrográfica del Tajo, Madrid.

CHT (2011). Memoria Anual de la Confederación Hidrográfica del Tajo. . Confederación Hidrográfica del Tajo, Madrid.

Cui J. and Schreider S. (2009). Modelling of pricing and market impacts for water options. Journal of Hydrology, 371: 31-41.

Rey D. (2014). Water option contracts for reducing water supply risks: an application to the Tagus-Segura Transfer. *Doctoral Thesis*, defended on June 27, 2014. Co-supervised by Prof. A Garrido and Prof. Javier Calatrava. Universidad Politécnica de Madrid.

San Martín E. (2011). Un análisis económico de los trasvases de agua intercuencas: el trasvase Tajo-Segura. Thesis, UNED.

3.2.4 Agricultural water markets in Marais Poitevin

***Authors**: H. Bouscasse, A. Duponteil*

- **Context and objectives**

The Marais poitevin is facing significant environmental problems as a result of the high water abstractions in the Marais in particular from the agriculture sector. To reduce the pressures on water resources, a reduction in water abstraction permits (quotas) allocated to the agriculture sector is currently proposed, with a -55% reduction as compared to the 2006 conditions foreseen by 2015. And many questions arise on the likely impact of such drastic reduction in water quotas on the economy of farms, and on the role tradable water quotas could have in limiting or compensating possible economic losses.

- **Methodology**

To address these questions, agro-economic (linear programming) models have been developed for different farm types of two management units of the Marais poitevin, i.e. the Lay and the Vendée Management Unit (MU). These optimization models help identifying changes in farm practices and land use, accounting for different farm constraints (labour, land, access to credit, water allocation, risk linked to product markets and crop water consumption, etc.). These agro-economic models have applied to assess the socio-economic impacts of three policy scenarios: the shift to the 2015 quota (reduction of -55% from the 2006 quotas); the establishment of water markets under both the 2006 and 2014 quota conditions; and the increase in the current water abstraction charge that would be required to achieve the same reduction in quota as the one proposed for 2015 (-55%).

- **Results**

The agro-economic models have been first applied to assess the loss in farm gross margins as a a result of different reductions in water quotas. As indicated in the figure below, the results show the non-linear relationship between the reduction in quota and the reduction in farm gross margins, as a result of the changes in farm practices and cropping pattern that farmers are putting in place to adapt to more water scarce conditions. Overall, a -55% reduction in water quotas lead to a -15% reduction in farm gross margins. The expected impacts depend on the types of farms and of the MU: in the Lay MU, farmers with mixed cropping pattern and livestock production, along with farmers specialized in cereal production, would be the most affected by reduction in water quotas; the farmers specialized in livestock production are the least affected. In the Vendée MU, the cereal producers with no high value production and with an irrigated area higher then 25% of the total farm area that are the most affected, the farmers specialized in livestock production or with mixed farming being the least affected.

The establishment of a system of water markets with tradable water quotas would bring additional flexibility in water allocation within each MU. Such trading would lead to adaptations in the cropping patterns of the different farm types, as illustrated in the figure below that present the changes in cropping patterns for farm types that would result from trading water quotas under the 2006 quota conditions. The overall impact on the agriculture production and on farm gross margins, would be however limited, in the order of ½% maximum. Different factors can explain this limited impact : the relative homogeneity of farming systems within MU; the use of average farm types as basis for the agro-economic models that “smoothes” real differences between farms that could lead to higher than modeled trading and socio-economic impacts; monthly water demands specified in the models that hide the short-term water scarcity that might hide the need for further reallocation; etc.

Additional simulations were made for assessing the impact of changes in water abstraction taxes on farm water abstraction – the question being in particular whether the required increase in water abstraction taxes for achieving a reduction by -55% of total water abstraction would be seen as "acceptable". Overall, the agro-economic models stress the need for significant increases in water abstraction taxes up to 0,27 €/m^3 (Vendée MU) or 0,30 €/m^3 (Lay MU) and . In the Vendée MU, a clear step exist when the abstraction charge increase from 0,27 €/m^3 – corresponding to an abstraction of 10,7 Mm^3 – and 0,28 €/m^3 – corresponding to an abstraction of 1,8 Mm^3. The reduction in farm gross margins that would result from such levels of water abstraction charges would be around -25% to -30%, thus (as expected) higher then the reduction resulting from the quota.

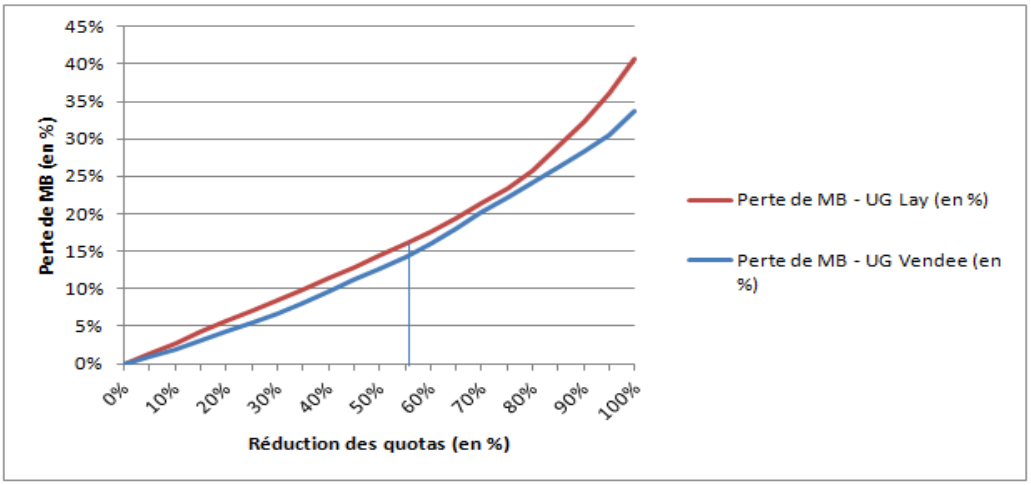

Figure 4: Loss of gross margin for various levels of quota reduction.

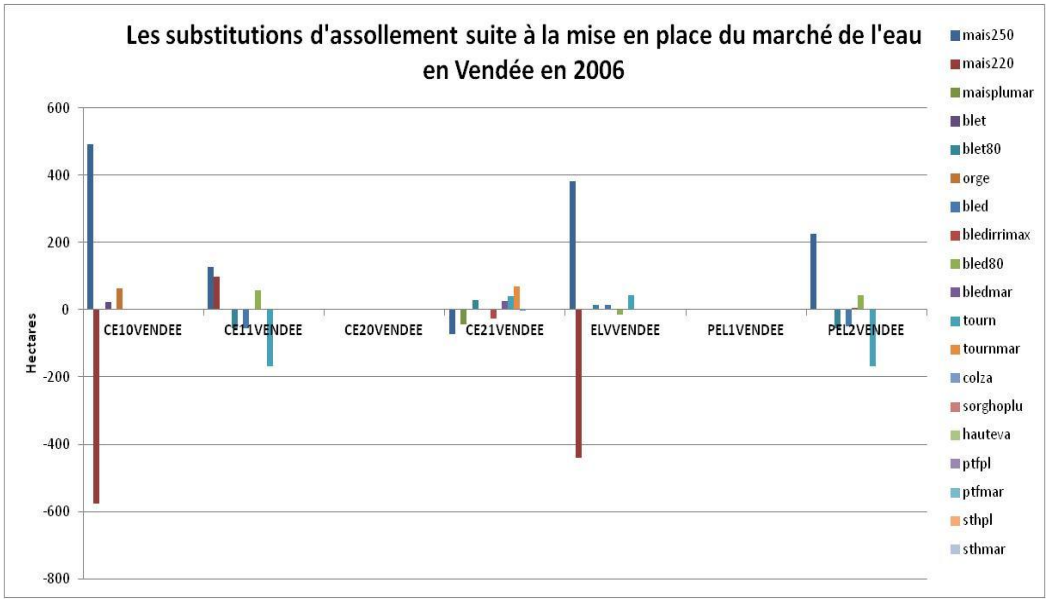

Figure 5: Changes in cropping patterns following the establishment of water markets.

3.2.5 Agricultural water markets in Italy

***Authors**: M. Zavalloni, D. Viaggi, M. Raggi*

- **Context and objective**

In Italy the law does not envision any type of water trade among private users. However, given concerns related to climate change, relevant stakeholders are showing a tepid yet increasing interest for water trading mechanisms. An analysis of the potential effects of the institutionalization of WMs appears to have significant policy importance. We consider two cases studies located in Northern Italy:

Water Trading with Multiple Water Sources: a Case Study in the Reno Basin: This case study provides a hypothetical simulation of extensive market adoption in a major irrigation area. The focus of the research is the effect of different source of water on water trading flows. Indeed the source of the resources at stake can highly affect the flows of transactions within a given market. Connection to surface water entails different issues than the connection to groundwater with respect to the typology of the economic structure faced by farmers, the managerial setup, and the necessary institutional arrangements (Negri, 1989; Wang, 2011). Since the institutional, managerial and technical environment in which WMs are introduced plays a major role in the subsequent functioning of the water trading mechanisms, via path dependence patterns, the type of water source present in a given area is an important element to take into account for the WM initial design (Harris, 2011; Libecap, 2011). Here we investigate how the attribution of water rights in an area where water sources are heterogeneous affects water trading flows.

Water Harvesting Reservoirs with Internal Water Reallocation: a Case Study in Emilia Romagna.: This case concerns a specific situation in which a form of "market-based" reallocation with a fixed price is already in place and can hence represent a realistic primer for the development of water rights trading in specific narrow contexts in Italy, even without challenging the national legal framework. We focus here on case study in the Consorzio Romagna Occidentale, a local irrigation board in Emilia-Romagna, where a form of water reallocation is in place in the hilly district More specifically, the area is characterized by the widespread presence of water harvesting reservoirs where water reallocation among farmers is allowed. Given the artificiality of the resource, and the partially private nature of the investments, the individual share of the investment in the reservoir construction is linked to the individual water rights (quotas) that are annually managed internally and are allowed to be transferred. Objective of the analysis is the economic assessment of the water reallocation mechanism, with a focus on the distribution of its gains.

- **Presentation of the market scenario considered**

The water market we simulated is characterized by:
- Transfer of water rights expressed in water flow volumes;
- The water trading is allowed only within the basin, or the reservoir in the second case study;
- No temporary restrictions are taken into account;
- The trading is allowed only within the agricultural sector;
- The government role is not explicitly modelled.

In water harvesting reservoirs, we also take into account the actual rules that govern the reallocation of quotas, which is based in the exchange of quota related costs.
Such a simulation is then compared to the current situation, so to compare the effect of water markets on the farm gross margins in the area.

- **Modeling methodology**

We develop a mathematical programming model for the two case studies. The model maximizes the gross margins of the area subject to a usual set of technical constraints, in two different institutional scenarios, one in case water trading activities are not allowed (so that water entitled to each farm is fixed) and one in which that is allowed (so that water entitled to each farms become flexible, and water is allocated to the most efficient uses). The differences in the relevant variables across the two institutional scenarios show the potential effect of water markets in the case study areas.

Moreover we carry out a sensitivity analysis on water availability to observe the potential effects of water markets in the occurrence of limited water availability. In the Reno Basin case study, we consider different cutbacks in water abstraction ("full capacity": homogenous cutbacks; "Water Ncer": groundwater is the only available source; "Water Cer": surface water is the only available source)

In the case of the rainwater harvesting reservoirs, we also compare the actual rules (based on the exchange of quota related costs – "VIB scenario") to a potential "pure" water market, where water exchanges are determined by market prices ("FT" scenario).

- **Results 1 - Water Trading with Multiple Water Sources: a Case Study in the Reno Basin**

The gross margins increase with the amount of water available and then stabilize at a fixed level at around 1200 m3 /ha for all scenarios. In all cases, the WT scenarios increase the gross margins of the area. In percentage terms, the patterns differ among the water availability scenarios. In the "Full Capacity", the gains from the water trade first increase with the water availability, then decrease after a level of 600 m3 /ha. In the other two scenarios, the gains from the trade increase with larger volumes of water availability, and then stabilize. The highest percentage increase from the institutionalization of WM in the area occurs in the "Cer Water" scenario, where the Cer group supplies water to the whole area.

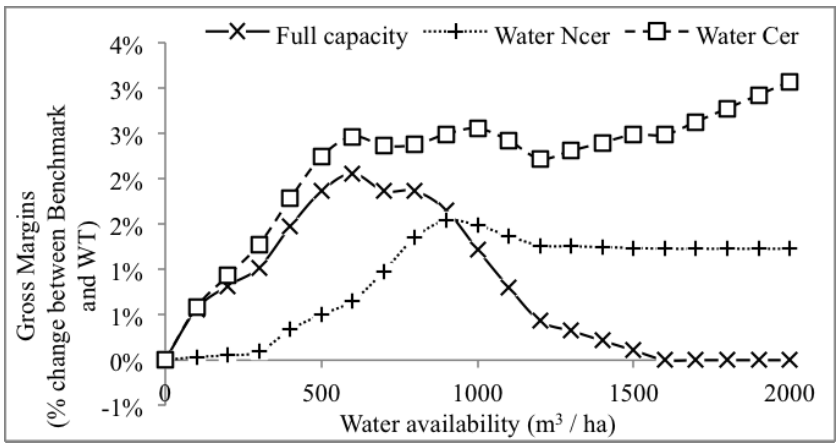

Figure 6: Gross margins—differences among scenarios (Reno Basin).

- **Results 2. Water Harvesting Reservoirs with Internal Water Reallocation: a Case Study in Emilia Romagna**

As expected, both reallocation scenarios are beneficial for the area, and the added value of both mechanisms increase with the total amount of water, for then decreasing after greater values of

water availability. The FT scenario leads to the highest payoff for any level of water availability. The greatest difference between the FT scenario and the VIB scenario lies before the average water availability (1000 m3 per quota) and then decreases. On average, the FT scenario leads to an increase of 3% in the gross margins, whereas the VIB scenario leads to an average increase of 1%, with respect to the NT.

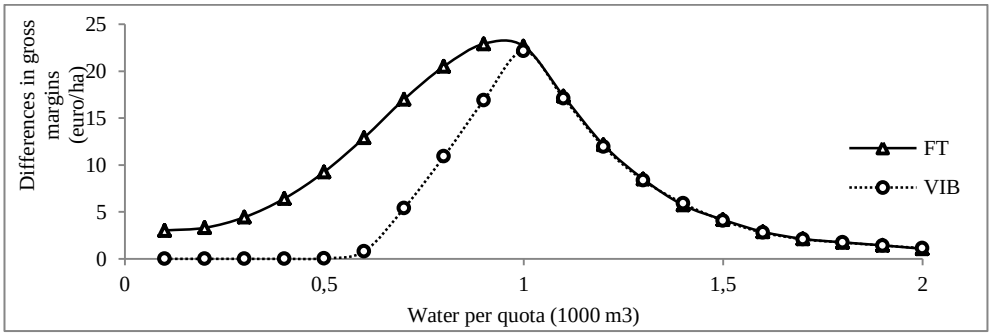

Figure 7: Gross margins—differences among scenarios (water harvesting reservoirs).

3.2.6 Agricultural water markets in Guadalquivir

Authors : *Giannoccaro, G. and Berbel J.*

- **Context and objective**

Although Spanish Water Law was reformed in 2005 to allow holders of water rights to trade them on a temporary as well as a permanent basis, up until now trading has been rare, has mainly occurred under drought conditions and the traded volume has been limited.

The achievement of a plenty operative water markets requires deeper knowledge of the factors affecting farmers' acceptance. Generally, mathematical models of water trade have been widely used due the absence of real market data, though empirical evidence does not reveal the same extent that theoretical and simulation works seem to anticipate. Therefore, research efforts was made in order to underline farmer's behaviour and how structural, socio-economic, and climatic factors would influence farmer's participation in water trading.

This task aimed to increase knowledge of water trading in Spain by focusing on stakeholders' perceptions and their willingness to trade irrigation water. Moreover, by using a contingent valuation method, the market value of irrigation water was calculated while the supply and demand curves were constructed according to farmers' responses. Finally, as water trading in Spain has mainly operated under drought conditions and is dominated by inter-basin transfers, this study also attempted to assess the influence of drought on farmers' willingness to trade and to establish the potential for intra-basin trading.

- **Presentation of the market scenario considered**

The analysis was carried out for the Guadalquivir and the Almanzora River Basins. The former is the largest irrigation area in Spain, while the latter is home to the most profitable irrigation agriculture in the country, with a high concentration of greenhouses and high value crops. Together they represent roughly 25% of Spain's irrigated area.

Both river basins in this study are located in southern Spain, and have a Mediterranean climate and a heterogeneous precipitation distribution. The variability in water availability and recurrent droughts have led to episodes of critical scarcity.

The irrigated area in the Guadalquivir Basin comprises 845,000 ha, covering olive groves, fruit orchards (mainly citrus and peaches) and general field crops, such as cotton, maize, sunflowers and, of minor importance, sugar beet. Overall available water resources amount to 3,362 hm^3/year, while net demand in 2008 rose to 3,578 hm^3/year, while 2,981 hm^3 was for irrigation.

The Mediterranean River District extends from the Strait of Gibraltar to the Almanzora River, covering the Mediterranean coastal area of Andalusia. Accordingly, urban water use makes up 21% of water demand in the district, while irrigation uses 73%. Industrial water use is of only minor importance. Total demand in 2008 was 1,157 hm^3. On average, 4,925 m^3 of irrigation water is applied per hectare on an irrigation system characterised by high value, mainly greenhouse crop production.

An inter-basin transfer system was built to connect the Guadalquivir River Basin to the Almanzora Basin. This allowed the inter-basin transfers under 2006-2007 drought conditions.

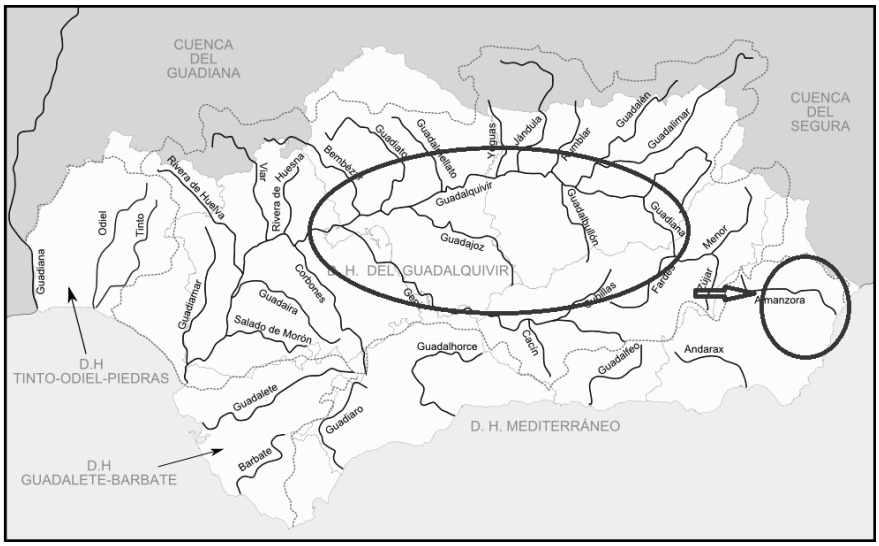

Figure 8: Map of inter-basin transfers.

The first inter-basin transaction took place in 2006 when 'Aguas del Almanzora SA' bought rice farms in the Guadalquivir Basin and transferred the attached water rights of 8.5 hm^3. During 2007, 35.5 hm^3 were sold on a temporary basis by four water user associations from the Guadalquivir Basin to 'Aguas del Almanzora SA'. The water was traded at a price of 0.18 EUR/m^3 at the seller's gate. On top of this, 'Aguas del Almanzora SA' approximately paid 0.20 EUR/m^3 for pumping and physically transporting the water.

In light of this, we considered a variety of item in order to build up different market scenarios. According to the last reformed Spanish law, two market typologies were given, namely an allocation market (leasing of water allocation) and a water right market (permanent transfers of water right). Holders and non-holders of a water right were equally arranged. Moreover, we supposed inter-basin transfers as well as intra-basin transfers. We limited the market agents to farmers. First of all, a normal against reduced irrigation water availability were supposed. A same agent was allowed to sell and/or buy irrigation water on the market. In the case of allocation trading, we established two fixed tradable volumes per hectare: 500 and 1,000 m^3/ha per year. The volumes are per hectare since water allocation is linked to land holdings. All other external variables were assumed invariable. The starting price and volumes in the auctions are in line with observed figures from 2006-2007 transactions.

- **Modeling methodology**

A different modelling approach was implemented in Guadalquivir / Andalucia case study, consisting in interviewing farmers to elicit their willingness to participate (as seller or buyer) in the water market. A survey was conducted with 241 farmers in spring 2012, in the Guadalquivir River Basin and the Mediterranean (Almanzora) Basin in southern Spain. Of the 241 administered questionnaires, 196 contained valid observations for the market section; 150 within the Guadalquivir Basin and 46 within the Almanzora Basin.

Farmers were asked to express their willingness to purchase and to sell irrigation water in a hypothetical seasonal market, both under normal water availability and under drought conditions.

Before the WTP and WTA questions, farmers were asked whether they agreed with water trading in general, if they would want to sell and/or buy, whether they agreed with trading on a temporary or a permanent basis, and if they were in favour of inter-basin and/or intra-basin trading. An auction simulation was conducted with those farmers who agreed with water trading in general. Questions about buying and selling were asked separately, depending on farmers' stated willingness to do

either or both. The survey combined both closed and open-ended WTP and WTA questions. We started with a closed bid of 0.18 EUR/m^3 and according to the farmer's response the price was increased or decreased by 33% (0.24 or 0.12 EUR/m^3, respectively). In the event that farmers either refused or accepted all bids they were asked their maximum WTP and/or minimum WTA. An example of an auction simulation can be found in the figure 2.

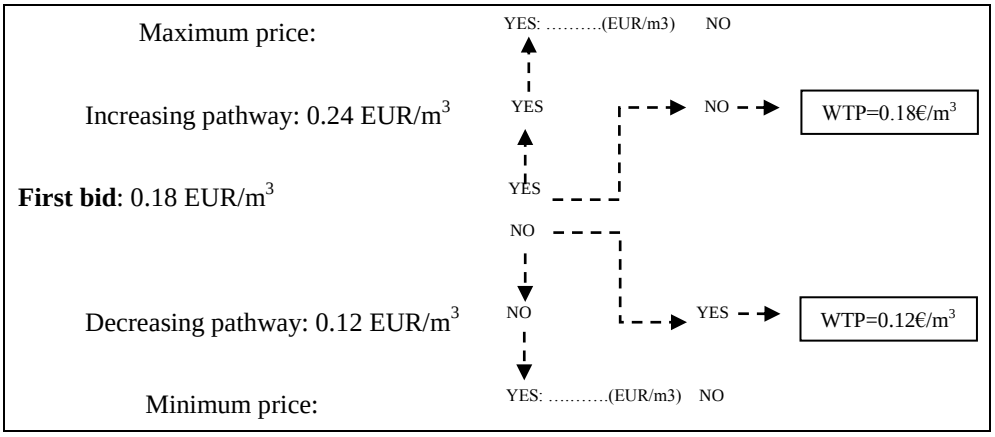

Figure 9: Sequence of CV questions (WTP).

In the sample, 16% of respondents, all of whom are from the Guadalquivir Basin, lack access to water for irrigation and are completely dependent on rainfall, while 58% have access to one water source, and 26% have access to multiple sources. Almost three quarters of respondents (n=176) are members of a Water User Association (WUA) through which they get their irrigation water, 28% have a private well and 10% rely on other sources. While more than 80% (n=195) of respondents are irrigators, the irrigated area covers only 64% of the total farmland in the sample (11,885 ha). The majority of farms (62%) are fully irrigated, accounting for 45% of the area. Rain fed farms (17%) cover 10% of the area, and farms with both irrigated and rain fed crops comprise 19% of the sample and cover 45% of the farmland.

- **Results**

Regarding attitudes towards water markets, 45% of respondents agree with trading through both inter-basin and intra-basin markets; 27% are only in favour of trading within the same basin; and 28% are against any type of water trading. Comparing the two areas, a majority of Almanzora farmers only want intra-basin trading, while the majority of Guadalquivir farmers are indifferent to the scale. Objections to water trading are much more common in the Guadalquivir Basin. The main motivation for objecting is the view that water is not a commercial good (100% of those against within the Guadalquivir Basin and 76% within the Almanzora District).

Table 4: Summary of attitudes towards water trading

Farmers' preferences	Yes, only within the same district	Yes, regardless of scale	No, regardless of scale	
Agrees with water trading? (Guadalquivir)	13.3%	52%	34.7%	
Agrees with water trading? (Almanzora)	71.7%	23.9%	4.3%	
Preferred facilitating institution (overall sample)	Public administration	WUA	Farmers themselves	Others
	26.1%	45.8%	26.1%	2.1%

Source: survey data; n=196.

Table 3 presents farmers' responses to the WTP and WTA questions. There are big differences between the basins. In the Guadalquivir Basin more farmers would sell than buy water allocation in a normal year (i.e. the baseline situation), while the reverse is true for drought years. This difference between normal and drought years is not found in the Almanzora Basin, but farmers there are generally more willing to trade (buy and sell).

Table 5: Summary of market behaviour

	Guadalquivir		Almería	
Baseline	*% farmers participate*	*Average WTP/WTA*	*% farmers participate*	*Average WTP/WTA*
500_WTP	12%	0.08	96%	0.39
1,000_WTP	12%	0.14	96%	0.39
500_WTA	27%	0.15	89%	0.40
1,000_WTA	27%	0.15	91%	0.41
Drought year				
500_WTP	47%	0.10	96%	0.54
1,000_WTP	46%	0.13	96%	0.54
500_WTA	15%	0.17	91%	0.55
1,000_WTA	15%	0.16	91%	0.55

Source: survey data; n=150 and 46 for the Guadalquivir and Almanzora Basins, respectively

In general, the findings show that average WTP is higher than average WTA in both basins, and that average WTP in the Almanzora Basin is higher than average WTA among Guadalquivir irrigators. This suggests that irrigation water will initially be traded from the Guadalquivir to the Almanzora Basin, as was observed during 2006-2007. The equilibrium market price increases from 0.17 EUR/m3 in the baseline scenario to 0.21 EUR/m3 under drought conditions.

Finally, we performed an econometric regression with the aim of underlining the determinants of farmer's WTP/WTA values. According to the findings, an increase of farmer's participation is related to their innovativeness, to the fact of having a formal agricultural training, and to farms with high value crops. Additionally, low supply security and appropriate information on seasonal water availability are also related to a higher probability of participation. Finally, farmers with knowledge of the water law and those who were aware of earlier trading were more willing to sell than farmers without this knowledge or awareness.

- **Conclusion**

The slopes changing of supply and demand curves based on the survey are in line with the neo-classical paradigm that demand increases under scarcity (i.e. drought) while supply decreases. Moreover, farmers' responses took account of a breakeven point for irrigation volumes, below which the increase in production from irrigation is not enough to compensate the investment costs in the necessary infrastructure. On the other hand, findings have also shown a right-based viewpoint of farmers who do not agree to trade water, basically for considering it as a non-tradable good.

To policy makers, our result indicates that more transparency and timely disclosure about water supply as well as better information on water market mechanisms may increase farmer's participation.

3.2.7 Markets for urban water management

***Authors**: JD Rinaudo, J. Calatrava, M Vernier de Byans.*

- **Context**

In France, the level of water losses occurring in drinking water distribution networks significantly varies across municipal drinking water utilities (DWU). While DWUs facing limited water resources and increasing water demand have heavily invested in reducing leakage (reaching 80% efficiency level in 36% of the municipalities), losses occurring in pipes still represent 20% to 50% (and sometimes above) in many municipalities who face very little economic incentive to invest in water conservation. In this paper, we investigate the possibility to create a system of tradable Water Saving Certificates (WSC) which could provide incentives to increase water use efficiency in all municipal utilities.

- **Presentation of the proposed mechanism**

The mechanism proposed in this paper assumes that Water Saving Certificates (WSC) or Water Efficiency Credits (WEC) could be created and allocated to users investing in water conservation actions and that a market could be created to trade these certificates. This “cap and trade” policy instrument would first require that water saving targets be set for water utilities that must fulfill this requirement by implementing various water conservation measures – in particular reduction of losses in distribution networks. Utilities who over fulfil their obligations would receive Water Saving Certificates (with an attached volume of water) which could be sold to other users or utilities who are not meeting their own target. The WSC market would be regulated by a public authority. This policy instrument could theoretically ensure flexibility and contribute to the implementation of cost-effective water saving measures. The fact that such a system is already operating in the energy sector suggest that there should be no major legal impediment to its implementation in France and other EU countries.

- **Practical implementation of the instrument**

The main steps for implementing the proposed mechanism in practice are the following.

- A Public Authority would need to assign a water saving target to each utility considering its characteristics (population size, urban or rural, type of dwellings, type and number of industries, etc.).
- Utilities would generate water saving through (i) funding water conservation programs directed at their customers (domestic or industrial); (ii) developing water conservation programs targeting public water uses (public gardens, public buildings, etc.); or (iii) investing in distribution network leakage detection and control to reduce losses beyond the official objectives.
- Utilities who have achieved greater water saving than their target would obtain a WSCs corresponding to the surplus water savings. This WSC could be sold to other municipalities not complying with their target or needing additional resources to satisfy a growing demand.
- An independent certification authority would issue certificates and verify water savings.
- An electronic tracking system would be established to register WSC, track transactions and prove compliance of users with water saving objectives.

- **Evaluation in a French case study**

A case study was conducted in Southern France to simulate how this potential market for WSC could work. Water demand was estimated for 300 municipalities in Western Hérault county. Water savings

targets were calculated using available statistical information. For each municipality, we then estimated the cost and effectiveness of 12 water conservation measures. Cost includes investment and recurring costs, and effectiveness corresponds to the volume that can be saved. The list of measures analyzed is provided in the table below.

Table 6: *Description of urban water conservation measures considered in the southern France case study.*

	Description of water conservation measure
M1	Improve detection and repair of leaks of distribution network.
M2	All households receive a voucher for free water conservation devices (faucet aerators + shower flow reducer)
M3	Water intensive landscapes replaced with xeric vegetation (public gardens)
M4	Seasonal water pricing (increased rate in summer) + automated reading meter
M5	Water saving appliances / kits in all public building (hospital, etc.)
M6	Distribution of water saving devices in hotels (faucet aerators, toilet flushes)
M7	Free plumber assisted audits of campsites and holiday parks. Installation of low flow flushes / showers, leakage detection in campsite distribution network, etc.
M8	Free plumber assisted water use audit for single houses owners; fixes leakages and installs various water saving devices depending on the situation
M9	Same as U8 for multifamily houses + automated reading meter.
M10	Replacement of irrigated lawns with artificial turf for sport grounds

An optimization model was developed to simulate the supply and demand for Water Saving Certificates and the hypothetical exchanges between DWUs. We tested the effect if several rules aiming at reducing the environmental impact of trade, such as restricting trade within sub-catchments. The model allows simulating the volume of certificated traded on the market and the price at which certificates are traded.

The results obtained are the following. In the reference situation, where trade is not allowed, the model predicts that 72 of the 312 DWUs cannot achieve their individual targets by implementing all possible conservation actions. In other words, the total Water Saving Potential is lower than the saving target in these DWUs. When trade is allowed, without spatial restriction, these 72 DWUs can reach their target by purchasing certificates from other DWUs. Other DWUs also engage into trade as purchasing WSCs is less costly than achieving their individual targets through water-saving measures. Overall, 138 DWUs (44%) purchase WSCs from 174 other DWUs (66%). The simulated WSC price is respectively 0.54 and 1.03 €/m3 in the Hérault and Orb basins. The total amount of WSCs traded corresponds to a volume of 2.46 million m3, i.e. 39% of the total water saving target (respectively 41% and 37% in the Hérault and Orb basins).

- **Conclusion**

The model presented above shows that the development of a market for WSCs is likely to generate significant benefits, estimated at 25% of total water saving costs. This estimate however does not include transactions costs which are likely to be significant. The acceptability of the proposed mechanism should also be studies through in depth interviews with stakeholders. These two issues will be addressed in future research.

3.3 PERCEPTION OF WATER MARKETS AND ACCEPTABILITY ISSUES (WP4)

3.3.1 Overview of activities

Lead	Contributors	
ACTeon	UPM / UPC	

Objectives: This WP aims at assessing and analyzing stakeholders' and policy makers' perception of water markets scenarios.

Change in work program: the number of case studies was increased as well as the range of stakeholders consulted. Results of this WP represent a major contribution of the project.

Activities performed

Partner	Description	Deliverable
ACTeon	Conceptual framework for assessing stakeholders' and policy makers' perception of water market scenarios	Technical Note TN15
ACTeon	Interviews and stakeholders workshops in Marais Poitevin (France)	Technical Note TN10
ACTeon	Interviews with selected stakeholders in Bièvre-Valloire river basin (France)	Report R5 (in French)
IRSTEA	Mini-debates with lay public (110 participants), Paris international Agricultural fair, France	Report R4 (in French) and technical note TN8 (in English)
UCO	Interviews with 40 stakeholders in Guadalquivir & Andalucía basins	Publications P16, P17 Technical note TN12
UNIBO	Workshop with national level stakeholders	Abstract below
UPM/UCO	Several workshops with stakeholders involved in the revision of the rules determining interbasin transfers between the Tagus and Segura basins	Abstract below

It was initially planned to develop a common methodology to address the perception of water markets and acceptability issues. In practice, complementary approaches have been developed by the partners, adapted to a diversity of local / national contexts (market already implemented or not, current debates on water market…). Overall, two major approaches have been combined by all teams: individual questionnaires or interviews and collective debates.

Individual perceptions : Semi-structured interviews have been led in all countries with key stakeholders of the case studies; the diversity of interviewees (farmers, institution representatives, policy makers…) underlines a diversity of perspectives, regarding water markets. Those interviews aimed to assess the perception of key stakeholders. Depending on the study sites, they could contribute to refine scenarios and to prepare focus groups. In

Collective debates : Organising collective debates enables to understand the social acceptability of water market in the various study sites. Three main types of collective debates have been implemented:

- Local focus groups have been conducted in France (Marais Poitevin / ACTeon) and in Spain (Guadalquivir / UCO). In each study site, 2 or 3 separate focus groups have been organized for now with different stakeholders (farmers, representatives of drink water suppliers, local institutions, etc.). Those workshops enable to learn about the general perception of a specific category of stakeholders about water markets; they allow for in-depth discussions about the local feasability and relevance of the scenarios.
- National workshops have been organised in Italy and Spain and are planned in France. This activity is part of WP7; however the mobilization of key policy-makers during those events

has been used as an opportunity to learn about their perceptions of water markets, through a survey or a collective debate.

- Mini-debates: an original experience was conducted in Paris / France, during the national agricultural fair, where IRSTEA invited lay citizens to short debates about quantitative water management. This experience enables to put the debate related to quantitative water management in the public arena and to know the perception of lay citizens.

During the focus groups and the mini-debates they organized, BRGM and IRSTEA adopt a specific approach, consisting in embedding the debate in a broader discussion related to alternative mechanisms. Three options for quantitative management of water are considered: administrative regulation, self-regulation and market regulation. The following table sums up the key characteristics of the methods used per partner and study site.

Case study	Methodology	Key characteristics
France – « Salon de l'agriculture »	Short questionnaires Mini-debates	This activity focused on public perception of water markets. Lay public visiting the fair was invited to take part to mini-debates (35mn). The discussion regarding water market was embedded in a broader debate about alternative mechanisms to manage water (administrative regulation, self regulation and market regulation). Short written questionnaires were used to collect individual perception and to introduce the collective debate. 110 participants took part in those short workshops (an average of 6 people per mini-debate).
France - Marais Poitevin	Interviews with key local stakeholders Focus groups	Semi-structured interviews have been conducted with a diversity of key local stakeholders. 2 focus groups have been organized and 2 others are planned with different categories of stakeholders: farmers, institutional representatives linked to agriculture, environment, urban facilities… Debates are oriented towards the relevance and the institutional feasibility of water market scenarios in the area. A baseline scenario describes the trends and situation around 2030 and introduces various water market scenarios, which are different from one FG to another.
Spain – Guadalquivir (UCO)	Semi-structured interviews Focus groups Survey among users	Interviews were conducted with managers of irrigation boards and irrigators, using simple structured questionnaire, including twelve five-point Likert-scaled statements. 3 focus groups have been conducted in 3 different areas, performed to separate potential sellers form permanent and annual buyers. During the discussion, all groups discussed topics such as administrative issues, required investments, interest in permanent vs. temporal water right trade, willingness to sell and to buy, problems in current water management as well as a water market system. Perceptions of involved institutions in existing water markets were also argued. The water market scenario was basically similar to the observed in the basin in 2005, 2006 and 2007 plus a possibility of permanent water rights trade.
Spain – Tagus – Segura basins (UPM)	Personal interviews, National workshop	Interviews have been conducted with water managers and farmers. Perception of water markets is discussed during the NAC meetings with different stakeholders from different river basins and organizations related with the water sector. Furthermore, the UPM team jointly held another seminar dealing with water market innovations in Spain. Finally, Prof. Calatrava conducted personal interviews in the Segura basin, both with potential and actual purchasers in water and river basin managers.
Italy – Reno Basin (UNIBO)	Semi-structured interviews National workshop	The methodology used has to consider the specific context in Italy: current Italian law not admitting water trade, citizen-initiated referendum in 2011 on the privatization of the water facilities. 5 semi-structured interviews were carried out with different stakeholders. Perceptions pro and cons on water markets were collected during two national workshops, through questionnaires distributed among participants: the first workshop was aimed at developing realistic scenarios on the future of water in its physical and institutional dimensions; the scenarios were then presented at the second workshop, aimed at assessing the stakeholder perceptions on the scenarios and on the possibility of institutionalize water trading mechanisms. The interest to conduct additional interviews and organize focus groups in Italy will be considered.

3.3.2 An analytical framework to analyse the social acceptability of water markets

Authors: F. Kervarec (ACTeon)

Social acceptance is critical to the long term viability of a policy; it might improve the implementation and effectiveness of projects or public policies, especially when the policy involves a large number of stakeholders and significant monitoring costs, which is the case of quantitative water management through water markets.

- **Social acceptability as a process**

In general, the social acceptability of a policy depends on several factors linked with the context and rationale of its implementation (i.e. crisis situation, high pressure on water resources or not, existing political alternatives or not…). Social acceptability changes over time along with the evolution of collective learning, scientific information of interested parties, shared values, etc. The process of policy development (including more or less public participation) is also critical. Thereby, social acceptability can be defined as a dynamic process which is built collectively. It is both complex (interrelations with both collective and individual levels, values, decision making process...) and dynamic (changing process). It reveals the perception and judgment (or evaluation) that stakeholders make on a policy or project, in relation with the specific geographic, social, politic, economic and historic situation. Analyzing the current debates on the policy and observing the frequency and level of conflicts also sheds light on the current dynamics of social acceptability.

- **Social acceptability of water markets**

Social acceptability of water markets is closely linked to available information on water markets, interpretation of that information by the public, trust in the authority implementing the new management rules and the existing institutional framework (existence of a mature legal system). Little literature exists on social acceptability of water markets, especially on ex-ante assessments, before market implementation. However, papers relating water market experiences in the world often inform on stakeholders attitude, perception and judgments about water markets.

- **Variations according to market types**

As an aggregate of multidimensional judgments, social acceptability raises different issues depending on the type of water markets which are considered. (1) In the case of intra-sectoral markets, it is the market mechanism as such which is questioned whereas in the case of inter-sectoral markets, the principle of transferring water out of the agricultural sector is closely linked to the market mechanism. As such, transferring water out of the agricultural sector raises specific acceptability issues. (2) Temporary markets appear to be more acceptable for communities than permanent markets, especially due to policy and economic uncertainty (supply, demand and prices) and the impact of water sales on the capital value of properties. Moreover, "[irrigators] might see their entitlement as an integral and inherent part of their farm" (Tisdell and al, 2001). Finally, lease markets are identified by farmers as a possible source of revenue, increasing their acceptance.

- **Judgment limiting social acceptability of water markets**

Based on the existing literature, a typology of judgments that may limit the social acceptability of water markets has been built. Four main types of judgments (or acceptability issues) can be distinguished.

Ethics and fairness/social justice issues refer first to the status of water, water being a "social good" not subject to market forces. The role of culture, rural traditions, and farmers' logic is often mentioned in this regard. Equity and fairness raises two other main issues: the policy framework for implementation and the initial allocation of quotas (which can be seen as unfair). Several experiences are based on former quotas (historical approach of initial allocation), which could lead to strategic behaviors, such as overstatement of abstraction volumes during the period before this initial allocation.

Arguments related to market structure and stakeholders' strategies pertain to fear of lack of transparency, asymmetry in market forces, increasing gap between small and big farmers. In this perspective, price variability and speculation might be perceived as an additional source of uncertainty.

Environmental concerns are generally related to changes in water use location and with the purpose of the new user: concentration of water use, negative impacts on water quality, reduced water flow on a segment of the river when moving upstream, activation of previously unused water. Those concerns appear to be very important in terms of public benefits, in relation with healthy ecosystems and key environmental assets, but also in terms of water for recreational and cultural purposes.

Considering local and rural development, various stakeholders feel concerned by potential impacts on the individual farmer's and the wider community welfare (for instance due to increasing costs of water supply to remaining irrigators whereas land value or value of the farm would be declining); impacts on the structural evolution of the territory would include abandoned farms and farmers leaving the sector/area and decline of labor, local services and property value. Besides those considerations, in rural areas water is not just a factor of production but the "stuff of life", being a "link between people" (Molle and Berkoff).

The following figure has been based upon a literature review related to countries where water markets are already implemented such as Australia, Chile, USA and Spain but also related to countries where water markets do not exist (Italy and France). Judgments about water markets refer partially to observed impacts (for instance land value declining in some areas) and partially to perception, beliefs or values (status of water). One key difference exists between (1) on the one hand, concerns that can be answered through institutional mechanisms, limits or market rule, and (2) on the other hand, categories referring to ethics, which might be more difficult to answer.

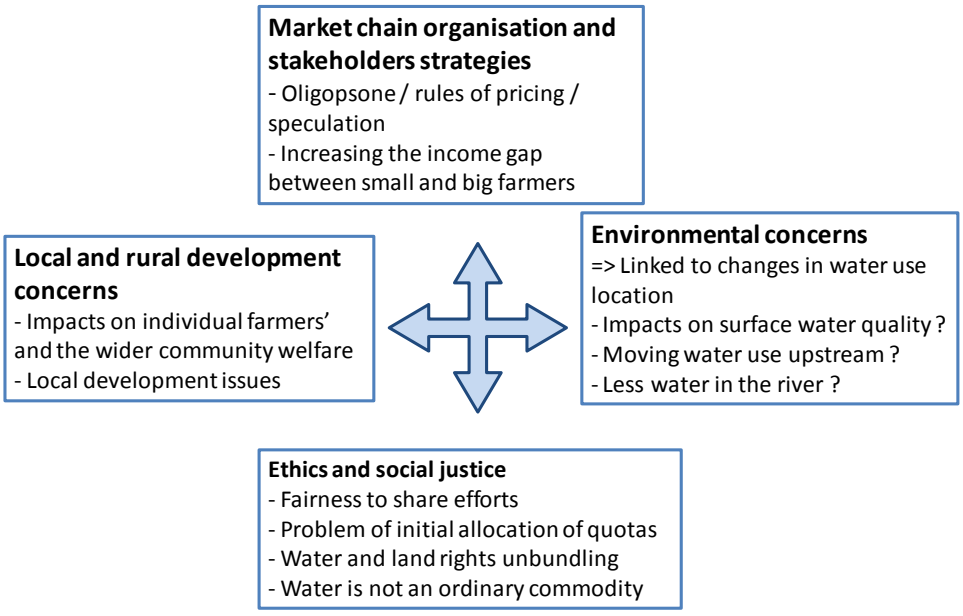

Figure 10: Acceptability issues related to water markets

Two key questions are addressed in this work-package: Are water market scenarios socially acceptable? Which could be institutional mechanisms for enhancing acceptability?

Different methodologies have been developed by partners to collect primary information related to stakeholders' perception, both at individual and collective levels. After a short review regarding the issue of acceptability of water markets in the literature, the methodology used in the various case studies for WP4 will be described.

- **Overview of acceptability issues**

The following figure sums up acceptability issues as approached in the literature. It has been based upon a literature review related to countries where water markets are already implemented such as Australia, Chile, USA and Spain but also related to countries where water markets do not exist (Italy and France). All categories represented below are of course interlinked; especially ethics is a transversal issue inter-related with all 3 other categories of issues.

Those acceptability issues refer partially to observed impacts (for instance land value declining in some areas) and partially to perception and beliefs. One key difference exists between (1) on the one hand, concerns that can be answered through institutional mechanisms, limits or market rule, and (2) on the other hand, categories referring to ethics, which might be more difficult to answer. This point is very important to consider in the perspective to study institutional shifts required to implement water markets.

3.3.3 Stakeholders' perception of water trading in Guadalquivir (Spain)

Authors: *G. Giannoccaro, V. Pedraza, Julio Berbel (UCO)*

During 2011 research was centered in the analysis of market in Spain and Guadalquivir. The scenarios selected to be analyzed were inter and intra sartorial trade both temporal and permanent. Some models were built to simulate observed trade in markets during the period 2005 to 2012. The models work well but shows that markets activate mainly during drought periods and the traded volume is lower than potential. Explanations to the gap between potential and observed market maybe: misspecification of models, transaction cost and barriers to trade. UCO team decided to focus in the latest and methodology will be based on interviews, focus group and survey.

- **Materials and Methods**

Quantitative and qualitative analysis was carried out based on data collected by means of a survey and focus group technique. Two different stakeholders of irrigation community in the Guadalquivir river basin were canvassed namely managers of irrigation boards and irrigators. Interviews were conducted from December 2011 to February 2012 to 47 participants. Simple structured questionnaire to both stakeholders including twelve five-point Likert-scaled statements was applied. Additionally, three focus groups with the irrigators were carried out, respectively in the provinces of Cordoba, Jaen and Seville. The three different meetings were performed in order to separate potential sellers from permanent and annual buyers of each member participating in these meetings. The participants were asked to fulfill the same questionnaire above mentioned. As a whole, 19 irrigators were selected for previously to the focus groups. Afterwards, an open discussion on the water market issue took place among the participants. For

both stakeholders, sampling procedure was based on the geographic distribution across Guadalquivir basin of irrigation sub-districts and farmer's features.

Characteristics of surveyed stakeholders are reported. In the case of members of irrigation boards, the sample covered 94,754 ha, of which 90% is irrigated area. The average size is 6,768 ha with annually volume of water used being of 6,769 m3/ha. Essentially, the water prices consist of a fee ranging from 57 to 166 €/ha. Main irrigated crops are citrus, rice, cotton, maize and olive oil.

As regards to irrigators, the focus groups were carried out respectively among i) a group of farmers that currently does not account for water rights; ii) a second group that covered irrigators who currently relies on a poor water entitlements, namely with less water allotments and supply security; iii) finally, a third group accounted for irrigators with higher water right allocations (6,000 m3/ha). In addition they have already sold water in 2007.

In the first act there were 11 farmers coming from Puente Genil (Cordoba). They are seen as potential buyers give that their farms currently do not rely on water entitlements. Farms average is 48 ha, traditional olive oil is the main crop and farmer's age is on average 52 years. Secondly, a focus group among olive oil producers in a small village called Cambil in province of Jaen took place. This group can be also seen as potential buyers given that uncertainty of water supply both in term of supply security and annual availability are common issues. Only 3 people attended to this focus group, 60 years was the average age and, 16 ha the farm size. Finally, less than 1,000 m3/ha is the annual water allowance for which a water tariff of 0.08 €/m3 is paid. In the third meeting, which was performed in a small town called Lora del Río (province of Seville), number of attendants was 5. This focus group embraced potential sellers of seasonal rights since they were one of the four sellers who sold their water allowance to the Aguas del Almanzora. As a whole, an amount of 12 Mm3 accounting for 1,000 m3/ha was sold in 2007. They show larger average farms (336 ha) and higher average allocations (6,000 m3/ha). The main irrigated crops are citrus, cotton and corn.

- **Methods for data analysis**

The five-point Likert scaled responses were analyzed by a T test that is used in statistics for population samples that follow a Student's t distribution. This type of distribution occurs when the population is expected to follow a normal distribution, but the sample size is small, such as in our case. In addition, the Mann-Whitney U test was used to test for differences between two independent samples which came from populations with the same mean. The MW-U test assumes that the variable you are testing is at least ordinal and that its distribution is similar in both groups. Finally, two-sample Kolmogorov-Smirnov test was used to validate the assumption of similar distributions whether populations differ in their rankings of statements on the basis of the maximum difference in cumulative relative frequencies.

- **Main results**

As a whole, statistical results show that the market idea as a good tool for water management is positively seen from the irrigation community in the Guadalquivir basin. Stakeholders perceive water right as a private asset and they agree with the permanent water rights trade to abandon irrigation, which in turn allows for receiving some compensation. Respondents are also in agreement with the short-term water mechanisms as the water rights remain linked to the land. Cultural belief arises from the negative perception of water markets because water should not traded as a commercial good. Statistical analysis reveals also other important aspect that may be related to the barriers towards water markets. This refers to the policy and property rights uncertainty. In spite of stakeholder's acceptance towards market idea, the results show as the willingness to participate in a market mechanism in the future either in a seasonal market, such as spot water markets, and in permanent transfer mechanisms, is not significant. Finally, the

comparative analysis between the views of managers vs. farmer shows significance for the Mann-Whitney and Kolmogorov-Smirnov two-sample tests, in the case of statement concerning to the water market opposition since water is not a commercial good. This result suggests that farmer's cultural belief might be the main barrier to the water trade, while managers of irrigation boards are unbiased.

On the other hand, analysis of the responses of three groups illustrates the different perceptions and preferences, as well as barriers according to each group. One of the most stressed problems by participants was lack of reliable information provided by the public institutions. Farmers complain about lack of information about the procedure for obtaining entitlements, the access to rights system and the way to assign entitlements. A second problem discussed was types of existing infrastructures and finally, a third problem identified is the asymmetry of information. Indeed, significant differences in the level of information about water market among the farmer's groups have been found.

Most of the findings are coincident to the evidence found in Australia, Chile and USA where water markets have been longer working. However, this study may be relevant for European policy makers who are currently evaluating the potential for water markets as a tool for dealing with water uncertainty and climate change.

3.3.4 Perception of water markets in the Bièvre-Liers-Valloire river basin (France)

Author: Soazig Hernandez (ACTeon)

- **Context and objective**

The work done on the Bièvre-Liers-Valloire river basin aims to provide a sociological perspective focusing on stakeholders' representations of water resources management. The territory of Bièvre-Liers-Valloire is located on the outskirts of Lyon, Grenoble and Valence's areas of influence. It is organized around plains, surrounded by two small mountain ranges. Plains are characterized by alluvial groundwater exploited for drinking water, agriculture, fisheries and industries. Streams are strongly connected through large infiltration areas and key sources for surface water recharge. The alluvial water table has multiannual episodes of water scarcity and is affected by the impacts of various pollutants (nitrates and pesticides mainly). In addition, the Bièvre-Liers-Valloire river basin meets flooding problems, its rivers are polluted and in poor physical conditions. Six interviews were conducted with various stakeholders of the river basin regarding their representations of water and quantitative water management in the future, including their perception of quantitative management through water markets. The synthesis is more specifically focused on this last point.

- **Regulation mechanisms proposed by stakeholders**

Stakeholders have addressed the issue of water-consuming crops and the difficulty to change crops which respond to international business opportunities. The economic viability of farms appears to be a key issue. Transforming agricultural markets seems to be an ideal and utopian solution. However other solutions exist, which are already partly implemented by stakeholders, such as techniques for water saving or water redirection and improvement in stakeholders' knowledge related to their water consumption levels.

Ongoing collective discussions concern landscape schemes in the area: collective reservoirs, infiltration basins, adaptation to crop rotation and reforestation of some plots. Meanwhile, a specific body for the river basin appears to be an attractive solution in order to improve quantitative water management.

- **Local stakeholders refusing water markets**

Water markets and water management through individual transferable quotas meet a severe opposition among interviewees even when a strong institutional framework is proposed. Stakeholders mainly raise ethical arguments, refusing to consider water as a commodity. For these reasons, interviewees refused to question the technical and economic feasibility of water markets. The issue was discussed at intra and inter-sectoral levels during interviews but the dialogue was blocked when considering ethics. Water was presented as a free and universal common resource.

This result raises the question of the social acceptability of water markets and identifies ethics and social justice as common values which are difficult to contradict. Water is seen as a common good and the risk of deviance of a market system creates great suspicion. This distrust is also linked to a potential loss of control and flexibility over the management of the resource.

Besides resistance to changing practices, concerns about a system producing inequalities limits social acceptability of water markets. Stakeholders point towards increasing potential inequity for a new farmer (or another new private user) to access to water resources. They fear that richer people speculate on water resources and that basic rules are not met, the market becoming thus uncontrolled.

Stakeholders are involved at various levels in a collective action for water management adapted to climate change at a river basin level. Risk awareness is shared but differences exist among interviewees regarding their perception of their own vulnerability to water resources degradation. A few stakeholders favour the economic perspective and give priority to maintaining or even developing water-consuming projects.

Current collective efforts are mainly directed:

- towards a positive vision of collaborative management, with a role played by the Water Agency and “chambers of agriculture”;
- towards the contribution of technical innovations to save water and act on its quality.

Stakeholders feel dependent on the world market especially in terms of choice of crop patterns; they think that being less dependent could help them in changing their practices and consuming less water.

3.3.5 Perception of water markets in Marais Poitevin (France)

Author: Fabienne Kervarec (ACTeon)

During the workshops, irrigating farmers and institutional stakeholders have been invited to react to the scenarios, considering their acceptability in the area of the Marais Poitevin ; they made general comments regarding both intra and intersectoral scenarios, but also more specific remarks.

- **General comments.**

Several comments regarding the specificities of the Marais Poitevin affect the acceptability of water markets in the area. Irrigating farmers have pointed out that in the area farms were small (family) and numerous, far from an American, Australian or even Spanish-like model were watermarkets are implemented. Moreover the aquifer is very reactive and charged and discharged very quickly; this characteristics leads to greater uncertainty about water availability. When considering its rotation, it is

impossible for a farmer to predict how much water is required each year. The current context of water management in the Marais Poitevin has been pointed out by all participants as being marked by crisis management (each year) and by the creation of water tanks. In this regard, institutional stakeholders have noticed that crisis could trigger policy evolution and innovation. They also mentioned that in fact, exchanges of water rights already exist; however they only happen between farmers growing specific crops[6] and remain very marginal.

- **Arguments regarding intrasectoral scenarios.**

Several types of objections or concerns have been raised regarding intrasectoral scenarios.

The context of high uncertainty makes it difficult, if not inconceivable, to exchange water (especially purchase water). The probability of a *drought bylaw* ("arrêté sécheresse", which leads to forbid irrigation for a specific period) is currently too high to take the risk of buying. The institutional stakeholders considered that the system could not be a response to a crisis situation (as assumed in the scenario context), because transfers would only happen when there is a strong enough guarantee for the buyer. Considering an increasing uncertainty about the water abstraction right/capacity, it does not seem acceptable to charge purchasers for uncertain volumes. For all participants (both farmers and institutional stakeholders), the system would be more suitable regarding abstraction rights in artificial water ponds, which offer guaranteed volumes. In the framework of a smooth development of water ponds and network, this system might be implemented.

Water is a "*public good*". Farmers do not feel like selling water abstracted from the aquifer, as it does not belong to them[7]. There is a consensus among participants: water rights transfers regarding groundwater body water are not acceptable both for ethical reasons (water is a public good) and fairness (considering young people who do not have access to such quotas). Institutional stakeholders have insisted on the major change required in the scenario, as water becomes a commodity whereas it is "*a common good of the nation*" for now. This would require deep legislative change.

The institutional stakeholders also agreed that the proposed system is incompatible with the principle of solidarity. The initial water rights allocation also raises an issue of inequity between those who will get the initial abstraction right on a historical basis and others. An important point would be that irrigating farmers do not trade directly with each other but that they go through a water bank, which ensures some transparency.

The market price seems difficult to be accepted for both irrigating farmers and institutional stakeholders for ethical reasons too, especially when price directly results from the balance between supply and demand; however institutional representatives have noticed that giving a value to water seems interesting in itself, as a rare resource. Trade between irrigating farmers at *a fixed rate* would be easier to accept.

Several farmers (4 /7 participants) would be interested in exchanging abstraction rights from "artificial water ponds and reservoirs" ("réserves de substitution"). But the practical aspects must be framed, from a technical standpoint (networking between water ponds), price formation, and initial water rights' allocation. Other farmers (3/7) were out rightly opposed to trade in both cases (either from the aquifer or from artificial water ponds). For all participants (farmers and institutional stakeholders) however, the scenario and the general approach could be useful to stimulate discussions about a market price for water

[6] Mainly crops subject to dispensation in the case of irrigation ban (for instance, melon, horticulture…).
[7] In French, « *L'eau prélevée dans la nappe (…) ne nous appartient pas* ».

from artificial ponds, considering for instance ratios for specific public (young people for instance). Eventually, a trading system to make it more flexible could be interesting.

Considering the water management efficiency, the need for a greater responsiveness of the administration was shared by all farmers participating in the first workshops. Allowing transfers could bring flexibility and could therefore make water management more efficient. Several participants agreed on the principle of trade, but that once more mentioned pricing as the remaining problem: a cost-sharing would make sense but nothing more. "*If you make a profit in trading, this is speculation*."

Institutional stakeholders mentioned that water market implementation would mean that all quotas would be used. The definition of the total available volume and its distribution among users should be reliable (which is quite difficult considering the hydrological system). Water transfers could be implemented only if getting out of the crisis management cycle. Water market could improve efficiency if farmers see that they have an interest to save water. Then a trade period in July for instance would encourage farmers to save water during spring, as they would be allowed to sell unused water. That said, an adequate water pricing can achieve the same result. Once more, in the context of artificial water ponds, intrasectoral transfers are of interest: in the current system, unused water might be available in July, despite it being costly. With the water trade system, the whole available water is likely to be used.

- **Arguments regarding intersectoral scenarios.**

According to irrigators, one specific interest of the scenario is that agriculture is considered in those scenarios as one user among others. Still, it is only “one-way transfers” from agriculture towards environment and/or drinking water. A few limits have been mentioned, especially regarding the scenario of transfers from agriculture towards drinking water. First the technical feasibility is conditioned by infrastructures (i.e. canals), which could be only justified by permanent transfers. Moreover required water qualities are not the same for all uses and this point might be taken into account. Irrigating farmers also mentioned that stakeholders market power are imbalanced (buyers are powerful), which might affect the water market functioning.

Regarding transfer from agriculture towards drinking water, institutional stakeholders mentioned that drinking water is a high priority for the water quantitative management and it seems difficult to compensate to farmers, except for the case of dams (as water storage has a high cost). Partly for that reason, they consider that there would be a very low acceptability from the general public for that scenario. However transfers based on the willingness of farmers (as a principle), as developed in the scenario, seems to be interesting in theory; but the problem still might be uncertainty on water availability.

Regarding transfer from agriculture in favour of the environment, institutional stakeholders pointed out a risk of inefficiency: during a water crisis (very dry year), purchasing irrigation water will not change the situation for the environment. In the absence of water for 4 months and in a context of highly reactive aquifers, "*even without irrigation environment suffers!* "(...)" *“Artificial water ponds are relevant response to water scarcity, considering our very reactive underground water body*”.

Participants representing environment and cities mentioned that a deep change of practices is required from irrigators and they feel that water markets are not the right tool to induce this evolution in the long term. This would require specific policies where farmers are accompanied for changing their irrigation practices. One current measure called “MAEt désirrigation” was mentioned in this regard: this policy measure leads to compensate farmers who voluntarily stop irrigating crops. It was mentioned during interviews and working groups as a first experience of water transfer towards the environment.

Environment and city representatives insist on the interest of the specific technical support associated with the measure, which entails a voluntary engagement of the farmer to change his practice for a better preservation of resources and environment. Moreover, the "MAEt désirrigation" is localized on one specific place (i.e. a wet area to be preserved).

- **Conclusion**

Pre-condition of water market establishment: finally the social acceptability of the scenarios depends also on institutional and technical constraints to be overcome as a pre-condition to establish intersectoral water markets. Stakeholders perceive two major technical constraints in this perspective. The first one regards the implementation of transfers from agriculture towards drinking water, which is conditioned by infrastructures such as canals; farmers and institutional representatives of agriculture feel that such investment could only be justified by permanent transfers. However those permanent transfers raise other issue related to acceptability. Differences of required water qualities for the diverse uses were also mention as a barrier, but not developed. The second one is related to the determination of abstraction volumes: the CAP is not well defined / accepted by all stakeholders. This pre-condition to establish water markets seems hard to obtain considering the specificity of the aquifers in the Marais Poitevin (highly reactive resulting in greater uncertainty about water availability) and the current strong political debate on quantitative water management; stakeholders'perception of intersectoral water markets reveals more deeply the current political debates regarding priority among uses of waters.

Limits to be considered: All farmers who took part in the interviews and workshops were involved in a diversity of local professional organisation (mainly irrigation or farmers association); even if they were asked to express themselves in their own (private) stake, their involvement could have introduced a bias in the general view expressed by the group.

Very few institutional representatives of agriculture sector and environmental/city representatives took part in the workshops. This is partly explained by political reasons, by other events and a research project that is not a priority in their schedule as not directly impacting their activity. This low participation deeply limits the representativeness of the findings coming from the workshops; however as a whole, 28 stakeholders of the Marais Poitevin have been consulted either during interviews or during workshops.

3.3.6 Perception of water markets and alternative allocation mechanisms by lay public in France

Author: Marielle Montginoul (IRSTEA)

- **Context and objective**

How should water be shared between farmers when demand exceeds available water resources? What should be the role of the State, of market forces and of farming communities in managing water allocation? Is it acceptable for society that water be allocated or re-allocated using market mechanisms? The objective of the work presented here was to understand how lay citizen would answer these questions. Their opinion is interesting because the different options to manage agricultural water have to be debated in the national arena before being adopted in the French regulation. Although the subject looks quite technical, we assumed that policy choices under consideration raise social, economic, ethical, and ideological issues that citizens would perceive and be willing to discuss. We more specifically wanted to understand how citizen would perceive the idea of establishing water quotas that could be traded between farmers. One of the objectives was to identify acceptability problems and issues with water markets.

- **Methodology**

Citizens were recruited at the "*salon de l'agriculture*", a national agricultural fair organized in Paris. This event is targeting a nonagricultural population but it attracts people potentially sensitive to agricultural issues. Using the stand rented by Irstea at this fair, we invited visitors to participate to mini-debates.

Figure 11: Picture of one of the mini-debate in Paris on 26 February

(Photo: IRSTEA, Maïté Dracon)

Although the objective was mainly to discuss water markets, we decided to embed this debate in a broader discussion of alternative mechanisms that can be used to share water between competing users in agriculture. Three scenarios were thus presented to participants, one of which was focusing on the introduction of a cap and trade scheme. The objective here was to keep participants in an "exploratory mind set", offering them contrasted visions of possible futures, and not only one market scenario that many participants would reject for ideological reasons. The first scenario presented to participants assumes that water allocation remains under tight control of State agencies. The second assumes that the responsibility of sharing water is transferred to an association of agricultural users. And the third scenario assumes that farmers are allowed to trade quotas of water which have been allocated to them based on historical uses.

A total of 110 persons participated, with 6 persons per group on average. The duration of each mini-debate was ranging between 30 and 45 minutes. Each session consisted in (i) a presentation of the scenario by a researcher; (ii) individual filling of a short questionnaire followed by (iii) an open discussion between participants, and, after the debate, (iv) a presentation of the results of a scenario workshop organized with farmers in southern France. This last part of the debate was intended to provide information back to the participants, as most of them were willing to "learn" something through participating to this experience.

- **Results**

When individually answering the questionnaire, citizens express a clear preference for the self-regulation scenario (42%), followed by the administrative scenario (22%) and the market scenario (20%). As shown on figure bellow, 16% of citizens declare preferring a hybrid solution, which would combines assumptions

from the combining administrative and self-regulations scenarios(for 10%), the administrative and the market scenarios (for 4%), or self and the market scenarios (for 2%). Respondents' age seems to influence the choice of a scenario. Young people are in particular more supportive of the market scenario.

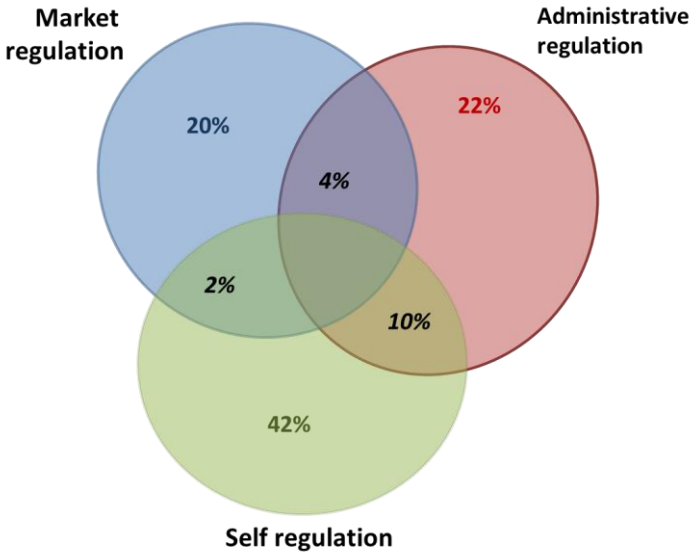

Figure 12: Results of individual votes (before collective debates) in Paris.

Another result is that while few respondents categorically oppose to the self-regulation (13%) or the administrative scenarios (8%), a high proportion (39%) is rejecting the water market scenario. Several reasons are advocated during the debate phase:

- Water should not be treated as a commodity; respondents characterize it as a "common good" (belonging to the community as a whole), a "public good" (meaning owned by the State) (common terminology, not economic) which cannot be privately appropriated. Creating a market for reallocating water makes it de facto a commodity like any other one.
- There is a risk of speculation ; respondents fear that water be pumped out not to make a beneficial use of it but to sell it at the best possible price for maximizing profits; this would in turn rule out of agriculture many farmers who will not be able to purchase water to cover the needs of their crops.
- Establishing tradable quotas will increase total use; respondents fear that, once selling is allowed, unused water will be sold while it is currently left in rivers (activation of formant rights);
- The cultural dimension is also advocated: trading natural resources is perceived as an Anglo-Saxon way of thinking which is not compatible with the Latine approach of the society.

- **Conclusion**

This experiment has demonstrated citizens' capacity to participate to contribute to this technical issue although it is not really linked with their immediate concerns. The interest of participants is attested by the time they spent with researchers, knowing that they were primarily visiting the *Salon de l'Agriculture* on leisure time. Reactions and comments were based on very brief description of the scenarios, which explains why some of them remain quite superficial. However, it is clear that citizens feel concerned and

that they could contribute to the evaluation of more precise scenarios if they were given more time, in a different setting. We suggest that less caricatured scenarios should be tested, in particular concerning water markets.

3.3.7 Perception of water markets in Italy

Authors: D. Viaggi, M. Zavalloni, M. Raggi

- **Results of two workshops - Stakeholder approach**

We worked on the approach to the stakeholders by designing two workshops. A first workshop was organized in Rome at ISPRA (6 October 2011). The main topic of the workshop was the assessment of the perception of professionals in the water sectors on the possibility of implementing markets for agricultural water exchanges. Summarizing, the people presents find a general interests (if not need) in investigating the topic, with a scientific (not political/ideological) approach. The interest is based on the perception of a potential water scarcity scenario for Italy, scarcity to be coped with an increase in the efficiency of water uses (achievable, among the different tools, by implementing water markets).

A second workshop was organized in Ferrara within the H2O conference (23/24 May 2012). A questionnaire, aimed at understanding the perception on the future of the resource "water" in its physical and institutional aspects, with a specific focus on the agricultural water. The questionnaire was submitted to some experts in the field of water. The goal of the questionnaire was the legitimization of the formulation of scenarios to be subsequently introduced in mathematical models.

3.4 TRANSACTION COSTS (WP5)

3.4.1 Overview of activities

Lead	Contributors	
UPM	UPM / UPC	
Objectives: The objectives of this WP are (i) to describe the institutional changes that are required to implement water markets and to assess the costs of establishing these institutions and (ii) to assess costs related to the functioning of the markets. To achieve these objectives, the following tasks will be performed: **Change in work program**: the objectives of this work-package could not be reached.		
Activities performed		
Partner	Description	Deliverable
UNIBO / UPC	Development of a general framework for assessing transactions costs, based on a literature review	Technical Note TN 9

3.4.2 Results

Transaction costs are a key category to connect market functioning and institutional development and, as such, they are a concept providing relevant insights into the issue of water markets, particularly at their inception. The experience from the previous literature about TC highlights the difficulties in estimation and separation from other costs sources.

As part of WP5, UNIBO and UPM produced a technical note (TN9) synthesizing the existing literature on transactions costs (TC) and water market. This document has two main aims: 1) to review the TCs in water markets, focusing on the different types of TCs, on their role in the functioning of the markets, and on their relevance for improving the institutional design of water market mechanisms; and 2) providing an empirical exploration of factors affecting Water markets establishment and functioning and that can be attached to the categories of transaction costs.

The technical note is organized as follows. Chapters 2 to 5 provide a literature review of transaction costs related to water markets. After an overview about transaction costs in general (chapter 2), we focus typologies and factors affecting transaction costs in water markets (chapter 3). Then we review practical issues in assessing TCs (chapter 4) and discuss policies aimed at reducing transaction costs (chapter 5). Chapter 6 provides the synthesis results of an empirical analysis of factor affecting water markets in the perspectives of transaction costs. More details and the individual reports of the single case studies are given in the annexes.

A practical framework was also developing to describe qualitatively TC associated with water market scenarios considered in the different case studies (see appendix of TN9). This framework could however not be applied, due to the hypothetical nature of water market scenarios considered.

The main insight for the water Cap and trade project is that it would be probably almost infeasible to try to assess transaction costs where water markets are not still in place (France, Italy). On the contrary it would be a useful exercise for Spain.

3.5 POLICY SIMULATION (WP6)

3.5.1 Overview of activities

Lead	Contributors	
UPM	UPM / UPC	

Objectives: The objective of this WP is to run experimental implementation (policy exercise) of water markets scenarios with a group of stakeholders representing the different actors likely to engage into future markets.

Change in work program: due to difficulties in mobilizing stakeholders for more than 4 hours, the methodology was adapted, using scenario workshops instead of real policy exercises (which usually takes longer). The experimental dimension however remains strong in the final methodology implemented, in particular through using narrative scenarios.

Activities performed

Partner	Description	Deliverable
Brgm / Irstea	Development of a common methodology to be implemented in all case studies.	Presented in journal papers P8, P9, P11
BRGM / IRSTEA	Scenario workshops in the Roussillon case study, France	P8, P9, P11 Report R1 (in French)
BRGM / IRSTEA	Scenario workshop in 5 groundwater basin, France	P8, P9, P11 Report R1 (in French)
BRGM	Development of a game to simulate water markets in agriculture	MSc. Thesis by Duponteil (2011) (AT1)

3.5.2 Development of a common methodology

The methodology was developed in two stages through (1) a first case study conducted in the Roussillon case study, followed by (2) five additional French case studies in selected groundwater basins in France. The methodology consisted in organizing stakeholder workshops were future contrasted water management scenarios were debated and evaluated.

One of the main features of our methodology consisted in **embedding the discussion of water markets into broader water management scenario**s. We argue that water markets are only one of several economic instruments which can be used for ensuring flexible water allocation. Their advantages and drawbacks can therefore only be discussed through a comparison with alternative instruments, allowing stakeholders to express their preference for alternative solutions. Workshops were therefore designed to evaluate several economic instruments, including water markets.

The main features of the operational methodology deployed are the following:

- Scenarios: To facilitate the debates, three contrasted, predefined future water management scenarios were used as material to initiate the debates. Scenario narratives were written by researchers in advance of the workshops, because we assumed that we would not have sufficient time to make trend-breaking scenarios emerge during the 4 - 5 hour scenario workshops. Each scenario consisted of a narrative describing groundwater management rules in 2030-2040. We used a press release format to present water management scenarios; scenarios were adapted to each case study, based on preliminary field work (interviews).
- 2030 time horizon: we purposely used long term scenarios. We consider that changes considered in the scenarios could not take place in less than 15 years' time, given the drastic institutional changes required.

- Participants: In each case study, we involved several groups of farmers and institutional stakeholders; the two publics were kept purposely separated. Although the scenario-workshop method usually involves the mixing of policy makers, business representatives, experts, and citizens, we decided to set up separate groups for various public – institutional representatives and experts on the one hand, and farmers on the other hand. We also opted for smaller groups (five to fifteen persons) in contrast to the scenario groups described in the literature, where each workshop comprises between 25 and 40 persons. This methodological choice was adopted to overcome the mistrust which characterizes relationships between farmers and public-sector experts.
- Workshop organization: workshop were organized in a neutral location and followed by a convivial meal; the average duration was 4.
- Analysis of the material collected: Discussions were tape recorded to allow further detailed analysis of the arguments quoted by participants. Participants were also asked to fill a questionnaire during the workshop, in particular to express their preference for the instruments proposed.
- Result final presentation: Results obtained in the 5 case studies were presented to participants in each of the 6 case studies at the end of the research process. Participants were also offered the possibility to review and comment the final report (R4, see list of deliverable).

This methodology was only implemented in the French context, by the Brgm and Irstea team. Spanish and Italian partners could not deploy it for several reasons: (1) significant work was required to adapt the scenarios to Italian and Spanish context; (2) local stakeholders would not actively support the organisation of workshops.

However, implemented by Portuguese colleagues (who were not part of the project) as a continuation of a past collaboration.

3.5.3 The French policy context

France is currently embarking upon a drastic reform of quantitative water resources management. This reform relies on two principles: the definition of an upper limit to water abstraction per surface/groundwater basin (“cap”), and the decentralization of the responsibility for allocating water among users. In the agricultural sector, newly established Water User’s Associations (WUAs) will first have to define how individual water quotas should be allocated to farmers. WUAs will then need to design and implement instruments that can ensure the enforcement of the total “cap”, and introduce flexibility allowing reallocation between farmers.

Different approaches can be adopted to reach these two objectives. One approach consists of using economic incentive based instruments to promote users’ decisions compatible with the targeted apportionment plan; this includes taxes to sanction farmers exceeding their quota; subsidies that reward farmers using less than their quota; the combined use of the two previous instruments; or the establishment of tradable water rights. An alternative approach consists of providing a regulatory framework for facilitating the emergence of cooperative behavior within groups of farmers who would accept to mutualize their water quotas, be collectively responsible for enforcing it and benefit from a greater flexibility on how they use it.

3.5.4 Case study 1: the Roussillon aquifer (France)

Authors: Rinaudo JD (Brgm), Montginoul M (Irstea) with the collaboration of M. Varanda and S. Bento, Portugal)

- **Context and objective**

The objective of this first case study, conducted at the beginning of the project, was to debate with farmers and stakeholders three different policy models for groundwater managements. The first model consists of developing direct administrative regulation, with systematic registration of abstraction points, the issuance of permits, the definition of groundwater rights, and the awarding of concessions. The second model consists of relying on economic instruments, such as water pricing or tradable water licenses, to regulate the use and allocation of groundwater. The third model is self-regulation, consisting of establishing semi-autonomous groundwater users' associations (GWUAs) with the internal capacity of organizing groundwater regulations, supported by higher-level authorities. Three narrative storylines were developed to introduce and to arouse debate on these three models with institutional representatives, experts, and farmers. These storylines are briefly presented below.

Scenario A: the Regulatory Approach. This scenario assumes that groundwater becomes entirely regulated by the State. Drawing on approaches implemented in Spain with the Regimen de Explotacion and in some groundwater basins in western states of the U.S.A., this scenario assumes that a government agency registers all groundwater abstraction points, issues permits, defines groundwater rights (volume per year), and awards concessions. It further assumes that farmers provide detailed information (at the plot level) on where they use water and for which crop, in a framework similar to what is currently done for obtaining Common Agriculture Policy subsidies. The government agency then checks that the declared irrigated areas and cropping patterns are consistent with the authorized water use. The enforcement problem is dealt with by the use of sophisticated remote-sensing technology coupled to a Geographic Information System. Satellite images are regularly acquired and analyzed to identify and map all irrigated areas. The volumes used in each field are estimated using the same images. This information is integrated into a numerical land registry in order to compare actual water use with legal water entitlement. In the event of inconsistency between declared and estimated water use, a field inspection is carried out. Severe sanctions apply in cases of non-compliance, the sanction consisting of a fine proportional to the excess water used. One of the problems associated with this scenario is the lack of flexibility: newcomers (young farmers) are unable to obtain a concession until another farmer relinquishes a license – possibly providing incentives for farmers to drill illegal wells or to engage in informal water trading.

Scenario B: Tradable Water Permits. The second scenario retains all the assumptions of the regulatory scenario and further assumes that water concessions can be traded among farmers. Both short- and long-term exchanges can take place. Transactions are approved and registered by a regulatory authority which checks that the transaction has no third-party impact. Details of all transactions are published by the regulatory authority (price and volumes exchanged) to ensure transparency. Specific measures are implemented to prevent speculation, mainly consisting of recalling dormant licenses from farmers who have not directly used them for several consecutive years. The main questions raised by this scenario are related to the functioning of water markets (type of farms likely to actively engage in trading, type of exchanges that would take place, namely short- or long-term sales), and to the social acceptability of considering trading water concessions in a legal framework in which water is considered to be a common good (France), and the risks of market failure in both the French and Portuguese contexts.

Scenario C: Self-Regulation. The third scenario is inspired by various examples around the world where water users have successfully organized themselves into associations to safeguard groundwater resources and to prevent the tragedy of the commons from happening. The example of the Ground-Water User

Association (GWUA) established in Eastern Mancha (Junta General de Regantes de la Mancha Oriental) was specifically studied when constructing this scenario. This scenario assumes that GWUAs are established and made responsible for the allocation of the Maximum Permissible Annual Volume (MPAV) among farmers. The GWUA develops the internal capacity to register boreholes and to monitor the volumes of water used by its members, without State interference. Membership in a GWUA is mandatory for any farmer wishing to exploit groundwater (the State ensures compliance with this). The GWUA, which is responsible for enforcing the overall quota (MPAV) controls the individual behaviour of its members. A Groundwater Tribunal, composed of elected farmers, is established to arbitrate conflicts, and to impose penalties on offending farmers (illegal wells or over-pumping). Government Agencies are asked to intervene only if the Tribunal's order is not carried out. The main questions raised by this scenario are related to the assumption that GWUA can effectively monitor groundwater access and use by its members, and to the assumption that self-adjudication and enforcement of sanctions can work.

- **Results**

We focus here on the results related to the water scenarios, additional information on the two alternative scenarios can be found in Rinaudo et al (2012).

Overall, stakeholders all express major concerns related to the ethical implications of establishing a market for water rights. They firmly oppose considering water as a commodity that can be traded. As one farmer puts it, 'we can sell everything but not water'. Also, they are particularly concerned by the assumed separation of land and water property, fearing that this would lead to the concentration of water rights in the hands of a few better-off farmers, resulting in the abandonment of large tracts of land. Concerning small farmers (who refer to themselves as 'peasants'), the scenario somehow threatens their own existence, whereas it opens new prospects for large farmers (who were not well represented in our groups).

After having made clear that this scenario was not a desirable outcome, the French farmers, who agreed to discuss this scenario in detail, acknowledged that it was not totally improbable. To support this judgement, they spontaneously quoted the existence of similar cap and trade mechanisms used for the regulation of greenhouse gas emissions. They also mentioned that similar markets already exist in agriculture for regulating the allocation of certain production rights, e.g., vine plantation rights, milk quotas, shellfish concessions, etc. Finally they agreed that tradable water rights should be considered and debated, given that these could appear on the policy maker's agenda in the future.

From that point in the discussion, some of the workshop participants clearly shifted to an exploratory mode, making an effort to envision how the mechanism would work. They identified a number of situations where trade could offer flexibility (for instance during the first 4 - 5 years of orchard plantation farmers could lease their water rights since they would not fully use them). They agreed that trade could be beneficial to farmers in specific situations. Trade would most probably remain limited and consist of long-term (or definitive) transfers (sale of water right after retirement), although short-term transactions (from a few weeks to a 1-2 years) might also take place at the margin. Participants were quite imaginative in identifying potential problems and drawbacks, including prohibitive transaction costs and third-party effects generated by the concentration of water rights in specific geographic areas. Tradable water rights were also expected to increase the complexity of land markets and to increase the resources needed by young farmers entering the sector (purchase of water rights in addition to land, machinery, etc.). A clear risk of speculation was pointed out, assuming that some farmers (market gardeners) might purchase water rights, use them during wet years, and speculate during drought years. Last but not least, farmers were concerned that water rights could be transferred to cities, for instance by farmers retiring, resulting in the progressive disappearance of agriculture. In conclusion, some of the farmers agreed that a system

of tradable water permits could be established, provided that water permits would remain linked to the land and exchanges were limited to short-term leases of permits.

3.5.5 Scenario workshops in five groundwater basins, France

Authors: M. Montginoul (Irstea), JD Rinaudo & C. Hérivaux (Brgm), AG Figureau (PhD student, Brgm & Irstea).

- **Policy context and research objective**

France is currently embarking upon a drastic reform of quantitative water resources management. This reform relies on two principles: the definition of an upper limit to water abstraction per surface/groundwater basin ("cap"), and the decentralization of the responsibility for allocating water among users. In the agricultural sector, newly established Water User's Associations (WUAs) will first have to define how individual water quotas should be allocated to farmers. WUAs will then need to design and implement instruments that can ensure the enforcement of the total "cap", and introduce flexibility allowing reallocation between farmers.

Different approaches can be adopted to reach these two objectives. One approach consists of using economic incentive based instruments to promote users' decisions compatible with the targeted apportionment plan; this includes taxes to sanction farmers exceeding their quota; subsidies that reward farmers using less than their quota; the combined use of the two previous instruments; or the establishment of tradable water rights. An alternative approach consists of providing a regulatory framework for facilitating the emergence of cooperative behavior within groups of farmers who would accept to mutualize their water quotas, be collectively responsible for enforcing it and benefit from a greater flexibility on how they use it.

The objective of the research was to analyse stakeholder's preferences for these different instruments. To achieve this objective, scenario workshops organized to identify technical, economic and psychological barriers that could impede the implementation of these instruments. Sixteen workshops were organized in five regions of France; they involved 80 farmers and 44 institutional stakeholders.

- **Presentation of the water management scenarios debated during workshops**

The three following instruments were presented and discussed with stakeholders during the workshops. Participants were provided with a narrative description of each of them, presented as a press release supposedly published between 2020 and 2035.

Scenario 1: combined payment-penalty system (P&P). This scenario assumes that farmers exceeding their quota are charged a tax for each cubic meter pumped in excess of their individual quota. The sums recovered are in turn used to subsidized farmers using less than their quota. This subsidy is granted proportionally to the volume of water "saved". The amount of the subsidy, expressed in €/m^3 saved, depends directly on the number of farmers infringing their quota during the same year.

Scenario 2: the joint liability contract. The scenario proposes that groups of farmers willing to mutualize their quota be allowed to do so through signing a contract by which they accept to become jointly liable vis-à-vis the WUA. Farmers gain two benefits from entering a group: reduced fees paid to the WUA, and increased flexibility concerning water use (since they can make any arrangements concerning water use they wish with farmers of their group). If the group exceeds its water entitlement, the fine is doubled as compared to what individual farmers are charged. The group is jointly liable for paying the fine. For groups, as for individuals, the fine is charged proportionally to the excess pumping. This scenario assumes

that joint liability will reinforce individual responsibility cooperation between members to reallocate water in an optimal manner, and is better able to cope with unforeseen events that may occur during the season. Group members have access to detailed information on volumes abstracted by each well of the group (combined use of smart meters and a web-based information system), which allows a mutual control within the group.

Scenario 3: water markets. The groundwater trading scenario takes place in 2035. This scenario assumes that individual water entitlements are granted to farmers for a 10 years duration. The total groundwater volume available is revised each year in March, after groundwater recharge is known. Individual annual allocations of farmers then be proportionally increased or decreased, without any compensation. Irrigating farmers can buy or sell their individual water allocation on a temporary basis (irrigation season). Agreements are made on a bilateral basis through the GWUA website which registers the transactions. Trading can occur only before the irrigation season has started, and within a groundwater management unit. The GWUA is in charge defining trading rules, including the management of third party effects. Trading information is made available to farmers of the water management unit through the GWUA website. Groundwater remains the Nation's public trust, water entitlement remaining administrative authorizations that can be adjusted, or even revoked without any compensation at the end of the period of validity.

- **Stakeholders' preferences for various economic instruments**

Preferences for the different scenarios were elicited at the end of the workshop through an individual voting procedure. Results shown in figure 1 illustrate that most participants are either satisfied with the baseline scenario (fixed water allocation ensured by WUA) or willing to implement Joint Liability contracts. Institutional stakeholders' vote illustrates the positive perception of decentralized water management. The incentive-based instruments, i.e. the "payment and subsidy" as well as "water markets" are the less preferred options, only corresponding to the preferred option for respectively 7-8% and 7-9%. The reasons advocated by participants to justify their preference reflect: ethical considerations; a preference for collective and cooperative arrangements rather than competition; perceived risks of using economic-incentive based instruments. Water markets are clearly discarded for many reasons which are presented in detail previously in this report by Hérivaux et al..

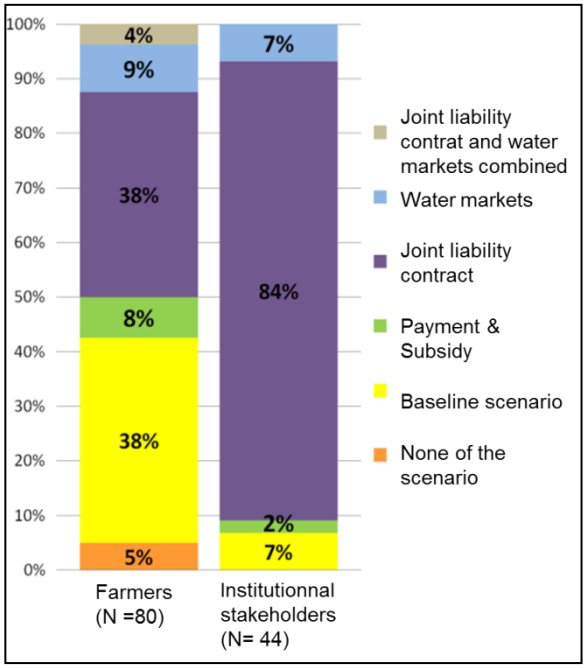

Figure 13: Preferences expressed by French stakeholders concerning 4 economic instruments, including water markets.

- **Perception of water markets**

Most participants expressed serious concerns with regard to the proposed trading scenario. On average 45% opposed to it while 42 % supported it under certain conditions and only 3% fully supported it. A detailed analysis of the 550 arguments quoted by participants helped understanding the motivations underlying their positions. These arguments were classified into five categories: (i) advantages, (ii) conditions that should be met before introducing a groundwater trading scheme, (iii) options or possible improvements, (iv) risks and (v) positions of principle. Arguments expressing positions of principle and risks represent 60% of the total number of arguments advocated during the workshops.

Positions of principle were generally quoted by participants at the very beginning of their speech. These arguments are mostly related to ethical positions: they consider that groundwater is a common-pool resource which cannot be privately appropriated by people nor traded. Most people denounce the risks associated to market mechanisms and they generally strongly oppose to their implementation in the water sector; on the contrary, some participants consider water simply as a commodity and argue that trade could help improving the effectiveness of its use.

Participants were particularly concerned with (i) risks of market failure and (ii) low transaction intensity. Concerning market failure, they fear that speculation could happen, increasing uncertainty and the economic risks farmers face on other markets. Also, all farmers would not have an equal access to the market, which could result in a concentration of water quotas in the hands of a few large farmers. This could in turn disorganize agriculture at a regional level, with a possible collapse of several productions, types of farms and even territories. Water market would also result in increased competition between farmers, at the expense of cooperative behaviours, increasing social fragmentation and eroding rural solidarity. Concerning market intensity, farmers expect that trading activity will remain very limited, especially in areas where groundwater management units are small and where farming systems are not diversified. They also fear that regulations that would be implemented to prevent third part effects would significantly restrict trade possibilities. Costs of establishing and running the market would thus largely overweight benefits.

Participants suggested that some of these risks may be limited if specific conditions are met before introducing a groundwater scheme. In particular, the initial water allocation should be considered as fair and equitable by all farmers; groundwater scientific knowledge should be sufficient to delimit trading areas, to guarantee the irrigation volume allocated to the farmer at the beginning of the irrigation season and to manage third party impacts. Several types of trading rules were suggested to control these risks: for instance imposing an upper limit to the water available for trade (to limit concentration of water use), or to set water price limits (to avoid speculating behaviours).

In spite of the fears expressed, and of the ethical positions against market mechanisms, half of the participants consider that the proposed groundwater trading scenario represents a plausible future evolution of French water policy, and 65% of the farmers declare they would participate, mostly occasionally (60%), if such markets were established.

- **Conclusion and policy recommendations**

Three conclusions can be derived from the consultation of farmers and institutional stakeholders. Firstly, there is still a long way to go before the preconditions to water trading are met: level of water scarcity, scientific knowledge, water entitlements' definition, positions of principle, and rules to establish initial allocation volumes should still evolve before envisaging the implementation of tradable water quotas in France. Secondly, groundwater trading schemes are expected to have a limited potential (in terms of trading activity) with trade taking place only in large and homogeneous groundwater units, and where farming systems are highly diversified. Thirdly, there will be a real challenge to choose the optimal regulation level of the trading mechanism, with a trade-off between (i) many trading rules to limit

economic, social and environmental risks and (ii) as few regulation as possible to propose a realistic and manageable trading mechanism and to enhance trading activity.

Figure 14: ***Scenario workshops organized in June 2012 in the CLain river basin with experts (left) and farmers (right)***

3.5.6 Development of a game to simulate water markets in agriculture

- **Objectives**

In countries where water has long been considered as a free access good (France, Italy), farmers have difficulties in fully grasping how water markets could operate in practice. We thus felt that there was a need to develop a tool that could help them experimenting the type of decisions they would have to take if such a mechanism was established. We therefore designed a playing role game, inspired from similar games used in fisheries (Fiskbanks) and other natural resources. The game was tested with students and not with farmers, by lack of time. **The game is now routinely used by Brgm and Irstea as part of MSC course in Montpellier University** (Water management, social science branch).

- **Results**

The game is structured as follow. Each player is managing a farm, which main characteristics are given. Each farm is allocated a given volume of water. The player is offered a limited number of possible decisions consisting in (i) increasing or decreasing his irrigated area or changing crops (associated costs and benefits are known); (ii) proposing to sell part of his volume of water or (iii) asking to buy additional water.

At each turn of the game, farmers send purchasing or selling bids to the market regulator. Bids are entered in a computer and a simple algorithm is used to calculate an equilibrium price, simulating a clearing house market mechanism (inspired from the Watermoove market in Australia). The regulator informs the players which purchase or selling bids were accepted. During a few turns, the players experiment different strategies. The game then usually converges towards a stable equilibrium price. A debriefing is then conducted to debate the pro and cons of the market mechanism simulated. The following figure illustrates the result of one turn. Ordered water selling and purchasing bids are shown in orange and green respectively.

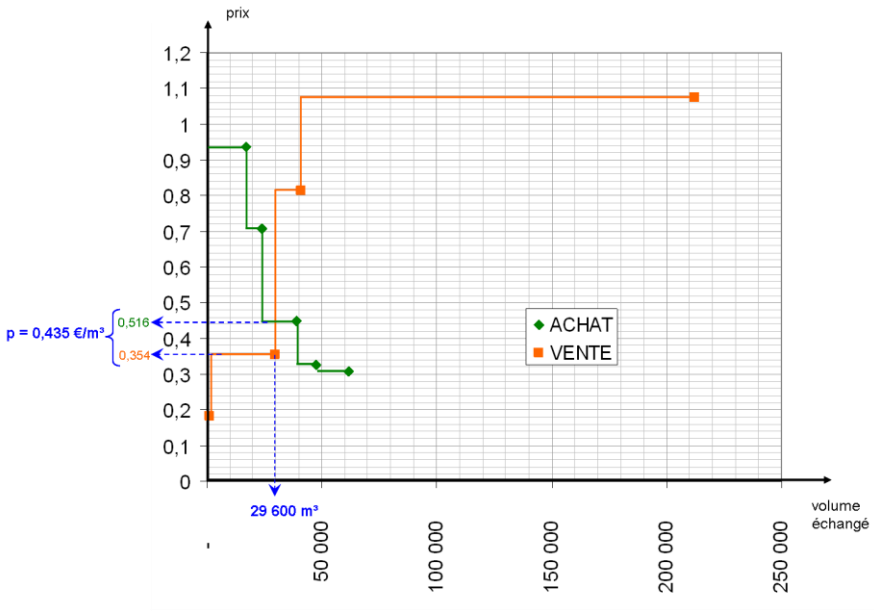

Figure 15: graphical output of a market equilibrium in the water market game (6 players).

3.6 SYNTHESIS AND COOPERATION WITH EXTERNAL ORGANIZATIONS (WP7)

The main events carried out as part of the project, involving some interactions with external organizations are listed in the following table.

Year	Date	Location	Organised b	Event objective	Participants	Output	Type
2011	03/01/2011	Córdoba, ES	UPM-UCO	Initial working meeting of the Spanish partners to establish common orientations across project activities for the Spanish case studies, prepare the project kick-off meeting and discuss the composition of National Advisory Committee	UCO, UPM, UPCT	Framework for coordinating activities on the Spanish case studies and	Internal
2011	27/01/2011	Montpellier, FR	BRGM	Project kick-off meeting	Research partners	Revised workprogram & methodology	Internal
2011	24/01/2011	Lisbon, PT	BRGM	Meeting with Portuguese researchers of Lisbon University (ISEG, ICS) to exchange on recent work on "the acceptability of water trading in Portugal". Preparation of a common research paper on this issue,	BRGM, University of Lisbon	Draft research paper	Collaborative
2011	06/04/2011	Madrid, ES	UPM-UCO	First Meeting of the National Advisory Committee	UPM, UPCT, UCO. Stakeholders: different river basin's institutions and irrigation districts, and also some water markets' experts from different universities of Spain	Very useful information for developing the water market scenarios	External
2011	12/06/2011	Poitier, FR	BRGM - IRSTEA	Organisation of scenario workshops on quantitative water management in the Clain river basin with 3 stakeholders groups	Institutional stakeholders	Material for reasearch	External
	13/06/2013	Poitier, FR	BRGM -	Scenario workshop (as above)	Farmers group 1	Material for reasearch	
	14/06/2013	Poitier, FR	BRGM -	Scenario workshop (as above)	Farmers group 2	Material for reasearch	
2011	27/06/2011	Madrid, ES	UPM-UPCT	IV National Seminar of the Water Observatory-Botín Foundation : Formal water markets in Spain	UPM, UPCT, Water Observatory members,	A better knowledge on the Spanish water	external
2011	06/10/2011	Montpellier, FR	BRGM	Seminar on water markets with regional stakeholders. Presentation of the US experience by Helen Hanak from Public Policy Institute ofr California (PPIC).. Presentation of the Spanish experience by JD Rinaudo. Debate on the potential of water markets fro the French context	RMC Water agency, regional council, county council, local river basin authorities, ONEMA, researchers	Dissemination	External
2011	03/11/2011	Madrid, ES	UPM - BRGM	2nd project meeting	Research partners		Internal
2012	25/02/2012	Paris, FR	IRSTEA	Organisation of mini-debates on "scenarios for quantitative management of water resources" at the Salon de l'Agriculture of Paris	General public	Research report on the perception of water market by lay public	External
2012	21/03/2012	Madrid, ES	BRGM-UPM	Working meeting with UPM - review of option market scenario. Preparation of outlines of research papers.	BRGM, UPM, UPCT	Draft outlines of research papers	Internal
2012	25/03/2012	Valencia, ES	BRGM	Meeting with researchers from Polytechnic University of Valencia to analyse existing water markets in the Jucar basin. Study of the Publiuc Water Purchase system. Organisation of a	BRGM,Polytechnic University of Valencia	Case study of Jucar public water purchase. Course to Master	Collaborative

2012	February to may 2012	Segura basin, ES	UPM-UPCT	Two interviews with officers in the Segura Basin River Authority and twenty interviews with representatives of irrigation districts' boards in the Segura basin.	UPM, UPCT	Information about water supply availability and reliability and water trading experiences (prices, volumes exchanged,	External
2012	22/03/2012	Marais Poitevin	ACTEON	Organisatio of scenario workshops on water markets in Marais Poitevin	ACTEON, BRGM, regional stakeholders and farmers	Material for reasearch paper	External
2012	18/04/2012	Madrid, ES	UPM-UCO	Second Meeting of the National Advisory Committee	UPM, UPCT, UCO. Stakeholders: different river basin's institutions and irrigation districts, and also some water markets' experts from different universities of Spain	Very useful information for improving the proposed scenarios	External
2012	27/06/2012	Lyon, FR	BRGM-IRSTEA	3rd project meeting	Research partners		Internal
2012	26/06/2012	Lyon, FR	BRGM	Mid-term project seminar	IWRM Net funding and research partners, invited water managers and policy makers (France)	Dissemination	External
2013	11/06/2013	Bologna, IT	UNIBO -BRGM	4th project meeting			Internal
2013	25/01/2013	Montauban, FR	BRGM-IRSTEA	Scenario workshop	Farmers group 1	Material for research	External
2013	29/01/2013	Moissac, FR	BRGM-IRSTEA	Scenario workshop	Farmers group2	Material for research	External
2013	30/01/2013	Montauban, FR	BRGM-IRSTEA	Scenario workshop	Farmers group 3	Material for research	External
2013	21/01/2013	Montauban, FR	BRGM-IRSTEA	Scenario workshop	Institutional stakeholders	Material for research	External
2013	12/02/2013	Montélier, FR	BRGM-IRSTEA	Scenario workshop	Farmers group 1	Material for research	External
2013	12/02/2014	Valence, FR	BRGM-IRSTEA	Scenario workshop	Institutional stakeholders	Material for research	External
2013	13/02/2014	Montélier, FR	BRGM-IRSTEA	Scenario workshop	Farmers group2	Material for research	External
2013	18/02/2013	Lyon, FR	BRGM-IRSTEA	Scenario workshop	Farmers group 1	Material for research	External
2013	19/02/2013	Lyon, FR	BRGM-IRSTEA	Scenario workshop	Institutional stakeholders	Material for research	External
2013	20/02/2013	Lyon, FR	BRGM-IRSTEA	Scenario workshop	Farmers group2	Material for research	External

2013	21/03/2013	Laon, Fr	BRGM-IRSTEA	Scenario workshop	Farmers group 1	Material for research	External
2013	22/03/2013	Laon, Fr	BRGM-IRSTEA	Scenario workshop	Institutional stakeholders	Material for research	External
2013	23/03/2013	Laon, Fr	BRGM-IRSTEA	Scenario workshop	Farmers group 2	Material for research	External
2013	28/12/2013	Venice	BRGM	Presentation of the results of the Water Cap & Trade project to the final conference of the EPI Water project (FP7)	Researchers	Dissemination	External
2014	08/01/2014	Laon, FR	BRGM-IRSTEA	Final result presentation	Farmers & institutional stakeholders	Dissemination	External
2014	09/01/2014	Poiriers, FR	BRGM-IRSTEA	Final result presentation	Farmers & institutional stakeholders	Dissemination	External
2014	14/01/2014	Valence, FR	BRGM-IRSTEA	Final result presentation	Farmers & institutional stakeholders	Dissemination	External
2014	15/01/2014	Montauban, FR	BRGM-IRSTEA	Final result presentation	Farmers & institutional stakeholders	Dissemination	External
2014	16/01/2014	Lyon, FR	BRGM-IRSTEA	Final result presentation	Farmers & institutional stakeholders	Dissemination	External
2014	10/02/2014	Paris, FR	BRGM/ONEMA	National Workshop on Water allocation policies	National experts & stakeholders	Dissemination - all documents on web site	External
2014	11/02/2014	Paris, FR	BRGM/ONEMA	European workshop on water market	European experts	Dissemination - all documents on web site	External

4 MAIN POLICY CONCLUSIONS CONCERNING WATER MARKETS

4.1 EXISTING WATER MARKETS

- WM have been operating for more than 30 years in western States of the USA, in Australia, in Chile. They were established under natural, economic and institutional conditions which significantly differ from those prevailing in most European contexts: (i) much higher water scarcity; (ii) clearly defined water property rights; (iii) cultural, ideological and legal context favorable to trading mechanisms. The transposition of these experiences to the EU context requires serious investigations of the conditions under which this instrument could serve the objectives of EU water policies. The Water cap & Trade project represents contribution in that direction.

- In all countries where water trading was established, the intensity of transactions remains relatively limited (typically 1 to 5% of allocated volumes). WMs can help introducing some flexibility in allocation when scarcity increases, but only at the margin. They should thus be considered as a complement rather than a substitute to economic, institutional and regulatory instruments. The establishment of a system of tradable water quotas in local European contexts is not expected to lead to profound changes in water allocation. The associated economic, social and environmental adverse impacts must be kept within very narrow limits.

- In Europe, the only country where trading of water allocation exists is Spain. This is probably due to (i) the high level of water scarcity associated to a high level of water productivity comparable to Western US and Australia; and (ii) the existence of a vast interconnected water infrastructure (dams, canals, inter-basin transfers) which is not matched anywhere else in Europe; (iii) the historical existence of water markets (auctions) in some regions of Spain. Spain thus remains a unique “laboratory” where water trading experiments should be carefully studied and evaluated prior to proposing an extension of this policy at EU level

- Since 2005, water markets became more frequent in Spain, although traded volumes represented less than 1% of all consumptive uses in one year. The existence of informal water markets in Spain proves that there is a demand for the reallocation of water resources among users. The legislation that regulates water trading, unique in Europe, illustrates the compatibility of this economic instrument with the EU regulatory framework. There is a great diversity of types of water trading: water can be exchanged within agriculture; between agriculture and cities; with or without inter-basin transfers. Public water buy-backs from water agencies to farmers have also been used as a measure to achieve the good environmental status (Guadiana, Segura and Jucar basins). Trade involves both temporal lease and permanent transfer of water allocation (concessions or rights).Trade can concern full property rights (established before 1986) or concessions – showing that the issue of private appropriation of water and trade can be kept separate.

4.2 HOW TO IMPROVE WATER MARKET FUNCTIONING IN SPAIN?

The following issues should be considered to improve water markets in Spain:

- Water regulation should move towards a more flexible, agile and dynamic management system.
- There is a need of more transparency, more information (prices, exchanged volumes, participants).
- Previous knowledge of market operations by irrigators encourages market participation so the dissemination of information on market instrument can promote market participation.
- Formal and effective separation of water rights and allocations (following the Australian system).
- Remove the hierarchy of use priorities, except for minimum volumes or allotments for urban suppliers and ecosystems.
- Allow water exchanges based on the water consumed, avoiding the use of diverted volume or unused water rights.
- Adopt regulations for inter-basin and inter-regional trading, with the objective of reducing the political interference and arbitrariness.
- The Spanish normative banns non-right holders to purchase water rights, this is supported by WAU and Administration, although some permanent rights buyers would like put an end to this barrier.
- Implementation of new and more efficient market mechanisms: water option contracts and other more innovative contractual agreements.
- Farmers declare that Water user associations (WAUs) are the preferred agent to intermediate in the market suggesting that farmers cooperation is perceived as a safeguard for proper management of the water resources
- A key role should be attributed to Water Users' Association to develop agricultural water market. Such farmers self-organizing institutions should be enhanced as a system to improve governance following an scheme of nested levels of decision making in the water resources management. In this sense, a community based approach is encouraged.

4.3 ARE PRE-CONDITIONS TO THE ESTABLISHMENT OF WATER MARKETS MET IN EUROPE?

- **In France**, investigations conducted as part of this project have mainly focused on water market scenarios within agriculture; evidences from case studies suggest that preconditions to establishing such agricultural water markets are not met:
    - In basins characterized by tensions over water use, resource augmentation (inter-basin transfers, small scale reservoirs) often remains an affordable solution that will be preferred to trading in the medium term; this situation will last as long resource augmentation will continue benefiting from public subsidies; overall, we consider that the water scarcity condition is thus not met.
    - The global "cap" is still contested, in particular in groundwater basins where insufficient scientific knowledge underpins its calculation. Potential market participants would thus

prefer investing time and money in lobbying activities aiming at increasing the cap rather than engaging into water trading.

- Individual water quotas which are currently being established in some French basins and allocated to farmers are not properly defined (weak legal foundation). Quotas are also not properly enforced (illegal abstraction points and metering problem). In addition, the "use it or lose it" rule represents a serious barrier to trade.
- Basins where demand outweighs available resources are those where storage and transfer infrastructure is inexistent or limited. There, yearly water allocation is highly uncertain (inter-annual and intra-annual variability), which reduces the potential for trading.
- In basins equipped with multipurpose reservoirs, water trade could possibly take place between hydropower, agriculture and urban users. Such water market scenarios should be investigated in future research.

- **In Italy**, the social/political context in which water markets are discussed is generally opposing the establishment of water markets in Italy.
  - The 2011 referendum on the introduction of private capitals in the ownership of the water utilities further exacerbates this situation and makes difficult to build scientific discussions on the topic. However, due to the recent drought events, it seems that stakeholders closers to the agricultural sector are exploring the whole set of possible institutional arrangements for the management of water irrigation, including water markets.
  - Water markets need a set of technical and legal conditions that are not met in the Italian context. From a legal perspective, in the Italian legislation water is a publicly owned. Water use rights are requested and granted through concessions. Water remains a non-tradable item. Water market would require a substantial change in the definition of the content of the concessions.
  - Moreover, one of the preconditions for water markets is the establishment of a "cap" on water uses. In the current situation, most of the concessions are not monitored on a quantitative basis, so that there is no legal definition of the cap (though in many areas there exist a de facto cap in the irrigation season). Also, in many instances there is no monitoring on the status of the resource, so that is not possible to quantify a reasonable cap. These technical deficiencies are to be covered before any institutional reform toward the introduction of water markets

4.4 HOW DO STAKEHOLDERS PERCEIVE WATER TRADING MECHANISMS?

- In France and Italy, a majority of stakeholders tend to oppose to water trading on ethical or ideological grounds. Water trading is often assimilated to water privatization. This triggers strong opposition since water has a legal status of public trust in both countries. The opposition is particularly strong in the agricultural sector where farmers fear that increased competition for water would weaken agricultural solidarity and cooperative behaviours and lead to the

concentration of water rights. This opposition strongly undermines the acceptability of this instrument.

- The situation is much different in Spain although a similar opposition has been reported after water trading was officially allowed 15 years ago.

    - There has never been much opposition to exchanging options amongst water right-holders. But some influential civil and environmental NGOs, as well as academicians have expressed serious reserves or even clear opposition. Most experts agree on the potential of water markets in Spain, but many suggest that the regulatory framework should be improved.

    - Although participation to water markets remains very limited, a significant proportion of farmers interviewed during the project declare that they would be willing to participate to water markets. Water trade favourable attitude increase in innovative, educated and high value crops orientated farmers. A majority of stakeholders favour seasonal markets (rights remain linked to the land) meanwhile permanent sales are expected to be scarce. Trade behaviour regarding attitude to buy or sell and expected price (willingness to pay and accept) depends upon hydrological conditions (drought versus normal year).

4.5 WHAT ECONOMIC GAINS CAN BE EXPECTED FROM WATER TRADING?

- Various economic models were developed in the project to assess how water trading would help increasing social welfare.

    - In Guadalquivir, mathematical programming models results in a unrealistic high volume of trade probably justified by the need to explicitly include transaction cost in the model of market behaviour. Therefore a survey was used to estimate stated willingness to buy and sell. Based on farmer responses, an estimated volume between 2 and 4% of Guadalquivir water resources will be traded with prices around The equilibrium market price increases from 0.17 EUR/m^3 in the baseline scenario to 0.21 EUR/m^3 under drought conditions. These results are in line with observed market prices during 2006-2007 (around 0.18 €/m^3)

    - In Tajo-Segura, the existence of an inter-basin water spot market during drought periods from irrigation districts of the Tagus Basin (sellers) to irrigation districts in the Segura Basin (buyers) can increase the mean economic result of the whole Tagus-Segura system by a 3.5%. But in a more stable risk-sharing agreement, in which transfers are contingent on the storage in the Tagus sector, the benefits would be about 11.7%, net of the costs (opportunity and environmental) in the area-of-origin.
    - In Marais Poitevin (France), In Marais Poitevin (France), it was estimated that the establishment of water trading could result in an increase of agricultural gross margin under 1%.

- In the Italian case study, economic model simulations indicate that water markets could increase agricultural gross margins by 2 – 3 %. The simulations however might underestimate these values since they have a medium term horizon, and the models are based on simplification of the heterogeneity of the water productivity across farms in the given area
- In Hérault, it is estimated that the development of a market for water conservation certificates, specifically targeting the urban sector, would allow decreasing by 30% the cost of meeting the environmental objectives of the Water Framework Directive. This estimate however does not consider transaction costs which might significantly reduce trade potential.

- The issue of transaction cost emerges as a complex one with some institutional and technical concepts acting as a 'barrier', i.e. a insurmountable transaction cost for some farmers. Additional research is required to gain knowledge in this issue.

4.6 WM, A RESPONSE TO DROUGHT?

- Water markets should be considered as part of the tool box to cope with drought situations.
  a. Results of surveys conducted with farmers in the Guadalquivir basin and in Andalucía indicate that the number of farmers willing to purchase or sell, and the price are influenced by the perceived climatic conditions (draught versus normal year). Water trade and prices increase in drought years confirming that it may be an instrument that contributes to reduce economic losses and improves efficiency in water allocation. In drought, uncertainty about the water allocation and the establishment of the drought protocol can be a significant barrier to market development.
  b. The Tajo-Segura case study shows that water option contracts have a significant risk-reduction potential in comparison with spot purchases. An option contract gives the holder the right to acquire a prearranged water volume if needed, paying to the seller a premium at the beginning of the year. There are a lot of benefits derived from this type of contracts. Among them, the reduction of transaction costs; less regulatory requirements than permanent transfers; more certainty about the amount of water available in each irrigation season; provides reliability independently from the water rights owned; gives farmers opportunity to budget their costs and plant crops early in the season knowing that water will be available later at a given or even cheaper price; and secures urban drought water supplies at a lower cost than water rights purchases while maintaining agricultural production. The gains from trade are on average higher when options can be traded.
  c. The establishment of water banks also represents an interesting option to cope with drought risks. Experimented in Spain, this approach consists of having public institution buying water back from water right holders (mainly farmers) and reallocating it to high priority urban or environmental uses.

CONTACTS

BRGM (French Geological Survey), project coordinator

Dr. Jean-Daniel Rinaudo
Water, environment and ecotechnologies department
BRGM (French Geological Survey)
Montpellier, France. Ph +33 4 67 15 79 90
Jd.rinaudo@brgm.fr

ACTeon

Dr. Fabienne Kervarec
ACTeon - Bureau de Nantes : 09.77.21.95.95
f.kervarec@acteon-environment.eu

IRSTEA

Dr. Marielle Montginoul
Irstea, UMR G-Eau
361 rue JF Breton - BP5095 - 34196 Montpellier cedex 5
Tel : 04 67 04 63 04
Marielle.montginoul@irstea.fr

UNIBO

Prof. Davide Viaggi,
Department of Agricultural Sciences (DipSA),
University of Bologna
Viale Fanin, 50 - 40127 BOLOGNA (ITALY) tel. +390512096114
davide.viaggi@unibo.it

UPM

Prof. Alberto Garrido, Subdirector
Research Centre for the Management of Agricultural and Environmental Risks, CEIGRAM
Department of Agricultural Economics and Social Sciences
Universidad Politécnica de Madrid
E.T.S. Ingenieros Agrónomos
Avda. Complutense s/n. 28040 Madrid ph: +34-91-4524900 (Ext. 1913)
alberto.garrido@upm.es

UCO

Prof. Julio Berbel
Universidad de Cordoba
Campus de Rabanales / Edificio C5
14014 Cordoba tel 957218457;
berbel@uco.es