Chapter 7
Water Markets in Spain: Meeting Twenty-First Century Challenges with Twentieth Century Regulations

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Abstract Water scarcity is a growing reality in many Spanish basins which creates the need for more flexible and efficient market-based allocation instruments. This chapter critically analyzes water markets' strengths and weaknesses, evaluates some recent trading experiences, and assesses some recent reforms in the Spanish water legislation. Formal and informal trading, and variants in between, have facilitated temporary and permanent water exchanges, with and without explicit support of public agencies. Based on our analyses and other literature findings, we propose a number of reforms that we consider necessary to upgrade water markets in Spain, including some innovations such as optioning rights, and quality-graded water exchanges.

Keywords Water markets • Spain • Market reform • Informal trading • Trade barriers

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7.1 Introduction

Water scarcity is a reality in many Spanish basins, and it will be exacerbated in the foreseen future by climate change and increasing water demands. This creates the need for more flexible and efficient market-based allocation instruments (Stefano and Llamas 2012). Markets facilitate the reallocation of water resources among users, improving water use efficiency and allocating water to high-value uses.

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. 2012a). 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 (see Fig. 7.1) 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. This chapter also reviews the informal or quasi-informal water trading in Spain.

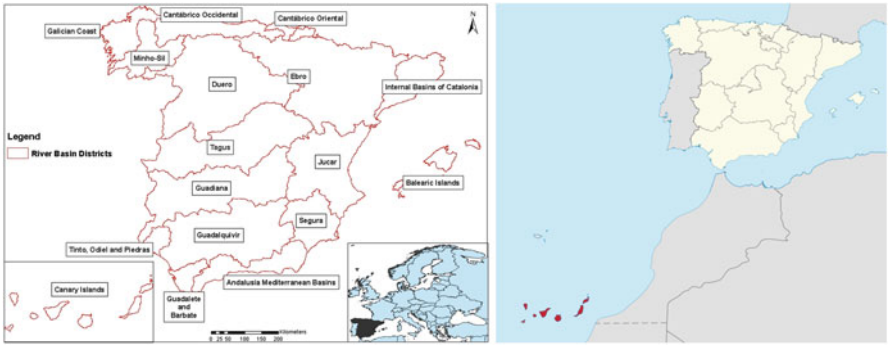

Fig. 7.1 Spanish river basins (*left*), including the canaries (*right*)

Under this diverse institutional landscape, the threat of climate change gives support to the development of water supply policies and institutions that are sufficiently flexible, adaptive, and robust to deal with an uncertain and changing water future (Adler 2009). According to the CEDEX (2011), precipitation will decrease in Spain by 7–14 % between 2010 and 2040 depending on the GHG emission scenario considered. In semiarid areas, decreases in available water resources may be equivalent to 50 % of the potential resource in Iberia (Iglesias et al. 2005; Moreno 2005; Garrido et al. 2012b). Water reallocation is seen as one pillar of water demand management, making a better use of existing resources as opposed to supply augmentation options (Molle and Berkoff 2006).

This chapter claims that the institutional design of water markets should be improved and new types of trading mechanisms should be developed in order to overcome the drawbacks of the current water market regulation. We proceed with a short review of the Spanish water market regulations and their most recent reforms. Then, the chapter summarizes all of the different trading formats and approaches, which have been recently documented in the literature (Ariño and Sastre 2009; Garrido et al. 2012a, 2013), including "informal" exchanges (Hernández-Mora and De Stefano 2013); and analyzes the causes of low participation in the market. At the end, some recommendations and conclusions are provided, that could be applied in Spain and other countries facing similar water scarcity problems.

7.2 Water Market Legislation in Spain

7.2.1 General Approach[1]

In Spain, there are public and private water rights. Public water rights are concessions granted by the Water Authorities for 30–75 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.

[1]This section borrows heavily from other authors' work (Garrido et al. 2012a).

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.

There are various types of barriers to exchanging water rights: market regulation barriers, barriers related to water rights' definition, institutional barriers, and environmental barriers. All of them make trading activity quite difficult by raising transaction costs as well as preventing certain types of trades. In Sect. 7.4, this issue is analyzed in depth.

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.

Initiated by the RBAs, water banks are set up as public tenders for interested right-holders who are willing to relinquish their water rights temporally or for the remaining maturity period. The bank's water supply operation involves procuring volumes from voluntary sellers, and making them available for other users and uses, including environmental restoration purposes. They may also acquire permanent water rights. Water Banks are supposed to be administered by the RBAs and operate in exceptional situations of drought or overexploitation of aquifers (WWF 2005). In practice, these *water exchange centers* have only functioned as buyers of water concessions or leased water use rights just for 1 year. Water has not been sold to other users. Instead, purchased water has been made available to other users in the form of new water concessions or devoted to maintaining environmental river flows and/or raising water tables in overdrafted aquifers.

There is a great diversity in the ways exchanging systems have evolved since the 1970s, primarily in the most water stressed areas (Segura and Jucar basins and the eastern part of the Andalusian Mediterranean Basins[2]). In Sect. 7.3, we provide a realistic overview of water markets and trading in Spain, including formal and informal trading, and the middle ground between the two.

7.2.2 Subsequent Reforms

At the national level, the last reform of the Spanish Water Law of May 2012 highlights the need to simplify and accelerate the administrative procedures, and to add more flexibility and efficiency to the water management system. The reform focuses mainly on groundwater resources. It proposed several measures to deal with water availability problems, including the encouragement of transformation of private water rights into public water concessions. Although this reform is meant to improve water management, there are also some details that could threaten groundwater resources sustainability, and be in breach of the mandates of the European Union Water Framework Directive (WFD), one of which is to avoid any further deterioration of a water body already heavily damaged. The new regulation establishes the possibility of recharging aquifers with external water resources in order to avoid the risk of not achieving a good quantitative status for these aquifers. This could potentially persuade water users that the best solution for declining groundwater tables is always to provide external resources, and thus it is not necessary to change the exploitation rate of aquifers. Also, the Reform grants new water concessions under certain circumstances in groundwater reservoirs at risk, which presumably will cause a higher overexploitation of groundwater resources.

The regional government of Andalusia passed more advanced legislation in 2010. This new Andalusian Water Law includes some differences from the National Law that result in more flexible trading mechanisms. However, the water market regulation in Andalusia is only applicable in the Andalusian Mediterranean Basins

[2]The Andalusian Mediterranean Basins are a series of basins on the southern Mediterranean coast of Spain that are completely within the boundaries of Andalusia and thus water management is the responsibility of the Regional Government of Andalusia. The Spanish Mediterranean basins include the Analusian Mediterranean Basins, the Segura basin, the Júcar basin, the Ebro basin and the Catalonian Internal basins (basins on the Mediterranean coast that are completely within the boundaries of Catalonia). The Andalusia region has other basins that are on the Atlantic coast including the Guadalquivir and Guadiana basins that empty into the Atlantic. The Guadalquivir basin includes territories in three regions different from Andalusia. More than 80 % of the Guadalquivir basin is in Andalusia and its climate is markedly Mediterranean but it is not included in the Mediterranean basin.

Table 7.1 Main differences between the National Law and the Andalusian Law related to water markets

Andalusian Law[a]	National Law
Agriculture, industry and tourism are considered at the same level in the water uses priority range	Agriculture is in a higher level, so farmers cannot sell their water rights for industrial or touristic activities
Water Banks are conceived as a mechanism to trade water under every circumstance	Water Banks are conceived as a mechanism to trade water only during drought periods
For acquiring water through a water bank, there is no need to be a water user with formal rights	Only users with formal water rights have access to the Water Bank or to purchase from other user

Source: Authors' elaboration

[a]The Andalusian Water Law take precedent over the National Law only in the basins that are contained entirely within Andalusia's borders as its regional government has jurisdiction over all water management in these basins

(see Fig. 7.1). The main innovations introduced by this reform are summarized in Table 7.1.[3] This approach could hopefully serve as a precedent for future amendments to the market regulation in the rest of Spain.

The differences in the Andalusian Law from the National Law provide flexibility for the water market system, allowing farmers (the main water rights holders) to sell water to industries, renewable energy plants (thermo-solar installations) or to the tourist sector. The most relevant criterion to determine the priority among these uses are: the impact on sustainability of the resource, maintenance of territorial cohesion and the higher added value in terms of job and wealth creation for the region. As in the National legislation, the Andalusian Law always guarantees the primary water requirements for the urban sector, and also for environmental purposes in order to achieve a good ecological status for all water bodies.

Water banks are considered an important tool not only for solving drought or environmental problems in Andalusia, but also to create a water stock for future purposes, to sell water use rights to users for a given price, and to avoid imbalances in the distribution of water resources. Through water banks the regional government can make offers for public purchase of rights, and expropriate or revise water concessions. The possibility of purchasing water through the water bank without previously being a right holder allows users facing new emerging water demands to obtain water. Currently there is an initiative to establish three water banks in three different basins in Andalusia.

[3]BOJA num. 155. Law 9/2010, July 30th. Andalusian Water Law.

7.3 Overview and Evaluation of Past Experiences

Two canonical water trading formats exist in Spain: one involves right holders exchanging registered water rights, using formal procedures and in full compliance with water law. The other canonical extreme involves two agents (persons or firms) agreeing verbally on purchasing a given volume pumped from an unregistered and unapproved borehole, leaving no written document or contract. This is the typical illegal type of exchange (no permit to pump, no water right, no records). This other extreme could also require, in some cases, the use of a pipe that connects points several kilometers away from each other. There are all kinds of middle ground in between these two extremes (formal and informal). Figure 7.2 attempts to sketch them out.

While formal trading has been thoroughly documented in the literature, very little has been published about the different types of informal trading. We will review some of the formats that have been documented in the gray literature or found in the authors' own field work.

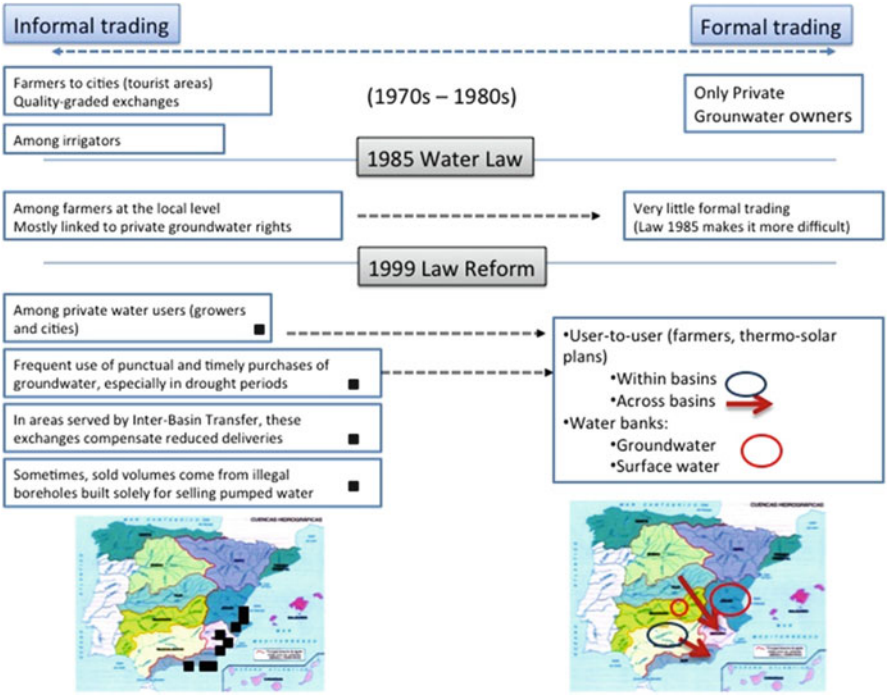

Fig. 7.2 Formal and informal trading in Spain (Source: authors' elaboration)

7.3.1 Formal Trading Mechanisms

Under this heading we review trading mechanisms that are situated on the extreme right, or close to it, in Fig. 7.2. Note, however, that two arrows connect trading schemes that begin on the left, (informal qualification) and end up being on the right side. These involve exchanges that are initiated and made effective without any legal support, but eventually are filed with the water authority and adjudicated. We are not aware of any reverse changes in trading format from right to the left.

7.3.1.1 Bilateral Agreements

The number of formal lease contracts were expected to increase significantly upon the approval of the 1999 Reform, especially between different areas of the same basin, but in practice they declined significantly. Temporary leases are predominant, whereas permanent exchanges of water rights are less common. Irrigation districts have been the main water sellers, with other districts, urban suppliers and thermo solar plants being the main purchasers. In general, prices have been high because most exchanges have occurred during drought periods, when water supply is low and demand is high.

One of the most important experiences in terms of traded volume was in the Tagus Basin in 2002, between a large urban retailer (*Mancomunidad de Canales del Sorbe,* buyer) and the irrigation district of *Canal de Henares* (seller). Twenty hm^3 were transferred at a fixed cost of 38,000 €/year, plus a volumetric charge of 0.04 €/m^3 for the first 4 hm^3 and 0.02 €/m^3 for the remaining 16 hm^3. In the Segura Basin, 35 formal lease contracts were authorized between 2000 and 2005, for a total volume of 10.1 hm^3, less than 1 % of total annual water consumption in the basin (Calatrava and Gómez-Ramos 2009). In the Guadalquivir Basin, several exchanges were approved that included just one right-holder permuting his rights from the lower basin (with higher salinity concentration) with his rights in the upper basin. As a result, more water is used in the upper sections of the basin, affecting water users downstream (Garrido et al. 2012a).

During the 2005–2008 drought period inter-basin exchanges were explicitly allowed[4] (see red arrows on the right-hand-side of the map of Spain, Fig. 7.2). There are two important aqueducts that enabled these exchanges: the Tagus-Segura Transfer (connecting the Tagus Basin in central Spain and the Segura Basin in southeastern Spain) and the Negratín-Almanzora Transfer (between the Upper Guadalquivir Basin and the Almanzora Basin in Almería, southeastern Spain). During these 3 years several exchanges took place, transferring water from the Tagus and the Guadalquivir basins to the Segura and Almanzora basins respectively.

[4]This required four annual Royal Decrees that permitted inter-basin exchanges, using pre-existing infrastructures, on the basis of drought situations in the recipient basins (Segura, Júcar and Andalusian Mediterranean Basins).

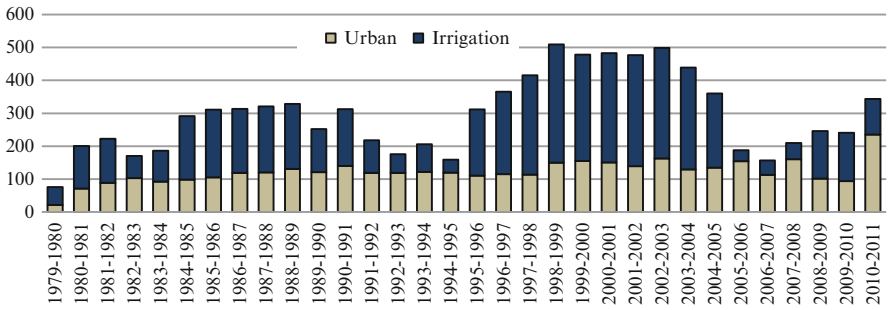

Fig. 7.3 Transferred water volume (hm^3) for irrigators and urban suppliers through the Tagus-Segura transfer, 1979–2011 (Source: San Martín 2011)

These were annual agreements for specified volumes, at prices net of transportation costs that ranged from 0.15 to 0.28 €/m^3. The severe drought situation that the country was suffering at that time led the Government to allow water users to use the aqueduct for these exchanges without paying any transportation fee (Garrido et al. 2012a). In the case of the Tagus-Segura Transfer, sellers were farmers from the Tagus Basin, and buyers were the major urban water supplier in the Segura Basin (Taibilla's Canals Commonwealth, *Mancomunidad de Canales del Taibilla)*, and the Central Association of the Irrigators of the Tagus-Segura Aqueduct (*Sindicato Central de Regantes del Acueducto Tajo-Segura*) (Garrido et al. 2012a).

In the Segura Basin, several large irrigation districts and a majority of municipalities depend on the water resources from the Tagus Basin, delivered through the Inter-basin Tagus-Segura Transfer,[5] which it is not a water market, but rather an institutional arrangement between both basins. The transferred volumes through this Aqueduct vary considerably from year to year, as they depend on the stock level in *Entrepeñas-Buendía* reservoir in the Upper Tagus Basin. One market driver with profound effects is the instability of these transferred volumes (see Fig. 7.3). In fact, short falls in deliveries were compensated for, in part, by water purchases referred to above in Sect. 7.3.1.1.

7.3.1.2 Water Banks

The 1999 Reform of the Water Law established the option of creating publicly run and administered water banks. Normally, water banks in Spain have been established to solve environmental problems. This was the case in Guadiana, Jucar and Segura basins, where water banks had different budgets, features, procedures and results (Garrido et al. 2012a). The Jucar and Segura water exchange centers did

[5]The Tagus-Segura Transfer also serves users in the Andalusian Mediterranean Basins and the Jucar Basin.

not meet their purchasing objectives, as there were not enough bidders to cover the entire budget and target volumes. In the case of Jucar, only 77.9 hm^3 (the target was 100 hm^3) were purchased between 2006 and 2008, at a cost of between 0.13 and 0.19 €/m^3.

Despite the large budget spent, the Upper Guadiana Water Bank was not well managed and did not provide the expected results (WWF 2012). This Water Bank was established under the "Special Plan of the Upper Guadiana", approved in 2008, as the primary instrument to solve the environmental problems caused by the overexploitation of one aquifer, which significantly affected the remarkable wetlands in the *Tablas de Daimiel* National Park (Martínez-Santos et al. 2008; Llamas et al. 2010). Its goal was to acquire water rights to reduce pumping rates by 250 million m^3 by 2027 and raise the aquifer's water table (Garrido et al. 2012a). The initial idea was to purchase water rights to be re-allocated to other farmers (30 %) and to the environment (70 %) (López-Gunn et al. 2012).

Although this Special Plan established several requirements and conditions for the performance of the Water Bank (defined a priority area near the aquifer, only allowed farmers that had been using water for the last 3 years to sell their rights, etc.), the truth is that these conditions were not always applied. This impeded the achievement of a better ecological status for the aquifer, and even increased water consumption in some cases. According to WWF (2012), groundwater extractions have only been reduced in 1.1 hm^3 at a cost of around 6 million euros in public funds.

7.3.2 Informal Trading

The combination of scarcity, intensive agricultural production and the urban expansion to accommodate newcomers and tourist capacity has provided the ideal conditions for "informal" water exchanges. Before and after 1999, informal water exchanges at the local level have taken place frequently in many Spanish basins, primarily in East and Southeast Mediterranean areas (Segura, Jucar and Mediterranean Andalusian Basins; Fig. 7.2).

Transactions normally occur when water scarcity problems arise and water users need a rapid solution in order to obtain enough water to irrigate tree crops or to supply other critical water uses. Water exchanged in these informal markets usually comes from groundwater sources and mostly from private groundwater rights. The price in this type of exchanges is quite high compared to formal lease contracts and public purchases, and is often of a speculative nature. The prices also vary by location, water quality, alternative sources of supply and, to a larger extent, the scarcity level. Prices have been documented to reach 0.7 €/m^3, although in general there will always be a ceiling marked by the charges for desalinized water, plus the transportation costs (0.33 €/m^3 in coastal areas, and 0.39 €/m^3 in inland areas, with a total of 0.45–0.47 €/m^3 at the point of use), in those coastal areas where the resources are available. Quality graded water fetches different market prices

with growers combining different sources to raise water quality to levels crops can tolerate. In addition, in some areas farmers or water companies desalinize deep saline groundwater, which is sometimes traded.[6] In some cases, water sold comes from illegal pumping.

It has been documented that even municipalities have participated in informal exchanges with farmers, mainly to meet the water demands derived from the tourist activity. That was the case of Benidorm (Alicante), with a seasonal population of 400,000 inhabitants and a regular one of 70,000. The resulting agreement was to swap fresh sources originally owned by horticulturalists for treated urban waste water (Martí 2005). In some cases, informal exchanges eventually become legalized or exchanged rights adjudicated by the Water Agency.

7.3.3 The Case of the Canary Islands

A very emblematic case of Spanish water markets is the one in the Canary Islands. This market has been active for a very long time, mainly for groundwater resources, and it is seen as an example of efficiency. Despite this, Canaries' water trading system has some problems and abuses: water is concentrated in a few hands (which determine the price and the conditions of the exchanges); there is a lack of transparency and information; water quality is not guaranteed by pipe owners and the owners are not responsible for water losses (Aguilera-Klink and Sánchez García 2005; Custodio and Cabrera 2012).

Some buyers prefer to purchase public water rather than private water, even when the price is higher than the price of private water in the market, mainly because it is more reliable, water quality is higher, and there are no charges for water lost in conveyance (Custodio 2011). Prices paid for irrigation water during high-demand periods can reach or exceed the price of seawater desalination; so only very competitive water users with high valued uses can afford to purchase it (Custodio and Cabrera 2012). However, the water market plays an important role for some agricultural areas and cities when there is no other available water source and it encourages economic and social development in the islands (Custodio 2011).

[6] A distinction has to be made between desalination of brackish waters and desalination of sea water. In some coastal areas of Southeast Spain, individual farmers (commonly larger ones) desalinize and use deep brackish water, about which hardly any reliable documentation can be found. Eventually, in drought periods, some of these volumes are sold in informal markets, mostly to smaller farmers that have shallower wells and no desalinization facilities. There are also water companies that sell desalinized/brackish water. We only know of one irrigation district desalinizing brackish water, as districts in Southeast areas more commonly rely on desalinized sea water, when available, of which some information exists about cost, contracts, and volumes used.

7.3.4 Economics of Spanish Water Markets

Based on authors' experience and knowledge about Spanish water markets, we can conjecture that, in general, market prices for water in Spain have been closer to the willingness to pay of the buyer. Obviously such market prices have been advantageous for the involved parties and have, for the first time, given users signals regarding the water scarcity value. The price range has been 0.18–0.30 €/m^3, in moderate drought situations, net of transaction costs and in a wide geographical area from the Tagus Basin to the South of the Iberian Peninsula (Garrido et al. 2013).

No author has set out to evaluate the actual impact of water markets in Spain, although a number of studies obtained hypothetical evaluations of welfare gains under various market scenarios (Arriaza et al. 2002; Calatrava and Garrido 2005; Albiac et al. 2006; Gómez-Limón and Martínez 2006; Pujol et al. 2006; Blanco et al. 2010; Blanco and Viladrich 2013). As mentioned earlier, the bulk of traded volumes involved inter-basin transfers. Therefore, the net benefit of an exchanged cubic meter would result from deducting from its use value the transportation cost and the opportunity, resource and environmental costs in the area-of-origin.

Due to the heterogeneity of water productivity values, the different environmental status of water bodies, the different parties involved in the water exchanges (inter-sectoral or intra-sectoral; inter-basin or intra-basin), and the need for conveyance infrastructures, it is difficult to obtain a single assessment of the economic value of Spanish water markets. What follows is a discussion about the most important trading activity in the country, and the factors that should be considered to obtain a solid conclusion about the impact of water markets on the areas involved.

In inter-basin water exchanges, the impacts may be larger than those derived from intra-basin exchanges. Corominas (2011) analyzes the inter-basin trading activity through the Negratín-Almanzora Transfer (Andalusia). Buyers were farmers (citrus and horticultural crops) in the Almanzora Basin. Sellers were farmers in the Guadalquivir Basin growing annual crops including rice. The considerable difference in average water productivity of these two regions (0.25 €/m^3 in the selling area, 1.6 €/m^3 in the buying area) facilitated the agreement. In 2007 and 2008, 25 hm^3 were transferred at a price of 0.18 €/m^3. According to Corominas (2011), the water price range that would afford benefits for both water buyers and sellers in the Andalusian region would be, approximately, 0.15–0.35 €/m^3 (Corominas 2011). However, in some cases, 0.15 €/m^3 may not be enough to compensate sellers for their income losses derived from the water exchange. For a complete assessment of the impact of such water exchanges, some other factors should be taken into account, such as the environmental cost due to the transfer of water to another basin (0.005–0.0244 €/m^3 based on previous studies in different Spanish regions (Elorrieta et al. 2003; Ramajo and del Saz 2012)). In some cases the multiplier effect of any displaced agricultural activity in the area-of-origin of the water should also be included.

The other important inter-basin water exchanges in Spain took place through the Tagus-Segura Aqueduct during the drought period 2005–2009. The agreed prices for

the exchanges were 0.19–0.22 €/m^3 for irrigators. The marginal value of irrigation water in the Segura Basin was 0.52 €/m^3 (Calatrava and Martínez-Granados 2012), whereas in the Tagus Basin it was around 0.07 €/m^3. So, there is enough room for increasing the price paid by sellers in order to compensate for any negative effects in the Tagus Basin (area-of-origin of the water): environmental effects related to the transfer of water (see the above estimates), foregone value of unused and transferred water and hydropower opportunity costs (0.09 €/m^3 according to Hardy and Garrido 2010).

In the case of the Water Banks in the Jucar, Segura and Guadiana, the buyer was the River Basin Authority. The prices vary across the basins, depending on the water productivity in each region. As an example, in the Jucar Water Exchange Center, the compensation for farmers who sold the water in 2005–2008 was 0.13–0.19 €/m^3. Although the environmental flow value estimations are relatively low, the Administration is willing to pay the irrigators' WTA with the aim of reaching a good ecological status for reservoirs and guaranteeing minimum environmental flows.

For bilateral agreements between water users within the same basin, such as the lease contracts that took place in the Tagus Basin and in the Guadalquivir Basin (see Sect. 7.3.1.1), the differences in the value of water are smaller than between different basins. Those gains from trade are expected to be smaller, which explains the relatively reduced market activity within most basins. Still transportation costs and environmental impacts are also expected to be smaller but will depend on the location of sellers and buyers in each basin.

Another important economic benefit from water trading, especially between users in different basins, relates to the potential improvement in supply reliability. For example, in the Guadalquivir Basin, several studies show that farmers are interested in increasing their water supply reliability. According to Mesa-Jurado et al. (2012) olive trees irrigators in the Guadalbullon Sub-Basin (Guadalquivir Basin) are willing to increase by 10–20 % the community annual payment and also to reduce average water supply by 30 % of the water concession to increase their water supply guarantee. Their study shows a WTP for improving water supply reliability of 0.034–0.074 €/m^3. The opportunity costs related to the reduction of water allocation from 1,500 to 1,000 m^3/ha is 0.39 €/m^3. Besides, water users in this basin are willing to pay 0.01–0.015 €/m^3 for improving water quality (Martin-Ortega et al. 2009). In the Segura Basin, Rigby et al. (2010) estimates the willingness to pay of horticultural farmers in the coastal Campo de Cartagena irrigation district for an increase in the water supply reliability to range from 0.22 to 0.5 €/m^3.

The results derived from all these studies show that potential buyers are willing to pay considerable amounts of money to increase their water availability and to improve their water supply reliability, but not that much to improve the water quality of the rivers. The government, in contrast, is willing to devote public funds to recover resources for the environment (or at least was before the current economic crisis). Through the water market, buyers can obtain the desired water supply reliability, sellers can be well-compensated for transferring their water, and the environmental status of the water bodies can be improved thanks to Water Banks.

7.4 Reasons Behind Limited Success of Water Markets in Spain

Several reasons can explain the limited development of water markets in Spain. First, there are a number of restrictions and pre-requisites before a water exchange is approved that certainly add transaction costs and red tape (Garrido and Calatrava 2009). These are meant to avoid speculation and water rights hoarding, and to protect third-parties from negative effects; but result in low market activity.

There are a number of regulatory elements, identified by Ariño and Sastre (2009: 100–101), that can restrict the functioning of water markets including: (i) rights to consumptive uses cannot be sold to holders of non-consumptive use rights (hydropower) and vice versa; (ii) there are restrictions on potential water buyers, such as that rights can only be leased out to other rights holders of an equivalent or higher category in the order of preference established by river basin planning or in accordance with the National Water Act; (iii) there are limits to the spatial extent of trading: licenses for the use of public infrastructure connecting different river basin areas may only be authorized if they come under the National Hydrological Plan or other specific laws; (iv) there are limits on prices; regulations may determine maximum prices for water licenses. Competitive pricing can be superseded by administrative intervention. Unlike the Australian differentiation of entitlements and use rights, in Spain only a formal right, in the sense of entitlement, is defined. It was decided that the market should only be available for pre-existing and fully legally supported users.

Second, environmental limits are those enforced by public agencies responsible for the stewardship of the ecological quality of rivers and water bodies. In general, these limits, such as minimum environmental river flows, are based on modeling evidence, and are seldom contested. Occasionally, an *environmental tax* is imposed as a proportion of the volume/flow to which the traded right is entitled and which should be left in the natural source.

Third, most water in Spain is currently allocated through public water concessions, rather than private water rights, which still exist because their owners had rights before 1985. Water markets do not always work efficiently because water concessions were not designed for market transactions. Consider the situation of a drought. One would expect that shortages would trigger more market activity, but in fact water authorities effectively reduce the volumes accessible to the right-holders in areas facing scarcity, thereby reducing any incentive to purchase a water right. In a sense, the Agency still has a major role in allocating water under scarcity conditions. But decisions are agreed upon by all represented stakeholders, in meetings of formal committees with executive power. So the market is not deeply ingrained in Spanish water culture, and more collective responses to drought are common and widely accepted.

Again, this is not the case in Australia or in Chile. Moreover, there is also a problem of poorly defined water rights in some areas. It is not a coincidence that most of water trading in Spain has been inter-basin trading because scarcity

situations have been different across basins and buyers and sellers have been able to trade different percentages of the volume or flow established in their formal right.

Fourth, with some exceptions, the potential for water trading between users in the same basin is limited, as differences in willingness to pay/willingness to accept are usually not significant. In addition, inter-basin water trading has only been allowed in drought periods as an emergency relief tool. The largest exchanges of water in the 2005–2008 drought period took place among users in different basins (Sect. 7.3.1.1).

Fifth, a significant proportion of agricultural users are grouped in Water Users Associations (WUAs) that in Spain usually take the form of communal entities. If their users agree, the WUA can become the right-holder of all the resources assigned to their members individually, but this implies the termination of the individual water rights. Under this case, WUAs rather than individual farmers are the ones participating in water trading, and they are less likely to participate as sellers in a water market. Furthermore, decisions to buy or sell are taken in Assembly or Commissions, rather than individually.

Finally, in spite of the functioning of formal water markets for more than a decade in Spain, there are still uncertainties. Criteria for approving or denying applications for water exchanges are not clear. Consequently, market participants rely more on previous experience than on a clear public definition of the circumstances under which trading is allowed (origin of water, area of destination, tradable volumes, fees to be paid, environmental restrictions, etc.). Similarly, the potential for inter-basin markets is hampered by the uncertainty about whether or not the Spanish Government will allow exchanges.

These and other barriers to trade result in other markets taking the role of water markets. The market for agricultural land (lease or purchase) and informal water markets substitute, to some extent, for formal water trading with a significantly higher cost. Consider the real case of a thermo-solar power plant, which needs water for cooling and replenishing vapor losses. If its owners do not hold water rights, the only way they can obtain water is by purchasing irrigated land and its attached water rights, and then request a change of use from the water authority. Furthermore, technologies and management practices, both on-farm, on site and at the district levels, have had a significant impact on reducing water application rates in Spain and deterring consumption. The energy cost component in many areas with abundant surface water supplies, on top of the financial and operating costs of recently modernized districts, have increased irrigation cost by 400 % (Hardy et al. 2012).

7.5 Possible Reforms

There are a number of shortcomings in water markets found in the Spanish system as well as in other countries: high transaction costs, slow administrative procedures, difficulties in finding buyers/sellers, high prices, rigid legislation, etc.

(Garrido et al. 2012a). However, markets in Australia, US and Chile are much more liquid and agile. As mentioned before, traded volumes in the water market have never represented more than 1 % of all annual consumptive uses. Furthermore water markets are mainly used during drought periods, except for a few water bank initiatives launched by basin authorities to buy-out groundwater rights. In the following points we offer some insights and ideas that would improve the functioning of water markets in Spain.

7.5.1 Option Contracts

Some of these barriers that affect the water trading activity could be avoided with option contracts. A formalized 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 the establishment of this type of contracts. Among them, the reduction of transaction costs (Garrido and Gómez-Ramos 2009); less regulatory requirements than permanent transfers (Hansen et al. 2008); more certainty about the amount of water available in each irrigation season (Garrido and Gómez-Ramos 2009); 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 (Cui and Schreider 2009); and secures urban drought water supplies at a lower cost than water rights purchases while maintaining agricultural production (Michelsen and Young 1993). The gains from trade are on average higher when options can be traded, by 46 % in competitive markets and by 63 % in dominant buyer markets (Hansen et al. 2008). A group of stakeholders and experts were consulted about introducing option contracts in the Spanish water markets. All of them agreed on the idea that option contracts could solve some of the inefficiencies of the current system. Option contracts may allow basins and users to manage drought and shortage risks much more effectively than spot markets. (See Chap. 4 for discussion of U.S. option markets for water).

7.5.2 Water Saving Certificates

In order to increase water use efficiency, an interesting alternative is the creation of water savings certificates. The most efficient water users who do not have easy access to other water sources would pay the less efficient ones to reduce their water losses. For that, they would get extra water corresponding to the water volume saved. These arrangements could increase water use efficiency in a given river basin, have beneficial impacts in the long-term and could help the recovery of overexploited

aquifers (provided some of the conserved water is allowed to recharge the aquifer). For instance, the new Water Law in Peru foresees that users which individually or collectively obtain certificates of 'efficient use' are granted fee rebates and given preferential access to water in times of drought.

There are numerous ways with which saving certificates can be defined and measured. Satellite images and proper field records, coupled with the inspection of infrastructure and metering, can provide accurate evaluations of water consumption. Creating certificates is one indirect way to provide market incentives, without necessarily having market transactions, and would put the focus on the technical measurement of consumption by independent auditors. Moreover, it would also help in dissociating the notion of water right as a rigid formal right from the actual consumption, which is an hydraulic and environmental relevant variable.

7.5.3 Improvement of the Water Market Legislation

Based on the above, the regulatory framework of water markets in Spain needs profound reforms to make them more effective, secure and sustainable. Pending a serious legal assessment, we believe that the Water Law itself must be reformed. The following elements could help overcome its major weaknesses:

- Introduce a formal and effective separation of water rights and allocations, the latter being made also tradable (following the Australian system). This will require a redefinition of water rights in Spain (see Chaps. 9, 10 and 11 on Australia's water markets). This could be fostered indirectly with water savings certificates issued by independent technical auditors.
- Remove the hierarchy of use priorities, except for minimum volumes or allotments for urban suppliers and ecosystems. Once basic human and environmental needs are secured, the rest of economic or productive uses should have the same status. This will also require redefining water rights, and make the market more efficient and less distortive.
- Allow water exchanges only of the volume irretrievably lost from a given use, not of the total volume diverted. Irretrievable losses amount to water lost due to evaporation, crops' evapotranspiration or direct incorporation in manufactured products. Develop certification and statutory rules to ensure that this can be made effective.
- Adopt regulations for inter-basin and inter-regional trading, with the objective of reducing the political interference and arbitrariness. The idea is to define most possible contingencies and clarify when and how much water can be traded on pre-specified rules that all parties – users and administrations – commit to go by.
- Allow non-right holders to purchase water resources, removing an artificial impediment that prevents more efficient users from accessing water rights, which often is avoided by loopholes and costly paper work.

7.5.4 Water Management Improvements to Promote Efficient and Sustainable Water Markets

Some other improvements would not require a change in water legislation, but would certainly improve the functioning of water markets:

- Define and approve the major allocations for all water basins, finalizing the planning mandates of the Water Framework Directive (WFD),[7] including the environmental flow regimes and other restrictions. This would clarify, a lot, what amounts are subject to trade by all water rights holders at any given moment and location.
- Implement cost-recovery levels that are considered to be in full compliance with article 9 of the WFD. This would remove historical distortions that are no longer appropriate under current legislation in force concerning water prices.
- Ban any type of market operation request for users whose status falls short of being in full compliance with the Law, reducing concerns for spurious use of exchanging options.
- Implement a pre-registration and screening procedure for users interested in becoming market participants, with the intention to monitor and review market operations much more quickly. The idea is to implement a system in which pre-registered users can exchange water, and make the market operations more robust, agile and environmentally safe.

7.6 Conclusion

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.

[7]Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

After reviewing the latest reforms in the water legislation in Spain, it is clear that water regulation should move toward 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.

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