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Robust Institutions for Sustainable Water Markets: A Survey of the Literature and the Wav Forward

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Summary

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Keywords: New Institutional Economics, Robust Design Principles, Water Governance, Institutions, Water Markets

JEL Classification: B52, D23, Q25

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1. Introduction

Water markets have been developed around the world as an instrument to deal with water scarcity problems and improve water allocation among users. Examples of countries where water markets have been studied include USA, Australia, Chile, Spain, South Africa and China (for more information see Mole and Berkoff, 2009; Grafton et al. 2010; Calatrava et al., 2012; and Zetland, 2011). There are different types of water markets which Calatrava et al. (2012) summarize as follows: *agricultural*, i.e. transfer of water to high-value crops, *inter-basin* (exceptionally allowed and controversial in Spain) *and inter-sector*, i.e. trade between users in different sectors such as agricultural, urban, industrial/energy, environmental. Inter-sector water trading schemes have been implemented in South-Western USA entailing water trading from agricultural to urban, in Australia from agricultural to government with the purchase of water from farmers to comply with environmental standards and recently in South Spain, from agricultural to energy. Other forms of water markets include groundwater, involving trading of abstraction rights instead of water itself (e.g. the establishment of national groundwater framework in Australia), and water supply options contracts by virtue of which one user accepts to reserve a share of his quota and to sell it to other user who might need it if certain conditions hold, for instance in drought periods.

As water markets in different countries function under different rules and mechanisms, it is difficult to conclude about their advantages and disadvantages. However, WWF (2007) (cited in Rey et al (2012)) attempts to summarise the main advantages of water markets in ensuring the allocation of water to the highest value use, providing incentives to users for water preservation and making possible additional water available for the environment without reducing the overall economic activity. On the other hand, water markets are faced with some difficulties, substantially varying in transactional costs and access to information due to discrepancies in income levels and access to capital. Other difficulties which can affect the functioning of water markets include third party effects and the fact that water markets for water rights are often not as active as spot markets.

Many past studies evaluated the costs and benefits from water trading schemes. For instance, (Bjornlund, 2006) in Australia allocation markets have been used to manage uncertainty and risk within and between seasons, while entitlement markets have been used to adjust irrigators' risk position in the long term, resulting in subsequent use of the allocation market to manage this new risk position. Furthermore, Brooks and Harris (2008) stated that water trading in Victoria's Watermove program generates substantial economic benefits, and the gains achieved might provide guidance on markets

mechanisms for other countries. Efficiency gains in Watermove reflect the reallocation of water from low to high valued uses, promoting structural adjustment in the agricultural sector as inefficient farmers exit it. More recently, Zetland (2011) has provided an overview of the water markets for water quantity and quality in Europe, which are underdeveloped due to difficulties in their implementation driven by institutional constraints and high transaction costs. Adler (2009) underlined the importance of global climate change and pressure on water resources and availability in the development of water markets. The author stated that a gradual change toward water marketing and market pricing will improve the management of water supplies, guarantee more efficient allocation of available supplies, and encourage cost effective conservation measures, thereby mitigating the impact of climate change on supplies and availability. However, Matthews (2004) argues that water markets do not function efficiently as water property rights were not designed for market transactions. The author raises several issues regarding the structure of a water right system driven by the experience in the western United States. Several recommendations for understanding the structure of property rights include the separation of water rights from land, registration of water rights for a certain period and well-specified rules for transferable water rights. Another study by Grafton et al. (2010) employed an integrated framework to assess and compare the institutional foundations, economic efficiency and environmental sustainability of water markets in Australia, the western US, Chile, South Africa and China and suggested that effective institutional arrangements and allocative mechanisms are of great importance for a well-functioning water market.

This paper discusses a framework for analysing robust institutions for water markets drawn on the new institutional economics school of thoughts which is based on Williamson, North, Coase and Ostrom theories on transaction cost economics, property rights and collective actions. Based on these theories, we review the evolution and development of water reforms and markets in countries such as Australia, USA, Chile, and in Spain. The reason for choosing these overseas countries is that there is considerable empirical evidence and research on the evolution of water markers, which allows us to identify costs and benefits, advantages and disadvantages of introducing and developing of water markets. We chose Spain as our country of study from Europe due to the fact that the absence of robust water governance and effective surveillance does not allow water markets to be efficient and socially accepted (Garrido et al. 2012). Based on the lessons learned from the Spanish and international review a list of robust recommendations for the improvement of water markets in Spain is provided, followed by a discussion on the development of a robust water governance model based on Sharma's approach

(2012). Even limited in scope, the review will provide an important insight on how water markets have been evolving so far and how they could be further developed to be environmentally, socially and economically accepted.

This paper unfolds as follows. Section 2 provides a brief definition of the new institutional economics approach followed by a discussion on the design of robust principles for governing resources in a sustainable way. Section 3 provides an example of the application of such approaches in the evolution of water markets in the Murray-Darling basin (Australia), in California and Colorado (USA), Chile and in Tagus river basin (Spain). Section 4 discusses a list of robust recommendations for improving water markets in Spain followed by the introduction of an effective water governance model for this country. The final section concludes.

2. The New Institutional Economics Approach

2.1 Theory

The New Institutional Economics (NIE) approach builds of two schools of thoughts: the neo-classical economics and the institutional analysis. Under NIE, some of the unrealistic assumptions of neo-classical economics (such as perfect information, zero transaction costs, full rationality) are relaxed, but the assumption of self-seeking individuals attempting to maximize an objective function subject to constraints still holds (Sharma, 2012, Libecap, 2006, Kherallah and Kirsten, 2001). The additional constraint that NIE assumes is that institutions matter for economic performance. The institutional analysis refers to a set of formal (e.g. laws, contracts, political systems, organizations, markets, etc) and informal rules of conduct (e.g. traditions, norms, customs, sociological trends etc) that facilitate coordination or govern relationships between individuals (Kherallah and Kirsten, 2001). Therefore, the NIE (Figure 1) suggests that economic activities are embedded in a framework of informal and formal institutions, and its purpose is to explain the determinants of institutions and their evolution over time, and to evaluate their impact on economic performance, efficiency and distributions (Nabli and Nugent, 1989).

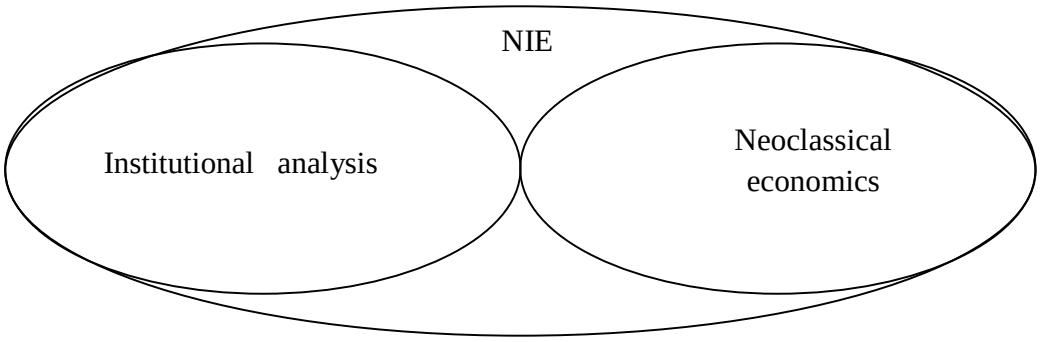

Figure 1.The New Institutional Economics Approach

Being a multi-disciplinary approach, NIE has several branches (Figure 2). These expand from new economic history and public choice & political economy (macro-level analysis) to transaction economics, theory of collective action and law and economics (micro-analysis) (for a more comprehensive definition of the NIE branches see Kherallah and Kirsten, 2001). Three components are of great significance in the NIE approach and are the focus of this study: i) the transaction costs economics, ii) property rights, and iii) collective actions. Transaction costs are defined as the costs of screening and selecting a buyer or seller, the costs of negotiating, monitoring or enforcing a contract (Coase, 1937) and, if ignored, can reduce the efficiency of economic activities. A major effect of good institutions is therefore to reduce transaction costs. According to North (1997), the major challenge is to evolve institutions in which firstly, the transaction costs are minimized and secondly, the incentives favour cooperative solution, in which cumulative experiences and collective learning are best utilized (Gandhi and Crase, 2009). In the same line of thinking with Coase and North, Williamson suggested that a trade-off has to be made between the costs of coordination and hierarchy within an organization, and the costs of transacting and forming contracts in the market. This trade-off will depend on the magnitude of transaction costs (Kherallah and Kirsten, 2001).

With transaction costs, property rights play an important role for efficiency. According to J.R. Commons (1957) property rights define relationships among people regarding things (Schlager, 2005). Schlager and Ostrom (1992) defined five types of property rights, *the rights of access*, i.e. to enter a defined physical property, *the rights of withdrawal*, i.e. to obtain the products of a resource, *the rights of management*, i.e. to regulate how to use and improve the resource, *the rights of exclusion*, i.e. to determine who enters the resource, and *the rights of transfer*, i.e. to sell, lease, or leave the resource

(Schlager, 2005). If property rights are not well defined then transaction costs can be high. As a result, good institutions need to minimize the transaction costs of renegotiations so that a new level of efficient equilibrium of resource-use can be achieved (Coase, 1960). The importance of property rights in relation to specific goals in water management issues was underlined by Bruns et al. (2005). After reviewing the water property rights reform in six countries, they concluded that the use of property rights as tools for more equitable, sustainable, and efficient water management requires better sequencing of reforms, redesigning institutions for participatory water governance, resolving tenure rights, and developing equitable arrangements for regulating transfers.

Moreover, the NIE approach takes into account the theory of collective action mainly driven by Ostrom's work (1990). Ostrom (1990, 1994) underlined that the institutions and institutional structures developed by individuals, groups and governments to organize human activities influence the outcome of managing "common pool resources" (CPRs) (Biswas and Venkatachalam, 2010). Furthermore, new institutional economic theories suggest that institutions contributing to sustainable management of CPRs are generally efficient in nature because only the efficient ones can survive by way of crowding out all the inefficient ones (see Alchian and Demsetz, 1972) irrespective of the social outcomes (Biswas and Venkatachalam, 2010).

Therefore, by relaxing some of the assumptions such as unbounded rationality and information availability and maintaining others like the concept of efficiency i.e. minimization of transaction costs, the new institutional economics approach can deal with a large range of phenomena, are water resource management, including economic, political and social considerations (Sharma, 2012). The next section discusses in more detail the theories of transaction cost economics and collective action, the 4 level institutional framework by Williamson (2000) and the robustness of self-organized common-property institutions by Ostrom (1990).

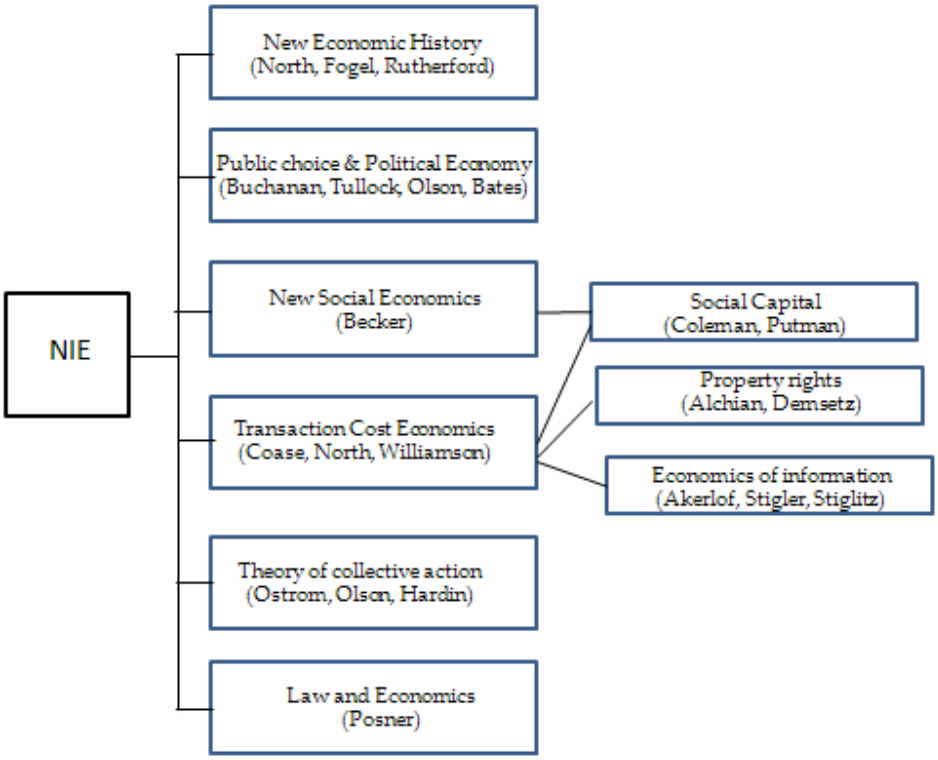

Figure 2. Branches of the New Institutional Economics Approach. Source: Kherallah and Kirsten (2001)

2.2 Levels of institutions (Williamson)

The NIE approach distinguishes between informal and formal institutional environment and between institutional environment and institutions of governance. This is evident in Figure 3, where the 4 level of institutions by Williamson (2000) is depicted. The solid arrows that connect a higher with a lower level indicate that the higher level imposes constraints on the level immediately below, whereas the reverse arrows that connect lower with higher levels are dashed and signal feedback (Williamson, 2000). The top level (Level 1) is the informal institutional environment which includes the customs, traditions and norms, which change very slowly. The next level (Level 2) is the formal institutional environment, which includes the constitution, the legal system, judiciary, polity, and property and contract rights. Level 2 introduces the "formal rules" of the game and opens up the opportunity for first-order economizing: get the formal rules of the game right (Williamson, 2000). "The play of the game" (Level 3) is the economic organization of contracts and governance structures; market, quasi-

market, and hierarchical modes of contracting, more generally of managing transaction costs and seeing economic activity through to completion (Patibandla, 2012). Level 3 opens up the opportunity for second-order economizing: get the governance structures right (Williamson, 2000). The fourth level is the level at which neo-classical analysis works e.g. evolution of resource allocation and employment and changes continuously. The 4-level institutional analysis by Williamson can be used as a framework to evaluate the performance of institutions for water reform related aspects and moreover, to allow for the establishment of new and better "pathways for reform" of water resource management policies in the face of looming water related problems (Sharma, 2012). Section 3 discusses the application of this framework to the Australian experience, the Murray-Darling basin where several water reforms occurred with respect to the definition of water rights, development of water markets and allocations, and to cope with water over-allocation problems. Recommendations for further improving the water trading mechanism in the Murray-Darling basin are briefly discussed as well.

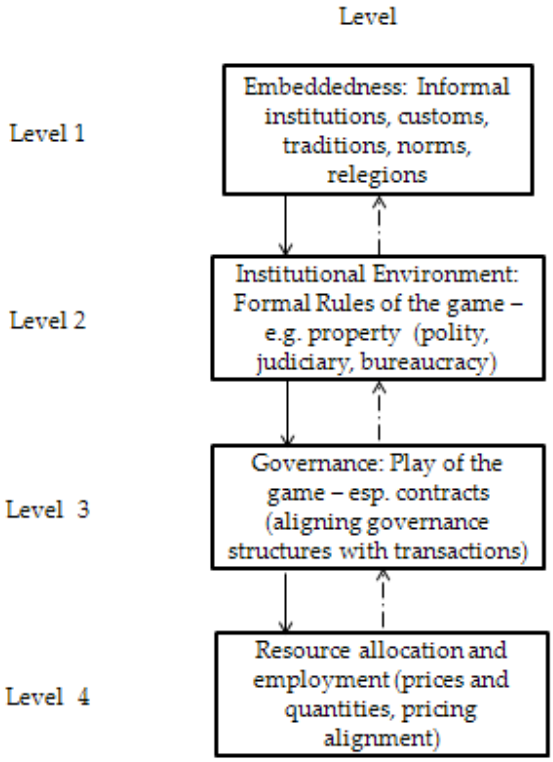

Figure 3.Four-Levels of institutions: Source: Williamson (2000) and Sharma (2012).

2.3 Robust design for self-organized common-property institutions (Ostrom)

Ostrom (1990) in *Governing the Commons* illustrated eight key design principles related to long-term robustness of institutions created to govern common-pool resource systems[1]. Examples of common-pool resources include both natural and human-made systems including: groundwater basins, irrigation systems, forests, grazing lands, mainframe computers, government and corporate treasuries (Ostrom, 2001). Examples of the resource units derived from common-pool resources include water, timber, fodder, computer-processing units, and budget allocations (Blomquist & Ostrom, 1985 and Ostrom, 2001). The analytical framework to long-term robustness of institutions for governing sustainable resources developed by Ostrom (1990) is illustrated in Table 1.

1. Clearly Defined Boundaries: The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.

2. Proportional Equivalence between Benefits and Costs: Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labour, material, and/or money inputs.

3. Collective-Choice Arrangements: Most individuals affected by harvesting and protection rules are included in the group who can modify these rules.

4. Monitoring: Monitors, who actively audit biophysical conditions and user behaviour, are at least partially accountable to the users and/or are the users themselves.

5. Graduated Sanctions: Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, from officials accountable to these users, or from both.

6. Conflict-Resolution Mechanisms: Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.

7. Minimal Recognition of Rights to Organize: The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.

For resources that are parts of larger systems:

8. Nested Enterprises: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Table 1. Design principles for governing sustainable resources derived from long-enduring studies of institutions. Source: Ostrom (1990, 2009).

[1] Common-pool resources produce finite quantities of resource units and one person's use subtracts from the quantity of resource units available to others (Ostrom, 1994, 2001).

The first design principle requires that the boundaries of the resource systems and the property rights of individuals are clearly defined. This principles ensures that participants know who is in or out of a defined set of relationships and therefore with whom to co-operate (Ostrom, 2009). The second principle refers to the rules that need to be well specified so that benefits and costs are allocated proportionally to the participants. If some users pay low costs but obtain high benefits over time, then the willingness by others to participate and follow the rules reduces. The third principle denotes that the users can participate in the process of making and modifying the rules, whereas the fourth principle is about the enforcement of rules and monitoring of the resource condition by the government or locally by the self-organized resource regimes. The fifth principle refers to the penalties that must be imposed when a user violates the rules and obtains benefits in the burden of others. Ostrom (2005, 2009) states that the first five principles work together. For instance, when the participants of a resource system make their own rules (collective action agreements) that are imposed and monitored by local users (monitoring) employing punishments for breaking up the rules (graduated sanctions) that clearly define who has rights to abstract from a well-defined resource (clearly defined boundaries) and that effectively assign costs proportionate to benefits (proportional equivalence between benefits and costs), then collective action and monitoring problems can be solved in a reinforcing manner (Ostrom, 2005 and 2009). Moreover, the sixth principle states that systems with low-cost conflict resolution mechanisms are more likely to survive, whereas the seventh principle suggests that external government agencies do not challenge the right of local users to create their own institutions (Cox et al., 2010). The last principle for robust systems postulates that the rules for instance, to allocate water among larger parts of a resource system may differ from those established for small or single parts. Therefore, among long-enduring self-governed regimes, smaller-scale organizations can be nested in ever-larger organizations (Ostrom, 2009).

The eight general principles for robust systems were reviewed and updated by Cox et al (2010) based on the results from an analysis of almost 100 studies which applied Ostrom's principles for managing common-pool resources. The improvements are related to the principles 1, 2 and 4. The design principle 1 is separated into two parts. The first one is on *user boundaries* where clear and locally understood boundaries between legitimate users and nonusers are present, and the second part is on *resource boundaries* where clear boundaries that separate a specific common-pool resource from a larger social-ecological system are present. The design principle 2 is also split into two parts,

congruence with local conditions and *appropriation and provision*. The former states that appropriation and provision rules are congruent with local and social environmental conditions, whereas the latter suggests that appropriation rules are congruent with provision rules, i.e. the distribution of costs is proportional to the distribution of benefits. Finally, the design principle 4 distinguishes between *monitoring users* and *the resource*. The former refers to individuals who monitor the appropriation and provision levels of users, whereas the latter refers to individuals who monitor the condition of the resource. Ostrom (2010) suggested that the improvements in the design principles 1, 2 and 4, together with the other principles, are robust and can ensure the probability of long term survival of an institution developed by the users of a resource.

Moreover, Ostrom's further work focused on designing principles to deal with economic and environmental challenges that could result in the sustainability of common pool resources. She especially highlighted the problems with "the tragedy of commons" (see Hardin, (1968)), which occurs as a perceived lack of incentive to keep the quality and quantity of the commons with a view towards long term sustainable usage. The latter necessary entails an acknowledgment that the resource is finite in the short term and only infinite in the long term if measures are taken to ensure that the resource can renew itself (Sharma, 2012). The lack of incentives can lead to over-use and eventually deterioration of the quantity and quality of the common resource. Therefore, Ostrom (1997 and 2001) provided an analytical framework that describes the conditions under which self-governing/localized government institution can form and manage successfully a common pool resource. These conditions which are displayed in Table 2 are separated into attributes of the resource and of the appropriators, i.e. users that withdraw resource units like water from a common pool resource.

Attributes of the Resource:

R1. Feasible improvement: Resource conditions are not at a point of deterioration such that it is useless to organize or so underutilized that little advantage results from organizing.

R2. Indicators: Reliable and valid indicators of the condition of the resource system are frequently available at a relatively low cost.

R3. Predictability: The flow of resource units is relatively predictable.

R4. Spatial extern: The resource system is sufficiently small, given the transportation and communication technology in use that appropriators can develop accurate knowledge of external boundaries and internal microenvironments.

Attributes of the Appropriators:

A1. Salience: Appropriators are dependent on the resource system for a major portion of their livelihood.

A2. Common understanding: Appropriators have a shared image of how the resource system operates (attributes RI, 2, 3, and 4 above) and how their actions affect each other and the resource system.

A3. Low Discount rate: Appropriators use a sufficiently low discount rate in relation to future benefits to be achieved from the resource.

A4. Trust and Reciprocity: Appropriators trust one another to keep promises and relate to one another with reciprocity.

A5. Autonomy: Appropriators are able to determine access and harvesting rules without external authorities countermanding them.

A6. Prior organizational experience and local leadership: Appropriators have learned at least minimal skills of organization and leadership through participation in other local associations or learning about ways that neighbouring groups have organized.

Table 2. Attributes of the resource and appropriators for self-governing of common pool resources. Source: Ostrom (1997 and 2001)

Ostrom (1997) concluded that robust, long-living self-governing systems could work if the resource system is sufficiently small and appropriators can develop precise knowledge of external boundaries and internal microenvironments (R4) and the flow of resource units is relatively predictable (R3). With respect to the attributes of the appropriators, important components are a common understanding among the appropriators, which includes knowledge about the operation of the resource system and the effect of each other actions (A2) and the establishment of trust and reciprocity among appropriators (A4). The analytical framework depicted in Table 2 was further developed by Ostrom (2007) to include the ecological aspect of governing a common pool resource, therefore called social-ecological systems (SES). Ostrom provided a multi-tier framework with seven variables (see Table 3) to analyze how attributes of a resource system (e.g. lake, river), the resource units generated by that system (e.g. water), the users of that system, and the governance system, jointly impact the interactions and outcomes obtained at a particular time and place and how these may influence and be influenced by larger or smaller socioeconomic and political settings in which they are embedded as well as by a larger or smaller social-ecological systems.

Social, Economic, and Political Settings (S)

S1- Economic development. S2- Demographic trends. S3- Political stability.
S4- Government settlement policies. S5- Market availability

Resource System (RS)	*Governance System (GS)*
RS1- Sector (e.g., water, forests, pasture, fish)	GS1- Government organizations
RS2- Clarity of system boundaries	GS2- Non-government organizations
RS3- Size of resource system	GS3- Network structure
RS4- Human-constructed facilities	GS4- Property-rights systems
RS5- Productivity of system	GS5- Operational rules
RS6- Equilibrium properties	GS6- Collective-choice rules
RS7- Predictability of system dynamics	GS7- Constitutional rules
RS8- Storage characteristics	GS8- Monitoring & sanctioning processes
RS9- Location	
Resource Units (RU)	*Users (U)*
RU1- Resource unit mobility	U1- Number of users
RU2- Growth or replacement rate	U2- Socioeconomic attributes of users
RU3- Interaction among resource units	U3- History of use
RU4- Economic value	U4- Location
RU5- Size	U5- Leadership/entrepreneurship
RU6- Distinctive markings	U6- Norms/social capital
RU7- Spatial & temporal distribution	U7- Knowledge of SES/mental models
	U8- Dependence on resource
	U9- Technology used
Interactions (I)	*Outcomes (O)*
I1- Harvesting levels of diverse users	O1- Social performance measures
I2- Information sharing among users	(e.g., efficiency, equity, accountability)
I3- Deliberation processes	O2- Ecological performance measures
I4- Conflicts among users	(e.g., overharvested, resilience, diversity)
I5- Investment activities	O3- Externalities to other SESs
I6- Lobbying activities	

Related Ecosystems (ECO)

ECO1- Climate patterns. ECO2- Pollution patterns. ECO3- Flows into and out of focal SES.

Table 3. Muti-tier variables in framework for analyzing a social-ecological system (SES). Source: Ostrom (2007).

3. International Experiences from Water Markets

3.1 Water Markets in Australia

The theories described in the previous sections have recently been applied in the Murray-Darling (M-D) river basin in Australia by Sharma (2012) where the performance of water reforms and institutions is evaluated over time. The author also provided further recommendations on how to improve the water trading in this basin, and eventually, a new robust water governance model, which can fulfil economic, political, social and environmental objectives.

According to the four level analysis of institutions by Williamson (2000), the water reforms in Australia till '90s, were focused more on level 4, i.e. on the development of water resource allocations (using the markets as a mean for allocating water). Less attention therefore was paid to make water reforms to address the levels 1, 2 and 3, i.e. to define the informal and formal rules and play of the game, for instance, water right systems and water allocation procedures or even to change social attitudes towards water, for instance, by focusing on making improvements in water quality and environment (Sharma, 2012). The situation, however, changed after 1990, with the reforms induced by the Council of the Australian Governments (COAG) in 1994 which were brought within the National Competition Policy, the Murray Darling "cap" to limit water diversions and eventually to National Water Initiative (NWI) and National Plan for Water Security (NPWS) in 2004. For the purposes of this study, we are focusing only on these reforms because we believe that they can be considered as robust for the sustainability of the water resources and the well-functioning of the water markets.

In 1994, the COAG agreement included several important recommendations. Increasing emphasis was placed on the development of water markets and improving water allocation arrangements with a special attention to environmental usage (Sharma, 2012, McCay, 2005). The former included recommendations for separation of water licenses from land title, allowing water access entitlements and allocations to be deployed to uses generating greater economic returns (COAG, 1994, Young and McCoil, 2002 and 2003). This was the first step to robust institutional arrangements for water allocation and management and as Young and McCoil (2002, 2003) suggested, the clue to the robust resolution of many of Australia's water resource problems lied more with separation than in integration[2]. With respect to improving water allocation arrangements for environmental usage, it was

[2] Young and McCoil (2002, 2003) suggested that robust institutional arrangements for water management and allocation could be achieved based on Tinbergen principle (1950), which states that to attain a given number of independent policy targets through time there must be, at least, an equal number of policy instruments. Therefore, the components of the

suggested that environmental requirements should be taken into account and the environment should be treated as a legitimate user of water. Both changes recommended by the COAG agreement and further adopted by the National Competition Policy act on level 2 and 3 institutions (Williamson), as the "formal" rules (Institutional Environment) and "play of the game" (Governance) were clearly and well-defined. They can also be defined as robust in accordance with Ostrom's design principles 1 and 2 (or equivalently, the updated list suggested by Cox et al. 2010 and further approved by Ostrom as well). Unbundling commenced in 2000 in the State of New South Wales and was formally required under the National Water Initiative established in 2004. The term "property right", was redefined and described as "water access entitlement" as it was easier to talk about the nature of each person's entitlement and avoid getting tangled up in debates about the nature of people's rights (Young, 2011). Young (2011) summarizes the robust unbundling water allocation regime as follows. Access entitlements took the form of a share and were usually issued in perpetuity. Once the system was set up the only way to secure an entitlement to a share of water in a system was to purchase a share from an existing shareholder. Ownership of entitlements was vested in individuals and arrangement put in place to enable water to be traded from one irrigation district to another. Allocation trades were implemented by debiting one person's water account and crediting another person's water account. Entitlement trades were implemented by amending names on a water entitlement register. Entitlements could be mortgaged and finally, brokers were employed to bring buyers and sellers together and dealt with each trade.

In addition to this, the introduction of a ceiling, called "cap" in 1994, for diversions from the Murray-Darling river system aimed to protect and enhance the riverine environment and eventually, to meet ecological and social needs. This reform placed the environment at the centre of policy making process (level 1 and 2 institutions) and affected the governance rules (level 3 institutions) for water allocation (Sharma, 2012). It can also be defined as robust according to Ostrom's design principle 4 (monitoring or equivalently, monitoring the resource). Moreover, the National Water Initiative established in 2004 although focusing on water markets and trading, can be considered as the first

existing allocation licensing regime would be robust if they are separable from each other. Moreover, based on Tinbergen principle, Young (2012) in a recent report suggests a new robust allocation licensing mechanism for the England and Wales, where an unbundling regime would include a long-term tradeable entitlement issued in perpetuity, a short-term tradeable allocation and a non-tradeable use, abstraction and discharge permit.

initiative that attempts to cover 2, 3 and 4 by including key policy areas such as best practice water pricing and institutional arrangements, water resource accounting, water access entitlements and planning framework and community partnerships and adjustment (National Water Commission, 2007b). Although the NWI can be denoted as robust based on Ostrom's design principle 1, it did not address other important components such as mechanisms to deal with conflicts between unaffected parties (Ostrom's design principle 6) or to improve the participation in the water markets (Sharma, 2012). Finally, the National Plan for Water Security (NPWS) addressed the over-allocation problems[3] which were created by the development of water markets with a purpose of guaranteeing that environmental assets received an appropriate allocation of water for regeneration. This reform, where the government buybacks entitlements for water allocation for the environment, can be considered as a change to level 1 and 2 institutions since the environment is the centre of policy making process and robust in accordance with Ostrom's principle 4 (monitoring or equivalently, monitoring the resource).

Moreover, Sharrma (2012) further applied Ostrom's analytical framework with respect to the attributes of the resources and appropriators (see at Table 2) in the Murray-Darling river basin. The author stated that the M-D basin is sufficiently large and the flow of resource units is not predictable and there is no common understanding and trust among the appropriators. In contrast, there is room for feasible improvement in the resource system, reliable and valid indicators of the condition of the resource system are frequently available at a relatively low cost. Moreover, the appropriators are dependent on the resource system for a major portion of their livelihood, they use a sufficiently low discount rate in relation to future benefits to be achieved from the resource and have learnt at least some minimal skills of organization through participating in other local associations.

Overall, it is concluded that it is of great importance an increased level of priority for establishing the informal and formal rules of the game and the play of the game to satisfy robust design principles for sustainable use of resources and then the markets can be used as a mean to allocate water. Sharma (2012) moved a step forward by providing some policy recommendations with respect to the improvement of water markets in the Murray-Darling river basin. The first proposal refers to the establishment of market entry restrictions in the temporary market trade only and not to the permanent trade in order to avoid market distortions created by the "activation of sleeper entitlements"[4]. The

[3] Over-allocation occurs when not enough water is allocated for environmental "regeneration".

[4] Sleeper entitlements are those entitlements that were not previously used. Once the water trading occurs, it is likely that the users of those entitlements would be willing to take part in the market to obtain some financial gain (Sharma, 2012).

advantage of the first proposal lies on the fact that there could be a better specification of the nature and number of participants in the temporary trade. The second proposal refers to the reduction in institutional transaction costs such as the time taken to process different types of water trading (permanent and temporary). For instance, currently the approval time for water access allocation varies across the basin, from 7 days in Queensland and 30 working days in New South Wales and South Australia. The final suggestion is related to the reduction of monetary transaction costs, e.g. administrative costs, water use monitoring and enforcement costs by introducing uniformity of fees and charges across different jurisdictions. This proposal could incentivize participants between different states to take part in trade. For instance, as it stands now, in the New South Wales the application fee for approval for temporary and permanent trade is $75 and $250 respectively, whereas the fee for registration of trade is $73.25 for the permanent trade. Moreover, in South Australia, the application fee for approval for temporary and permanent trade is even higher, $205 and $349 respectively, whereas in Victoria the application fee for approval for temporary and permanent trade is $70 and $150 respectively, and the fee for registration of trade is $101 in the case of a permanent trade. With respect to dealing with conflicts between disaffected parties in the M-D basin, it has been proposed a shift towards more centralised approach. This implies that the Federal government should be responsible for the rules and the play of the game, with consultation from the state level representatives, whereas the responsibility of water resource allocation would reside with the state governments (Sharma, 2012).

Although there were several robust institutional arrangements in the M-D basin for water allocation and management, water over-allocation problems occurred and now the environment is on the centre of attention for the policy makers. Therefore, a new robust governance model for the Murray-Darling river basin must be introduced. According to Rogers (2002), governance refers to "the capability of a social system to mobilize energies, in a coherent manner, for the sustainable development of water resources and includes: i) the ability to design public policies (and to mobilize social resources for their support) which are socially accepted, whose goal is the sustainable development and use of water resources; and: ii) to make their implementation effective by the different actors/stakeholders involved in the process" (Solanes, 2012). In the case of the M-D river basin, the new robust governance model – based on the theories of Williamson, North and Coase on institutions and transaction cost economics, and Ostrom's work on robust institutions (Tables 1 and 3)- should give the environment the highest priority in the policy making process and implementation, and second priority should be given to social and economic needs which then can denote the role the

political components needs to play in facilitating the realization of the environmental, social and economic objectives (Sharma, 2012).

3.2 Water markets in California and Colorado (USA)

This section discusses the water markets and legal change in California based on the study by Brewer et al. (2008) where the New Institutional Economics approach is implemented. The section also includes a discussion of the development of water markets in Colorado where inter-sectoral transfers had positive impacts from an environmental, economic, and social perspective. The empirical evidence is based on the studies by Howe and Goemans (2003) and Howe (2011) and the water reforms were evaluated based on the framework analysed in the previous sections.

Following the New Institutional Economics (NIE) approach, Brewer et al. (2008) looked into the interactions among regulation, property rights, and water markets in California over the period 1987–2005. The authors examined whether and how the definition of water rights and the regulation of water transfers have affected observed market activity in the extent and pattern of water trades and their duration, and the nature of the contracts used (short-term leases, long-term leases, and sales). Over the period of study, the authors identified the changes in law that either strengthened or weakened property rights to water and raised or lowered the transaction costs of trading. It was mentioned that the greatest activity for legal change to support water markets were in the years 1987, 1988, 1991, 1993, 1999, and 2003, whereas changes that limited water markets occurred in 1988, 1999, and 2001 (for more detail see Brewer et al., 2008). For instance, in 1991 the Drought Water Bank of California was created to facilitate temporary transfers of water from agricultural to the urban sector, at a single price set by the state government, through different types of contracts (Level 3 institutions) (Rey et al, 2012). The results indicated that most active and subsequently robust factors in support of markets were making the water right more precise such as defining beneficial use to include trading activities, allowing for the transfer of water rights, separating water from the land for trading, and defining conservation and the trading of conserved water. In contrast, the most active factors limiting water markets were restrictions on transfers to protect other water users, restrictions to protect the environment, requiring third-party compensation, requiring notice of transfers, and allowing for third-parties to protest and challenge proposed transfers (Brewer et al., 2008).

Moreover, in western USA, water rights are defined as appropriation rights meaning that they are obtained on the basis of beneficial use rather than land ownership (Hodgson, 2006). Under the appropriation system of water rights, all water withdrawn from the natural setting is represented by a "water right" or by a groundwater pumping permit, owned by individuals, municipalities or water companies, and the shares of these organizations can be therefore bought or sold (Howe and Goemans, 2003). This type of rights is in contrast to the riparian rights which refer to the situation where both land and water need to be purchased if water is used for another purpose. Below we will focus on the characteristics of the water rights, and the benefits from intersectoral trading between the two regions of the Colorado basin- the South Platte and Arkansa- where water is transferred through the federal Colorado-Big Thompson (C-BT) project.

As part of the above mentioned project, the Northern Colorado Water Conservation District (NCWCD) was founded with the responsibility of carrying out the diversion works of the project and the allocation of water on the eastern side of the mountains (Howe, 2011). The U.S. government continued to be the owner of the water but the District owned the right to allocate all the water made available by the C-BT project as long as it was meeting repayment obligations and was operating and maintaining the project facilities as stipulated in the repayment contract (World Bank, 1999). NCWCD shares have unique characteristics that make water trading activities very attractive. Firstly, they are homogeneous units meaning that each share gets the same amount of water and there are no priorities (Level 2 institutions). For instance, the amounts of transfers were annually collected and were classified by size and nature of seller and buyer (e.g. agricultural to urban or agricultural to agricultural). Secondly, the water district holds the rights to all return-flows and thirdly, transfers do not have to pass through the water court but require only the approval of the NCWCD board (Level 3 institutions) (Howe and Goemans, 2003, Molle and Berkoff, 2009). Therefore, in this case well-defined property rights strengthened the development of water resource allocations and kept the transactional costs low resulting in significant economic and environmental benefits for the participants.

The results indicated that the economic impact, both directly and indirectly, per acre foot of water transferred from agricultural to urban uses within the basins, was very positive. Moreover, although there was an increasing rate of share of ownership over time for the cities and industry, the share in actual use is not increasing rapidly as cities "rent" some of their water back to agriculture on an annual basis, subject to recall in drought years (Howe and Goemans, 2003). The volume and direction of rentals depend on weather conditions, for instance, during drought period cities may

withhold water from agriculture and charge higher prices (Howe, 2011). Also, the NCWD preserved the water resources by paying attention to the preservation of productivity of agriculture lands, water quality in soil, aquifers and maintenance of ecosystem services. Hence, within the Colorado-Big-Thompson system, robust institutional arrangements such as the homogeneous nature of water shares and the avoidance of water court review approval for water transfers, allowed buyers and sellers to carry out small transactions as the need arises rather than occasional large transfers. It is therefore concluded that the efficient and continuous water market within the Colorado-Big-Thompson system fulfils Ostrom's design principles 1, 2, 4 and 6. New institutions, i.e. well-defined property rights, were successfully adapted to the specific circumstances and needs of the region (local level), homogeneity of water shares allowed water transfers among groups with the same needs and concerns and fostered the protection of the open-access resources; finally, any water transfer approval was dealt locally (Ostrom, 1990, Ostrom et al. 1993, and Ostrom and Gardner, 1993). However, considerable attention needs to be paid to the case when there is an out of basin water transfer. If the region where the water is taken from is economically depressed, then a water transfer might cause difficulties in its financial vitality (e.g. loss in agriculture production, income, employment). Therefore, a transfer fee per acre foot could be imposed on the buyer and transferred to a unit of general government in the area of origin to support social services during the period of transition (Howe and Goemans, 2003 and Howe, 2011).

3.3 Water markets in Chile

This section discusses the development of water markets in Chile based on the study by Donoso (2011) evaluating the water reforms based on the new institutional economics approach analyzed in the previous sections. In Chile, the government introduced neo-liberal economic policies which supported private property rights and free markets through the establishment of the National Water Code (WC). The 1981 WC maintained water as "national property for public use", separated rights from land and granted transferable water-use rights (WUR) to individuals through the Directorate General of Water (*Dirección General de Aguas, DGA*). The WUR allow a person to have a certain water flow of a river or aquifer with a cap. When the level of water flow of the river or aquifer is not sufficient to satisfy the WUR that have been granted, then these WUR act as shares (i.e. certain % of river flow or maximum cap in the case of an aquifer). The WUR are not sector specific and can be transferred among sectors such as from agriculture to sanitation, industry, mining etc. Delving into the definition of water rights, according to the resource availability, they are divided into permanent and

temporary and according to the time of the use of the resource the rights are classified into continuous, discontinuous and alternated. Also, depending on the use of the flow, consumptive (irrigation) and non-consumptive (hydropower) water rights are also defined (Rey et al., 2012). This means that non-consumptive (e.g. hydropower) use rights allow the owner to divert water from a river with the obligation to return the same water unaltered to its original channel. Consumptive use rights do not require that the water be returned once it has been used (Donoso, 2011). The WC 1981 did not address any environmental sustainable policies (third-party effects and environmental impacts) except in 2005 when it was reformed to consider regulation for the establishment of minimum ecological flows. However, the registration of water rights was not adequate. There is a significant number of rights with no record although they are in use and exercise. The lack of legal certainty of water rights and the absence of a system to identify the current right holders in a given watershed or river section are the main difficulties that authorities have to face to make efficient functioning of water markets in the country (Rey et al. 2012).

Moreover, the 1981 WC clearly separated the role of the government from the private sector. As far as the Government Bodies are concerned, the role of State in water management is mainly focused on measuring and determining the availability of water resources and on protecting natural resources, the impact assessment service and environmental legislation. The Directorate General of Water (*Dirección General de Aguas, DGA*) is responsible for granting, monitoring and enforcing of WUR. It has very little regulatory authority over private water use and can't cancel or restrict water rights once they have been granted (Rey et al. 2012). Finally, the management of water in day to day decisions and issues is carried out by the User' organizations**.** Different types of User's associations exist. The first one operates on natural resources, rivers, and aquifers, whereas the second one is responsible for the distribution of water in channels. These organizations do not own water rights, however, they have arbitration powers and represent members against third parties. Thus, any entity holding water rights must join any organization or association established in the Water Code (Rey et al., 2012).

Empirical evidence in assessing the efficiency of water markets in Chile indicated that the volume traded remained limited but reallocation has performed reasonably well, even though third party effects and speculative behaviour reduced efficiency (Mole and Berkoff, 2009). Grafton et al. (2010) pointed out that 8 to 32% of the agricultural sector's contribution to regional GDP, $22 million annually, can be attributed to water markets. However, there is an uneven spread of pricing information

in the market that particularly disadvantages market participants with fewer resources and also increases transaction costs. Donoso (2012) suggested that the allocation framework based on a market allocation system established by the 1981 Water Code has been efficient from an investment point of view, as several economic sectors undertake significant investments to improve water use efficiency and to increase the availability of groundwater through exploration. Likewise, the free transaction of water use rights, even though in many areas water use rights markets have not been very active, constitutes an efficient reallocation mechanism which has facilitated the reallocation of granted rights (Donoso, 2012).

Although the Water Act in 1981 defined the rules of the game (Level 2 institutions) and its subsequent amendment in 2005 to consider regulation for the establishment of minimum ecological flows to improve water allocation arrangements for environmental usage (Level 3 institutions), their implementation was not effective. Therefore, we can't consider the Chilean water market as robust due to the lack of proper registration of water rights, high transaction costs or conflicts between upstream and downstream users over the return flows, with the exception of unbundling the rights from land. Therefore, the effectiveness of water markets in Chile could be enhanced by employing more robust changes which could overcome the following difficulties. Firstly, data on WUR transactions and prices for buyers and sellers is needed to overcome the lack of WUR and WUR market information. Secondly, WUR needs to be clearly specified, ownership secure and formally registered. Thirdly, the existence of transaction costs can be dealt with collecting information on water transactions, water right prices and water market activity. Finally, a rapid and efficient controversy resolution system to solve conflicts among water users needs to be further developed (Donoso, 2011).

3.4 Water markets in Spain

This section evaluates the performance of water reforms to facilitate inter-sectoral water transfers in the Tagus river basin in Spain based on the study by IMDEA (2011) where Williamson's four-levels of institutions scheme is implemented. An overview of the legal, institutional and environmental barriers to water markets in Spain is also provided in this section.

Water use rights are defined by the abstraction point, type of use, calendar, plots and crops to be irrigated and irrigation technologies, usable volume or flow and return flows (Garrido et al. 2012). The type of use, location, abstraction or return points cannot be changed without an explicit approval by the River Basin Agency (RBA) (Rey et al. 2012). Rights differ in the priority of their access to water

depending on the type of use (domestic, environmental, agricultural, hydropower or industrial) (Rey et al., 2012, Calatrava et al. 2012). During the drought events in the Tagus river basin, in 1993 and 2002, two water transfers occurred, from irrigators to urban suppliers. In the first case, water was transferred from irrigators in the Henares Canal to provide drinking water to several towns supplied by the Mancomunidad de Aguas del Sorbe (MAS) (Sorbe Water Community) (with Alcala des Henares being the most important town). In the second case, water was transferred to the city of Madrid from irrigators of the Alberche river.

Both water transfers addressed the fourth level of Williamson's institutions as their aim was to allocate water from low to high value users. These water transfers were allowed thanks to the reform of the Water Law in 1999 (*Law 46/1999*) which introduced the so-called water right lease contracts (*contratos de cesión*) and water banks (*centros de intercambio*) that eased certain transfers of water rights for a given period of time including a pecuniary compensation (IMDEA, 2012). However, in the case of transferring water from the irrigator areas of the Alberche river to the city of Madrid, no clear and well-defined registration of the irrigators water rights was available a priori. As a result, not all farmers were able to participate in the trading process. In 2005, the government with a decree (RDL 15/2005) allowed water users adjoin to public irrigation land to sign transfer contracts, provided some conditions were met (IMDEA, 2011). The 1999 and 2005 water reforms can be considered as changes on level 2 and 3 institutions (Williamson), as the "formal" rules (Institutional Environment) and "play of the game" (Governance). Also, the 1999 water reform defined that water transfers need to be approved by the administration which can be time consuming, requiring up to two months. Moreover, the river basin authority can reject a water transfer if it concludes that negative impacts on the environment and water resource might occur. With respect to the drought events in 1993 and 2002, the Ministry of the Environment, Rural and Marine Affairs (MARM) and the Ministry of Agriculture, Fishing and Food Affairs were involved in the regulatory process (IMDEA, 2011). This legal reform addressed level 3 institutions with the government playing an important role in the whole process, though concerns about high transaction costs might rise.

Although these legal reforms attempted to define the rules and play of the game to facilitate the implementation of water trading in Spain, they can't be considered as robust since there are still considerable barriers to trade, which Garrido et al. (2012) split into legal, institutional and environmental. The legal barriers include market barriers, e.g. the number of buyers and sellers and barriers related to the definition of water rights e.g. rights to consumptive uses cannot be sold to

holders for non-consumptive uses (hydropower) and vice versa. Institutional barriers include regional and intersectoral barriers that occur when representatives of one sector collectively fights exchanges that go against their political standing within the hierarchy of water rights and political priorities (Garrido et al. 2012). Finally, as far as environmental barriers are concerned, these are those enforced by public agencies responsible for the ecological quality of rivers and water bodies. For instance, the minimum environmental river flows, are based on modeling evidence, which are hardly contested (Garrido et al. 2012).

Rey et al. (2012) and Garrido et al. (2012) give a comprehensive overview of the water market activities in Spain, which include informal trading of surface water resources, trading of private groundwater rights, formal lease contracts, purchase of land to use water in other parts of the basin, inter-basin water trading and public exchange centers/water banks and option contracts. Also, IMDEA (2012) provides empirical evidence about the water trading activities from one basin to another such as in the Tagus-Segura interconnected basins, emphasizing that there are significant legal restrictions and they are mostly limited to emergency periods. The following section provides a list of robust recommendations for improving the water trading schemes in Spain and a new robust governance model for sustainable water resource and use for this country.

4. Policy Recommendations

We believe that the analysis conducted in this study can be a valuable roadmap for understanding which factors weaken or strengthen the development of water markets, and how they could be further developed to be environmental, social and economic accepted. Therefore, combining together the lessons learned from the Spanish and international experience from the evolution of water markets, we provide robust recommendations for improving the water trading schemes in Spain. These include: 1) Climatic, geologic and hydraulic information for the definition of water rights; 2) Registration institutions to record water rights; 3) Unbundling water allocation and management regime; 4) Flexibility in water transfers; 5) Recognize the environment as legitimate water user e.g. by establishing guidelines for minimum environmental flows (see Katz, 2012 for more detail), avoid external effects on third parties e.g. return flows or over-allocation problems.

The definition of secure water rights allows for the development of water markets. Clear information of how much water is allowed for abstraction, use and minimum ecological flows, within a

defined period and location and registration of these rights increases transparency. An unbundling allocation licensing regime allows changes in water reforms to be target specific. In other words, each component is defined in a manner that enables decisions about one component to be made without consideration of implications for other components because each component is defined in a hydrologically and legally robust manner (Young, 2012). Unbundling, coupled with verification of registers, could therefore maintain transactional costs low and enable water trading.

Moreover, flexible water transfers, from one sector to another, for instance from agriculture to urban, industry and energy, and between non-consumptive and consumptive uses could facilitate water trading from low to higher-value uses. For instance, the reform in the 2010 Andalusian Water Law allowed changes in the priority system, meaning that irrigators are on the same level with other users such as industries and therefore, exchanges between these users are permitted (Garrido et al., 2012). Another example is illustrated by Gomez (2012). In the case of Mallorca, the possibility of the water supply firm to buy rights from farmers in dry years is showed to avoid the cost of infrastructures such as dams and desalination plants required to secure the supply of drinking water. This way water trading allows supply security with lower water tariffs and an income guarantee for farmers in dry periods (Gomez, 2012).

Furthermore, environment is an important user in the whole process. As Gomez et al. (2012) emphasized transferring water from one source to another may have external effects on third parties coming from the fact that farmers in the low part of the basin use the return flows of farmers and other users utilizing the water upstream, including recycled wastewater and/or discharged cooling water from power plants, which might be essential to maintain water flows in the river. Therefore, recognizing the environment as legitimate water user could result in environmental sustainability of the water resource and in avoiding externalities.

Other recommendations equally important include: 6) Reduction in institutional and monetary transactional costs, for instance the timing and fee of approval of water trading, 7) Registration institutions to collect information and data from trading activities, for instance the amounts of transfers can be collected and be classified by size and nature of seller and buyer. As a result, the perception of the process, the quality and accessibility of market information and guarantee of market proficiency are enhanced, 8) The need of cost-benefit analysis, to quantify benefits and externalities, 9) Establishment of specialist environment courts responsible for resolving disputes concerning water rights which do not have to be located solely at the level of the water administration but could also foresee specific

local resource management bodies such as water user associations (Hodgson, 2006). As the users participate in the administration of water resources, their expertise in local issues may effectively influence the development of the water market and fairly resolve any disputes which may arise (World Bank, 1999). 10) Water markets can be particularly successfully if they are localised, meaning that the new institutions can easily adapt to the specific circumstances of the region. Moreover, if markets are conducted among homogeneous groups as they share the same concerns and needs compared to heterogeneous groups. Their expertise can also be important for dealing with local disputes and environmental sustainability of the water resource.

In addition to the above robust recommendations for improving the water markets in Spain, a new robust water governance model is proposed. This model is based on Sharma's (2012) approach but re-prioritizing its components. A robust governance model for Spain is depicted in Figure 4 and should include the elements of environmental responsibility, political support and action, social education and acceptance, effective administrative systems and adaptive governance. Environmental responsibility implies that environmental guidelines, in relation to how much water is diverted, abstracted or return to a water resource, needs to be clearly defined by those who have the knowledge to do so e.g. environmental scientists. Political support is required in the case when water re-allocations are not beneficial between parties (sectors) or when environmental guidelines are not respected. Together with political support goes political action which can take the form of social education programs, design and enforcement of legal rules and establishment of administrative institutions (Sharma, 2012). Social education and acceptance implies raising awareness of the environmental, economic and social value of a water resource for both stakeholders and citizens. Effective administrative systems can take the form of not only recording information related to market activities but also of a dispute resolution mechanism in case voluntary agreements are not successfully (Sharma, 2012). Finally, adaptive governance implies that institutional regimes need to be flexible to meet unpredictable conditions, i.e. to be able to change the rules of the game, for instance to include new scientific knowledge or to apply a variety of policies in the face of changing conditions (Sharma, 2012, Walker et al. 2002, Drieschova et al. 2008).

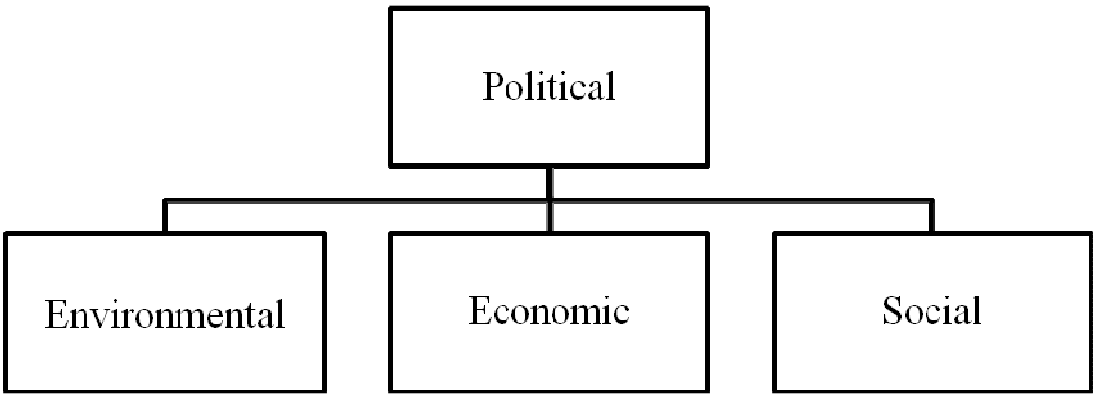

Figure 4. A New Robust Water Governance Model.

Therefore, as it can be seen from the figure above, the role of the political component is given the highest priority and second priority is given to environmental, economic and social needs. The reason for giving the highest priority to the role of political component in the new water governance model is explained by the fact that the water markets in Spain are weak because of the lack of transparency in water price-setting, the lack of public information about who uses the water and for what, the lack of clear conditions in the current legislation about the spatial and temporal restrictions to trading (Garrido et al., 2012). As a result, legal and political institutions that support clear property rights, recognize the environment as legitimate user of water, encourage political and social support and action, will lower the transaction costs of trade and facilitate the smooth exchange of water from low to higher-value uses, facilitating therefore the realization of environmental, economic and social objectives.

5. Conclusions

In this paper we reviewed the introduction and development of water markets, based on the new institutional economics approach, in countries such as in Australia, USA (California and Colorado), Chile, and in Spain. Based on the theories by Williamson, North, Coase and Ostrom on transaction cost economics, property and collective actions, we reviewed the evolution of water reforms changes and identified factors that strengthened or weakened the development of water markets. Based on the lessons learned from the Spanish and international experience review, we provided a list of robust

recommendations for the improvement of water markets in Spain, a country in which the absence of robust water governance and effective surveillance does not allow water markets to be efficient and socially accepted (Garrido et al. 2012).

The main results from the international review on the evolution of water reforms for water markets suggest that well-defined rights, appropriate regulation of water markets and changes in beliefs and notions are preconditions for the development of water markets. Additionally, institutional representation of the environment is of paramount importance and needs to be included in the robust design principles for sustainable water resources and well-function of markets. We believe that the international review on water markets can be a valuable roadmap for understanding why water markets function or not and how they could be further developed to fulfil environmental, social and economic objectives. Therefore, a list of robust recommendations for improving water markets in Spain includes among others not only the definition of secure water rights, for instance, registration of rights or recognition of environment as a legitimate user, but also the monitoring of water trading activities, for instance collection of information for prices and quantities or cost-benefit analysis for quantifying benefits and externalities. Moreover, it is concluded that water transfers can be particularly successful if they are localised, meaning that the new institutions can easily adapted to the specific circumstances of the region and if they are conducted among homogeneous groups, as they share the same concerns and needs compared to heterogeneous groups. Their expertise can also be important for dealing with local disputes and the environmental sustainability of the water resource. Finally, following the approach of Sharma (2012) the well-functioning of water markets in Spain would further require the establishment of a robust water governance model in which environmental responsibility, political support and action, social education and acceptance, effective administrative systems and adaptive governance are important components. The highest priority is given to the role of legal and political institutions and second priority to environmental, economic and social needs.

We hope that the framework presented in this paper will function as a tool for researchers and policy makers in Spain and other European countries to understand how water markets can be further developed to be economically and environmentally efficient, and socially accepted.

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