Hybrid governance systems of water markets and water user associations:

A systematic case study review

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Description of research group and personal interest in the thesis:

This research is linked to the Institute of Environmental Science and Technology of the Autonomous University of Barcelona (ICTA-UAB). By investigating the hybrid governance system of water markets and water user associations it falls within ICTA´s research on policy approaches for a sustainable economy.

This research comes from my own interest as I have lived several years in Chile, where the national water management has become highly political and a central topic in the social uprisings of 2019. Chile has one of the first water markets, implemented in 1981 under dictator Pinochet, and is the only country where water was privatized nationwide. After being praised as a showpiece of economic sustainability, today, it shows various social and environmental issues. My experience in Chile provided the impetus to conduct research on policy approaches comprising economic, social and environmental sustainability, especially being interested in water markets and their implications for local communities.

Guidelines for International Journal of Water Resources Development:

- Maximum word count: 8.000 words (including abstract and footnotes, but excluding bibliography, tables and figure captions)
- Inclusion of Abstract (100 words) and up to 6 keywords
- Include abstract, author affiliation, figures, tables, funding, and references. Also, if applies, it should include disclosure statement (acknowledgement) and data availability statement
- References: No specific requirements for reference formatting if consistent and contains key information: author(s) name(s), journal title/ book title, chapter title/article title, year of publication, volume number/book chapter and the article number or pagination must be present. Use of DOI is recommended.
- Spelling can be US or UK English, usage must be consistent

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Abstract

Consensus is growing that new and innovative governance forms are required to address our urgent and multiscalar environmental problems. The trichotomy of state governance, market governance or local-based community governance has been replaced by interest in hybrid governance forms. The hypothesis is that hybrid governance forms strengthen the benefits and neutralize the weaknesses of the single governance forms, leading to more sustainability. This study partially confirms this hypothesis by looking at the hybrid governance systems of water markets, which are somehow participated or managed by water user associations.

Keywords: Hybrid governance, water markets, water user associations, environmental governance, case study review

Word count: 11.942 including abstract; excluding bibliography, figure captions and tables

1. Introduction

The recently published part *The Physical Science Basis of Climate Change* of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change is the first document signed by 195 states, acknowledging that human influence is the main driver of climate change (IPCC, 2021). What Garret Hardin 1968 famously coined the *tragedy of commons,* using the example of a sheep pasture (Hardin, 1968), can now be observed for our planet. According to Hardin, openly accessible resources, such as the atmosphere, will inevitably be depleted due to the inability of users to cooperate and sustainably use these resource (Villamayor-Tomas, 2014). The latest IPCC report seems to back up his theory. Due to our continuously growing greenhouse gas emissions, "global surface temperature will (…) increase until at least the mid-century under all emission scenarios considered" (IPCC, 2021, p. 18) leading to climate change and the degradation of our ecosystems (IPCC, 2021). This trend can also be observed for water resources. During the last century, the global use of water has increased twice as fast as the population growth. And while competition for water is growing alongside urbanization, rising incomes and changing diets, climate change is decreasing availability and reliability of water supplies (D. E. Garrick et al., 2020). 5 out of 11 regions of the world are already experiencing water stress (United Nations, 2021) leaving 4 billion people with severe water scarcity during at least one month during the year (Mekonnen & Hoekstra, 2016).

Environmental governance attempts to counteract this trend. Through a "set of regulatory processes, mechanisms and organizations (…) political actors [can] influence environmental actions and outcomes" (Lemos & Agrawal, 2006, p. 298). Literature has long debated which of these ¨political actors¨ - state, market or more recently, civil society – is the most efficient in managing resources sustainably. One of the most famous scholars defending strong state agencies to develop water systems was Wittfogel (1957). Based on his experience in Asia, he argued for strong political structures being able to mobilize labor and financing needed for the construction and maintenance of large-scale hydraulic systems. During the second half of the twentieth century nearly 45.000 large dams were built to meet water and energy needs (World Commission on Dams, 2001). However, during the 1970´s and 1980´s, evidence was rising that many state systems were not meeting expectations, having a variety of economic and environmental problems (Jeuland, 2020). Moreover, research about locally managed small and medium sized irrigation systems was growing. Long-lasting irrigation organizations were characterized by clear and strong property rights and decision-making authority on constitutional, collective-choice and operational rules (Meinzen-Dick, 2007) as well as individual benefits over the costs of sharing an irrigation system (Ostrom, 1993). Yet, continued overuse of water, combined with neoliberal reforms, reinforced the application of market institutions at the turn of the century. Water was pushed to be treated as an economic good and subjected to market mechanisms (D. E. Garrick et al., 2020). Market- and agent- focused instruments, such as the marketization of resources, ecotaxes, subsidies or ecolabeling aim to mobilize individual incentives in favor of the environment (Lemos & Agrawal, 2006). By 2010, however, doubts were increasing that water challenges could be met by "getting the prices and property rights right" (D. E. Garrick et al., 2020, p. 2). Today most scholars agree that there is "no panacea" as "each of these approaches has failed to live up to expectations, largely because the variability of local situations (…) were not taken into account" (Meinzen-Dick, 2007, p. 15201). Hence, environmental governance should be, and in practice is, a hybrid system, where the three

actors: state, market and civil society, collaborate and support each other (Lemos & Agrawal, 2006; Driessen et al., 2012; Meinzen-Dick, 2007; Muradian & Rival, 2012). Lemos & Agrawal (2006) argue that hybrid forms benefit from the strengths of each governance form, complementing each other and leading to greater efficiency. According to the authors, hybrid governance forms hold the promise to take advantage of markets, addressing the inefficiencies of state action via competitive and profitability pressures; of communities addressing equity issues of markets by providing time- and place-specific information, equitable allocation of benefits and increased participation; and of governments addressing the lack of coherence of markets and garmented communities. Empirical case studies on this hypothesis are, however, rare (Dietz & Stern, 2002 in Villamayor-Tomas, 2014, Svensson, 2021).

This work investigates this hypothesis by looking at a specific hybrid system of two governance forms: water markets, as a market-based instrument, and water user associations, as a local-level community approach or common property regime. A systematic case study review reveals the many facets and interdependencies of this hybrid governance form and analyzes its social, economic and environmental outcomes.

2. Literature background

2.1 Theory on markets and common property regimes

Already pointed out by David Hume in 1740 and picked up by Mancur Olson in 1965, the problem of collective action is a long-debated issue. Both scholars found that only a small sized group might be able to act in their common interest. However, “a thousand neighbors” (Hume, 1740) with no “coercion or some other special device” (Olson, 1965) will act as self-interested individuals, disregarding the social optimum. Garett Hardin (1968) coined this phenomenon the *tragedy of commons,* which he claims can only be overcome by either state control or the establishment of private property (Hardin, 1968). Similarly, economist from the 1950s to the 1970s conclude that the solution to collective action problems is the allocation and the enforcement of private property or the simulation of private property rights through licenses or quotas (Cheung 1970, Gordon 1954, Johnson 1972, Posner 1977, Scott 1955 in Acheson, 2006). They argue, that by directly receiving the benefits, private owners are incentivized to conserve and invest into their property. Moreover, they argue, that owners are likely to use their resources and capital efficiently as they seek to maximize income, rejecting less productive options of resource use or technology (Acheson, 2006). However, in practice, market failures, such as negative externalities and the unsustainable use of resources by private owners, are not rare (Acheson, 2006, Meinzen-Dick, 2007). In order for a market to function efficiently several preconditions have to be fulfilled: clear property rights, low transaction costs (Acheson, 2006; Kloezen, 1998; Leonard et al., 2019), complete information on resource availability and market, e.g., sellers and buyers, prices, etc. (Muradian & Rival, 2012; Winchester & Hadjigeorgalis, 2009) and a certain level of dependence on the market through resource scarcity (Donoso, 2012; Winchester & Hadjigeorgalis, 2009; Svensson, 2021).

Common property regimes were long frowned at as an obsolete governance form of the past, slowly disappearing in the face of modernization (Agrawal, 2001). In the mid-1980, though, as human

impacts on the environment became more and more visible, the approaches of imposing state or individual institutions over resource users were started to be questioned (Cox et al., 2010). Numerous studies were published stressing the ability of resource users to avoid the tragedy of commons under certain conditions (e.g., Agrawal, 2001; Ostrom, 1990). Among other scholars, Elinor Ostrom stands out for the design of institutional arrangements, that help to build and maintain trust, reciprocity and social cohesion, which in turn, enables collective action and prevent the deterioration of common-pool resources (Ostrom, 1990). Ostrom and colleagues consent on a number of characteristics that help to agree on and enforce collective rules: "a sense of community, social capital, social homogeneity, dependence on the resource, leadership, and secure boundaries" (Acheson, 2006, p. 127), a small size and the recognition by state authorities (Acheson, 2006; Ostrom, 1990).

As described above, markets and common property regimes, have preconditions that need to be fulfilled for them to function well. Also, each governance form has strengths and weaknesses (Acheson, 2006). They are listed in the methodology section in table 1. Both, preconditions (as variables of functional characteristics) and strengths and weaknesses (as outcome variables) are translated into variables and analyzed for the hybrid system of water markets that are somewhat participated or managed by water user associations (WUAs), in order to be able to evaluate the outcome of the hybrid governance form.

2.2 Theory on water markets and water user associations

Water is a typical common-pool resource, defined by two characteristics: First, water is subtractable, meaning that one unit used is not available anymore for another user (at least not in the same quality) and second, other users are hardly excludable (Ostrom, 1994). As a result, and according to Hardin´s *tragedy of commons,* water resources are overexploited leaving some users (people and environment) with little or no water. This dilemma is exacerbated by climate change. Moreover, water is difficult to manage. Unique characteristics of water are high variability in time and space, high mobility and heaviness, making water availability and quality very unpredictable and water difficult to transport and store (D. E. Garrick et al., 2020). Following the theory on markets and common property regimes, two water governance forms have evolved, or have been implemented, to meet these challenges: The market-based privatization of water, implementing water markets, and the community-based decentralization of water governance, transferring responsibilities from the state to local-community based organizations, such as water user associations.

When talking about the privatization of water, some initial distinctions have to be drawn. On the one side there is the privatization of urban water utilities, where the management of water storage (through big water projects like dams) and the management of water distribution pass from public entities into the hands of private companies. Much of the literature on this topic comes from an Urban Political Ecology perspective focusing on the inequalities of water access, quality and affordability (e.g., Mack & Wrase, 2017; Truelove, 2019). On the other hand, there is the marketization of raw water, in which water rights are traded on a water market (Bakker, 2009). In this research I use only the latter form of water markets. The existing water markets in the world differ widely in their institutional frameworks. Informal markets for groundwater are emerging throughout the Global South, particularly in India, where many regions are lacking the regulatory

and administrative capacities to establish and enforce water rights, often facing the over-use and inequalities in access and water quality (D. Garrick et al., 2020). Formal water markets, however, are still rare. A formal water market requires three initial steps: i) the creation of an extraction cap limiting resource extraction in a defined area, ii) the allocation of tradeable water rights, recognizing the withdrawal and use and excluding non-right holders, and iii) the creation of trading rules, to facilitate transactions and avoid negative impacts of trading (D. Garrick et al., 2020; Svensson et al., 2021). I define water markets as the regulatory framework allowing water users to sell or buy raw water using a pricing system. The first countries introducing formal water markets were Chile, Australia and the USA, followed by Mexico, Spain and Canada (D. Garrick et al., 2020) and, more recently, China (Svensson et al., 2021). However, success has been limited. While economists of the World Bank initially promoted Chile´s neoliberal water markets as an example to follow, scholars now point out worsening water conflicts due to the "lack of institutional governance or integrated water resources management" (Bauer, 2015, p. 147). Also Australia´s water market in the Murray-Darling basin was called a "failed experiment" (D. E. Garrick et al., 2020; Meinzen-Dick, 2007) after issues of over-allocation and equity became visible (D. E. Garrick et al., 2020).

While these experiences stopped the expansion of formal water markets, there is a growing recognition of the potential of less formal arrangements, such as self-organization by water users, referring to common property regimes (CPR) (D. Garrick et al., 2020). One example for CPRs are water user associations (WUAs). In this study WUAs are defined as a group of farmers managing water resources collectively. In a participatory way WUA members select a set of rules to manage a shared irrigation system and water deliveries (Lohmar et al., 2003, Zhang, 2014). They act on an operational, collective choice and/or constitutional choice level (Meinzen-Dick, 2007). Operational level actions are physical activities e.g., building fences or patrolling the borders of their agricultural land. Collective choice actions are decision about the operational actions e.g., the decision to reduce water shares during a drought. Constitutional choice actions are decisions about how collective choice actions can be established and changed (Ostrom, 1994). Depending on their level of autonomy (by state transfer), WUAs operate on one, two or all three levels of action (Meinzen-Dick, 2007).

2.3 Theory on hybrid governance forms

Hybrid governance forms are based on the recognition that no single governance form, no single actor, can "address the multiple facets, interdependencies, and scales of environmental problems" (Lemos & Agrawal, 2006, p. 311). Moreover, it recognizes the need of environmental governance to be adaptive and transformative, combining "governance of transformation and the transformation of governance" (Pahl-Wostl, 2017, p. 2929). In the sector of water governance, case studies evaluating hybrid governance forms, are still limited (Meinzen-Dick, 2007) and rather new. Positive outcomes of common property institutions in combination with transferable quota institutions have been detected by Villamayor-Tomas (2014) for the case of Spain. According to the author, transferable quotas contribute to the flexibility of farmers and this in turn increases cooperation in irrigation systems (Villamayor-Tomas, 2014). Also, Svensson et al., (2021) concludes that hybrid irrigation systems, combining government regulations, market mechanisms and WUAs can be successful. His investigation concentrates on the "two-hands approach", the mixture of government and markets demonstrating how this hybrid system works and how actors influence each other (Svensson et al., 2021). Contrary, Mirumachi & Van Wyk (2010) demonstrate that there is no positive effect of hybrid governance forms on power asymmetries between stakeholders. Analyzing the case

of South Africa, the authors conclude that the new hybrid water governance does not change the old, predominant power structures (Mirumachi & Van Wyk, 2010).

This study follows these authors, by evaluating the hybrid system of water markets and WUAs. In a first step it analyzes the characteristics of each governance form and their mutual influence. The second part evaluates the performance of the hybrid governance form and its social, economic and environmental outcomes. The evaluation is based on the hypothesis - deducted from Lemos & Agrawal (2006) - that hybrid governance forms benefit from the strengths and neutralize the weaknesses of water markets and WUAs, leading to social, economic and environmental sustainability.

3. Methodology

My research questions are: What are the institutional and functional characteristics of water markets and WUAs? Are the preconditions for water markets and WUAs fulfilled? How do the two governance forms of the hybrid system, water markets and WUAs, influence each other? What are the social, economic and environmental outcomes of the hybrid governance form?

To answer my research questions, I conducted a systematic case study review, or meta-analysis. By synthesizing and evaluating the results of individual studies, this methodology is used to find consistencies allowing to “draw robust and broad conclusions” on a specific question or issue (Siddaway et al., 2018). Following the recommendation of Siddaway et al., (2018), I structured my study in 5 key stages: i) surveying the existing literature and formulating a research question, ii) planning the literature search by formulating search terms and inclusion and exclusion criteria, iii) searching and inspecting literature, iv) screening the literature for potential inclusion in a first and second screening and v) deciding on the eligibility of inclusion of a case study after reading the article.

In order to find suitable case studies, I searched for literature on hybrid governance forms of water markets and water user associations. I established two categories of key words. The first including “water markets” and very similar terms, namely “water transfer” and “water trading”. The second category including “water user associations” and very similar terms, namely “irrigation community”, “irrigation association”, “common property regime”, “collective action” and “cooperative”. The scope was limited to academic peer-reviewed papers in English. I excluded books, book chapters, editorials, notes and conference papers due to limited access. Using the electronic database Scopus I collected 1.631 results in June 2021 entering the following search strategy: *("water market" OR "water transfer" OR "water trading") AND ("irrigation community" OR "water user association" OR "irrigation association" OR "common property regime" OR "collective action" OR "cooperative") AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")).*

In my first screening of the articles, I eliminated all duplicates and those papers which don´t mention at least one keyword of one category in their abstract, title or keywords. Following these guidelines, I excluded 1.117 results and maintained 476. In 34 cases no abstract was available on Scopus. I

therefore extended my search to Google Search and other sources, where I was able to find all but 8 papers. In the second selection, I read the abstract carefully, eliminating those studies which were modelled or clearly had a different topic. Although the modeling studies explore economic consequences of water markets, I decided to exclude them, as they are not able to provide contextualized information on water markets and WUAs but concentrate on specific outcomes. In the final selection, I fast-read the remaining 206 papers and again excluded modelled cases (16), systematic literature reviews, presenting no specific case (18), papers that were not available (3) and papers which did not provide information on a hybrid system (135). This last group is comprised of i) papers with related but different topics e.g., water security, transboundary conflicts over water, etc., ii) papers presenting markets and WUAs as alternative, not hybrid, governance forms, iii) papers without water markets according to my definition (see below), although sometimes mentioned as a future recommendation and iv) papers without information on WUAs, providing information on community at large or WUAs as a future recommendation. My final sample included 34 papers with 36 cases meeting my inclusion criteria: cases presenting a hybrid system of market mechanisms, where water rights are traded based on a pricing system, and collective management of WUAs, acting on an operational, collective choice and/or constitutional choice level. The case studies are listed in the annex in table 2.

A qualitative coding scheme was used to analyze the 36 case studies. In the first part of the scheme, contextual variables gather data on geographical information and the characteristics of water markets and WUAs. By looking at the institutional and functional characteristics, the study aims to detect differences within the hybrid governance forms, as well as to determine if the preconditions for markets and CPRs are fulfilled. It also analyzes how the governance forms interact and influence each other, to understand the configuration and functioning of the hybrid governance form. The variables of this first part are taken from the above-mentioned theory on the preconditions for markets (e.g., Acheson, 2006; Donoso, 2012; Muradian & Rival, 2012) and CPRs (Acheson, 2006; Ostrom, 1990), as well as from differences in water markets and WUAs found in the literature (e.g., formal or informal, permanent or temporary trading, etc.). These contextual variables and description are listed in the annex in table 3. In the second part, outcome variables, based on the strengths and weaknesses of each governance form (see table 1), evaluate the performance and social, economic and environmental outcomes of the hybrid governance form. I measured them according to “high”, “moderate” and “low” levels. Variables with less detailed information were measured in “yes”, does exist, and “no”, does not exist, or “positive”, “negative” and “no change”. Doing this I aim to verify the hypothesis of water markets and WUAs complementing each other in a hybrid governance form, leading to social, economic and environmental sustainability. Variables, category and theory are listed in table 1:

Table 1: Variables on the social, economic and environmental outcomes of the hybrid governance form, deducted from the theory on the strengths and weaknesses of (water-) markets and CPRs

Outcome variables	Variable Description	Outcome category	Theory on markets (M) and CPRs
Cooperation	Cooperation among WUA members (within WUA: includes sharing local knowledge, sharing actions on operational level and participation in decision-making process; outside WUA: same than within WUA)	Social	Strength CPR: Cooperation between WUA members and outside organizations (includes the sharing of local knowledge, sharing actions on operational level and participation in decision-making process) (Acheson, 2006)

Social Capital	Social capital (solidarity, trust, reciprocity) among the WUA members or between WUA members and outsiders	Social	Weakness M: Decrease of social capital, homo economicus: individual-based agent who chooses his/her own benefits over social optimum (Sofoulis, 2015) Strength CPR: Experience of cooperation creates social capital (or not) (Acheson, 2006)
Equity in resource distribution	WUA members receive water resources equitably	Social	Weakness M: Inequity in water allocation (concentration of water on big farmers) (Pujol et al., 2005, Zekri & Easter, 2007) Strength CPR: Equitable allocation of benefits (Lemos & Agrawal, 2006)
Power asymmetries	Power imbalances in the decision-making process, market participation or access to water, within WUA or between WUA and outsiders	Social	Weakness M: Dominance of big farmers (Sumpsi et al, 1998, in Pujol et al. 2005) Weakness CPR: Dominance of subgroups in the collective decision-making process (reproducing social and cultural power asymmetries) (Acheson, 2006)
Social relation to water	Relation of WUA members to water and nature in general. Process of commodification of water taking place.	Social	Weakness M: Negative impacts on social relation to nature through the commodification of water (Sofoulis, 2015)
Economic profit	Level of profit for individual WUA members and/or collective WUA	Economic	Strength M: Increased economic profit (Acheson, 2006)
Implementation of water efficient technologies	WUA members or WUA undergo a modernization process implementing new technologies	Economic	Strength M: Increased economic efficiency through the implementation of resource efficient technologies (Acheson, 2006; Donoso, 2013; Meinzen-Dick, 2007; Kloezen, 1998)
Water allocation towards highest value use	WUA members change crop mix towards higher value	Economic	Strength M: Increased economic efficiency through (re-)allocation of water towards highest value use (Acheson, 2006; Donoso, 201;, Meinzen-Dick, 2007; Kloezen, 1998)
Transaction costs	Level of transaction costs for information gathering, monitoring, sanctioning, trading process, conflict resolution and other	Economic	Strength M: Low transaction costs for conflict resolution through courts when property rights clear (Acheson, 2006) Weakness M: High transaction costs for information gathering ex ante y ex post trading (Leonard, 2019; Williamson, 1985, in Pujol et al., 2005) Strength CPR: Lower transaction costs due to different activities such as conflict reduction and monitoring (Donoso, 2013)
Externalities on third parties	Existence of externalities on stakeholders within or outside the WUA, created through trading or the hybrid system in general	Economic	Weakness M: Negative externality on third-party stakeholders when trading (Howe et al., 1986, in Pujol et al., 2005)
Water use short term **Water use long term**	Change in water use of WUA members or WUAs in the short term Change in water use of WUA members or WUAs in the long term	Environmental	Strength M: Sustainable use of resources due to price mechanisms (Acheson, 2006) Weakness M: Unsustainable use of resources due to private interests (Acheson, 2006)

			Strength CPR: Sustainable resource use through community institutions (Acheson, 2006) Weakness CPR: Unsustainable use of resources due to unsuccessful management (Acheson, 2006)
Impact on the environment	Impact on the environment of trading or hybrid system in general	Environmental	Strength M: Incorporation of negative externalities on environment through pricing

4. Results

4.1 Geographical information

Of the 36 case studies included in this review, most cases investigated governance systems of water markets and WUAs in China (7), USA (6), Chile (4) and Spain (4). Followed by Oman and India (each 3), Mexico, Algeria and Australia (each 2) and Bangladesh, New Zealand and Taiwan (each 1). Hence, they represent the most prominent formal and informal markets that are currently active (Easter & Hearne, 1995).

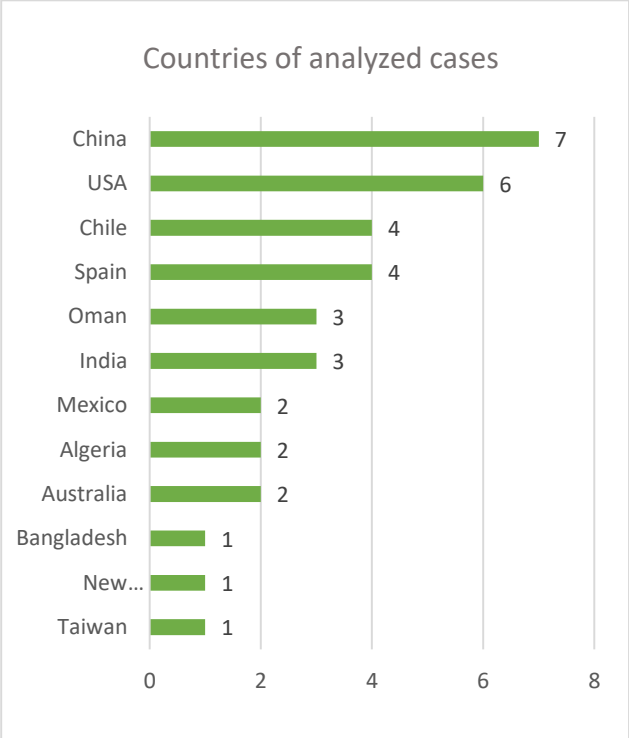

Figure 1: Countries of analyzed cases

4.2 Market information

Looking at the gathered data about markets (Fig. 1), it becomes clear that the analyzed cases present big differences in the characteristics of water markets. Depending on the legal framework of the country, as well as the market rules established by WUAs, water markets can take many different forms and shapes. "Institutional characteristics", being the basic structure of water markets, "objective(s)" for the implementation of market-mechanisms and "functional characteristics", influencing the functioning of markets, are therefore important to analyze in order to get a complete picture on how water markets function within a hybrid governance system.

4.2.1 Institutional characteristics

"Institutional characteristics" are characteristics, which depend on the institutional framework of the water market. They include "formal and informal markets and their water sources" (Fig. 2), "trade within vs. beyond the agricultural sector and WUA organization" (Fig. 3), "permanent vs. temporary trade" (Fig. 4) and "property rights vs. water use rights" (Fig. 5).

4.2.1.1 Formal and informal water markets and their water sources

In China, the USA, Chile, Oman, Mexico, Australia, New Zealand and Taiwan all cases investigated take place within a formal market, based on a legal framework implemented and recognized by the respective governments. Formal markets mainly trade surface water or both, surface and groundwater (subsurface water).

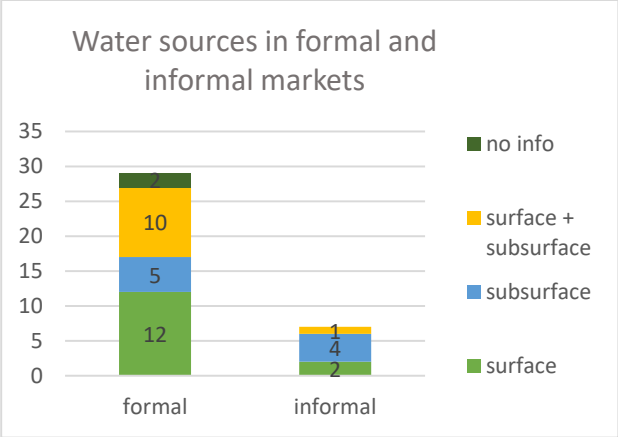

Figure 2: Water source(s) in formal and informal water markets

In Spain 2 formal and 1 informal markets are investigated, indicating that, although there is a formal water market, informal exchanges outside of the legal framework also exist.

In the cases of India (3), Algeria (2) and Bangladesh (1) markets are informal, meaning that no formal tradeable water rights have been introduced (in the country or specific region), however, water trading is taking place. Yet, the extraction of water is recognized and even encouraged by some governments paying subsidies for the installation of collective tube wells as in the case of Hamamouche et al. (2020). Informal markets mainly trade groundwater. Further analyzing the 7 cases of informal water markets, it is interesting to note that "power asymmetries" are "high" (5), especially in relationship to market participation. The cases that provide information on this topic (5) all present some kind of dominance structures, mainly between WUA and outsiders. As is the case of Hamamouche et al. (2020), where the state subsidizes the construction of collective tube wells, giving agricultural cooperatives financial advantages over non-cooperative market participants; or in the case of Imache et al. (2009), where access to land and water is restricted to state-recognized farmers. Farmers without an official license, the "lessees", can therefore never sell water, but only buy it. In the case of Sanchis-Ibor et al. (2019), a dominance structure is expressed by the urban water supply authorities only trading with big WUAs due to a better developed infrastructure. Small WUAs are left out of the negotiations and "do not receive treated wastewater from the coastal cities, but they are affected by the extractions of groundwater that other agricultural users are regularly sending to the urban areas" (Sanchis-Ibor et al., 2019, p. 4).

4.2.1.2 Trade within vs. beyond the agricultural sector and WUA organization

Of the 36 cases water trading mainly takes place within the agricultural sector (19). There is only one case where water is solely being traded beyond the agricultural sector. In this case water is not traded within the community, which is working with a shared allocation system. Only when sold out of the community to the mining sector, water is leased in exchange of money (Garrido, 2011).

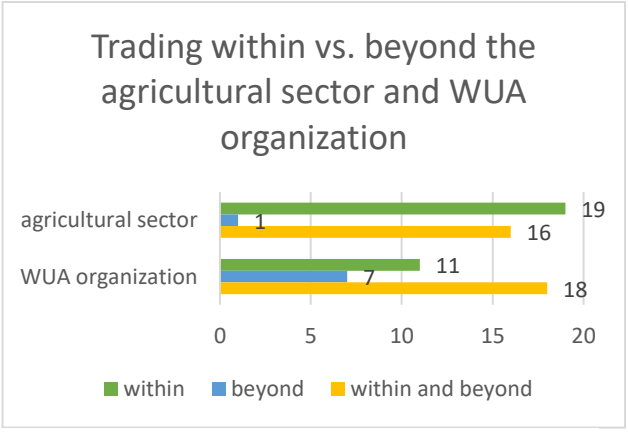

Figure 3: Trade within vs. trade beyond the agricultural sector and WUA organization

Also, in quite a big number of cases (16) water is traded both ways, within and beyond the agricultural sector, namely between agriculture and domestic/urban uses or between agriculture and industry. The cases where water is traded beyond the agricultural sector, are at the same time those that trade beyond WUA organization (7), being sold from one or several WUAs to another sector. Though, the inverse is not true. There are cases that trade beyond WUA organizations, but within the agricultural sector. This is the case for e.g., Kloezen (1998), where surplus water is traded between WUAs within the agricultural sector. WUAs more frequently trade beyond. Trade beyond single WUAs is therefore higher than trade beyond the agricultural sector.

4.2.1.3 Permanent vs. temporary trade

Trading is mostly temporary. Temporary trade can vary from leasing additionally needed water for a few hours (Al-Marshudi, 2008), or renting water for several cropping seasons (Imache et al., 2009), to transferring water rights from 5 up to 50 years (Gastélum et al., 2009). In 19 cases water traded on the market is solely temporary, in 14 cases both, temporary and permanent, and in 3 cases only permanent. Reasons for the primarily temporary trading are state or WUA restrictions on permanent water sales (Pincus & Shapiro, 2008; Hanemann, 2014), higher tran saction costs on permanent than on temporary trades (Donohew, 2009), or the feeling of uncertainty over future water supply, discouraging farmers to permanently sell their water rights.

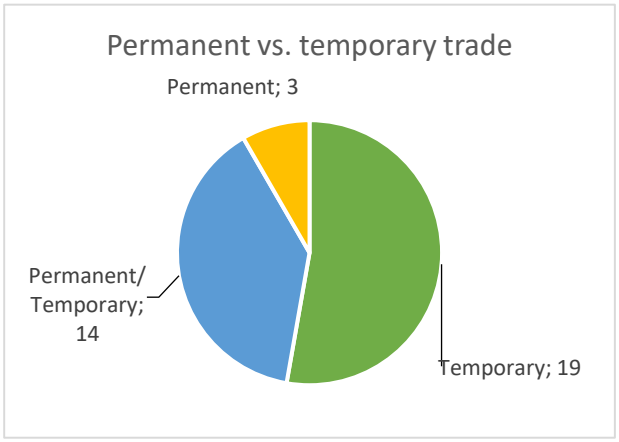

Figure 4: Permanent vs. temporary trade of water or water use rights

4.2.1.4 Property right holders vs. water use right holders

In the 36 reviewed cases water property rights (Fig. 5, inner circle) and water user rights (Fig. 5, outer circle) are often in the hands of two different actors. From the cases that provide information on the ownership of property rights, the majority lie with the state (15). However, water user rights lie mainly in private hands (17), followed by collective entities (8). Some cases (5) show a mix of water use rights, as e.g., in the case of Al-Marshudi (2007), where the WUA members hold private water rights and the WUA organization holds collective water rights which are leased to WUA members with an additional need for water. The revenues obtained by the leasing are used to cover the operation and maintenance costs (Al-Marshudi, 2007). Also, in the case described by Gastélum et al. (2009), the state holds the property rights over all water resources and "issues water rights to private interests (concessions) and to governmental entities (assignments) such as municipal water supply systems" (Gastélum et al., 2009, p. 88). The 5 cases with "no formal water rights" are all cases of informal markets. The only case of an informal market, which does have formal water rights, is the case of Sanchis-Ibor et al. (2019) already mentioned above, where a formal market with collective water use rights exists, however, trading takes place outside the legal framework. Interesting is also, that the 3 cases of "private" property and water use rights are all cases from

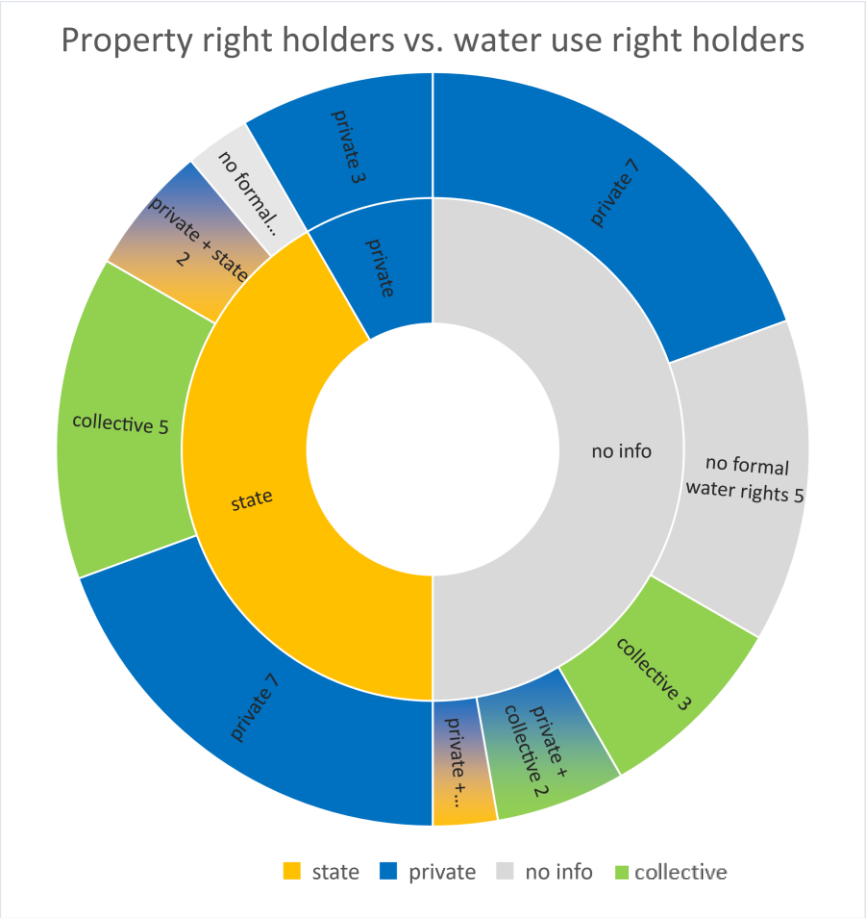

Figure 5: Property right holders vs. water use right holders

Chile, where "water rights [are] private and transferable property" (Urquiza & Billi, 2020, p. 1939), however, the reform of the water code of 2005 establishes "a presidential discretionary power to eliminate certain water rights from the market to 'protect the public interest'" (Borzutzky & Madden, 2013, p. 257). In this sense, property rights can also be restricted or eliminated.

4.2.2 Objectives

The objectives of introducing market mechanisms to water governance systems are various, however, current or future possible water shortages are the main driver. The objectives of "tackle water scarcity" (13), "drought resilience" (6), "uncertain water supply (due to climate conditions)" (3) and "risk reduction (due to shortages)" (4) all aim at guaranteeing water supply. "High/increased demand" (6) includes the increase of water demand due to population growth and/or agricultural/industrial expansion. "Create access to water" (5) refers to water access for more users, within or across different sectors. "Control consumption" (3) refers to the attempt to control the excessive use or overexploitation of water

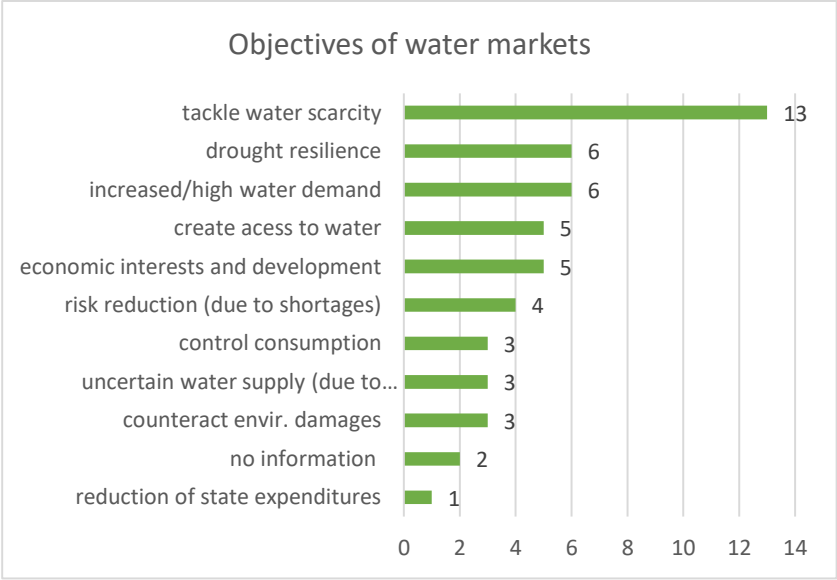

Figure 6: Overview of the objectives of water markets

resources by introducing a ceiling on water rights or water tickets as in the case of G. Huang (2015). One case mentions as objective the "reduction of state expenditures", referring to the decrease of state expenditures when passing water governance from the hands of the state to the hands of markets. Most cases state several of those objectives. Again, it is interesting to note that informal markets mainly evolve due to limited access or availability of surface water as in the cases of Hamamouche et al. (2020) and Imache et al., (2009) where informal groundwater markets evolve in response to the "surface water crisis" (Hamamouche et al., 2020, p. 158) or to state restrictions on water access for *lessees* (unrecognized farmers by state authorities).

4.2.3 Functional characteristics

The analysis of functional market characteristics, which have the potential to influence the functioning of the markets, shows the following results: Out of 20 cases that provide information on this topic, 16 indicate a high (6) or moderate (10) dependence on water markets, indicating a relatively high dependence of water users on the water they purchase in the market, having little or no alternative of meeting their water demand through other sources or precipitation. A good example is the case of Hamamouche et al. (2020), where the available surface water is not sufficient anymore and farmers depend on the traded groundwater. The dependence exacerbates for farmers who do not have the means to finance a private tube well or are part of a subsidized cooperative.

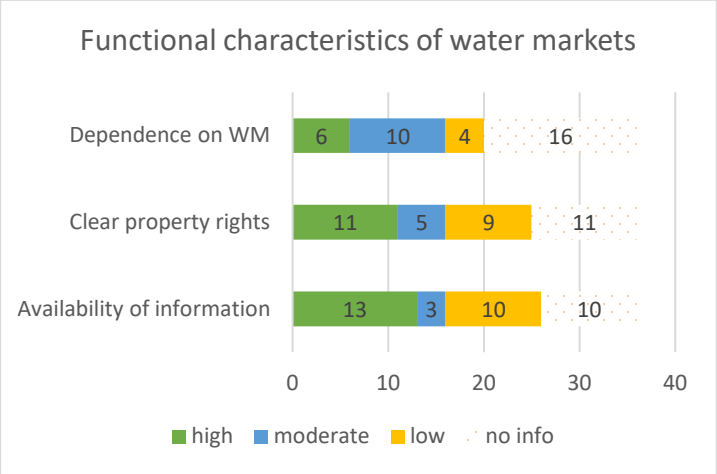

Figure 7: Level of functional characteristics of water markets

The variables of "clear property rights" and "availability of information" show the same total level of "high" and "moderate" cases, namely 16 combined, however, the responses for "low" are higher. "Unclear" property rights often exist in groundwater markets, where neither property is clear, nor water access and use controlled (Imache et al., 2009) or in cases with a "quilt-work of property rights to water" (Hanemann, 2014, p. 21), where property rights and water use rights lie in the hands of different actors. The variable of "availability of information" shows similar results, with 10 out of 26 cases indicating a lack of information. In these cases, information is missing on resource availability (Urquiza & Billi, 2020), the initial allocation process of water rights (Carrasco, 2016), water right holders and transfers (Kloezen, 1998), trading prices (Nicol & Klein, 2006) or trading rules (Palomo-Hierro et al., 2015).

4.3 WUA information

This section provides information on "WUA activities" and "functional characteristic of WUAs".

4.3.1 WUA activities

The main activities WUAs are carrying out is the operation and maintenance of irrigation infrastructure (O&M) (19), overseeing the process of water allocation to its members (13). Also mentioned is the election of leader(s) (7), the decision making on rules (6), the charging of fees (6), conflict resolution (6), the construction of infrastructure (5), ownership of infrastructure (5), monitoring (4), decision making on investments (4), administration of irrigation area (3) and sanctioning (3). Other activities are mentioned twice or once.

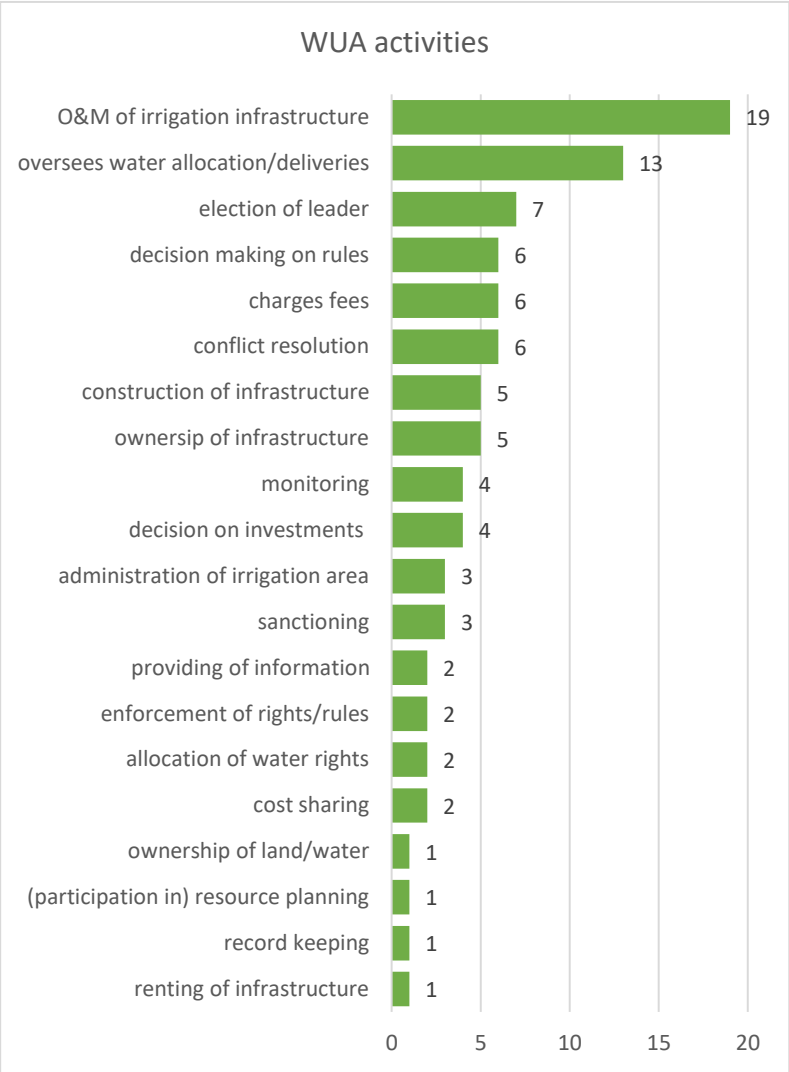

Figure 8: Overview of activities carried out by WUAs

4.3.2 Functional characteristics

In general, the cases present less information on the functional characteristics of WUAs than on markets. More than 60% of the cases don´t provide information on size, dependence on irrigation agriculture and leadership. Of those cases that do provide information, small, medium and large "size" WUAs are equally present (3 each). All other variables have a clear tendency towards one of the evaluation levels. The variable of "leadership", referring to the trust of the WUA leaders by its members or the good performance of WUA leaders, as well as the

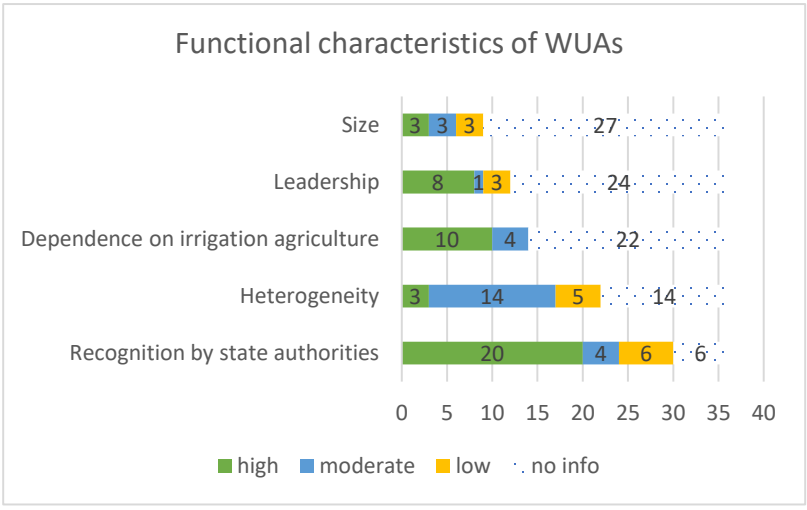

Figure 9: Level of functional characteristics of WUAs

variable of “dependence on irrigation agriculture” tend towards “high” levels, with 8 out of 12 and 10 out of 14 cases respectively. Of those cases with “high leadership” it is interesting to note two different types of leadership. The first with a top-down, or authoritarian, approach, where WUA leaders are political leaders of the village, as in cases from China (Hu et al., 2014; G. Huang, 2015) and India (Mosse, 1997) and the second with a more democratic approach, where leaders are elected and accountable to WUA members, as in cases from Oman (Zekri & Al-Marshudi, 2008) and the USA (Lepper & Freeman, 2010). “High dependence on irrigation agriculture” is given in cases e.g., of Hu et al. (2014), where "most residents earn their livelihood through irrigated agriculture…" (Hu et al., 2014, p. 162), or Mosse (1997), where “high proportion of cultivated area [is] irrigated” (Mosse, 1997, p. 492).

More information is provided on “heterogeneity” and the “recognition by state authorities” of WUAs. From 22 cases 17 indicate a “high” or “moderate” level of “heterogeneity”, presenting differences in the scale of farms, socio-economic differences between farmers and differences in water supply according to the priority of their water rights (junior vs. senior rights). WUAs are relatively highly “recognized by state authorities” with 20 cases indicating “high”, 4 “moderate” and 6 “low” levels. It is important to mention, that the recognition of WUAs not necessarily matches the recognition of water markets. E.g., Mandal (1987) describes an informal groundwater market, where no formal water user rights have been allocated, however, the state officially recognizes and encourages the creation of WUAs by implementing a state program, designed to rent electric tube wells to farmer cooperatives. Another example is described by Carrasco (2016), where formal water markets have been introduced but many irrigation communities have been left out of the initial allocation of water rights: The indigenous community is facing disadvantages over private mining companies, which are the official water right holders.

4.4. Hybridity and the interrelation of water markets and water user associations

By looking at the role WUAs play in water markets, as well as the influence WUA characteristics have on markets, the interaction between the two governance forms is demonstrated.

4.4.1 WUA role in the market

Apart from the above-mentioned activities, some case studies specify the role of WUAs in the market. In 9 cases a WUA realizes negotiations about trading conditions with the state, other organizations/sectors or farmers (Gastélum et al., 2009; Hamamouche et al., 2020; G. Huang,

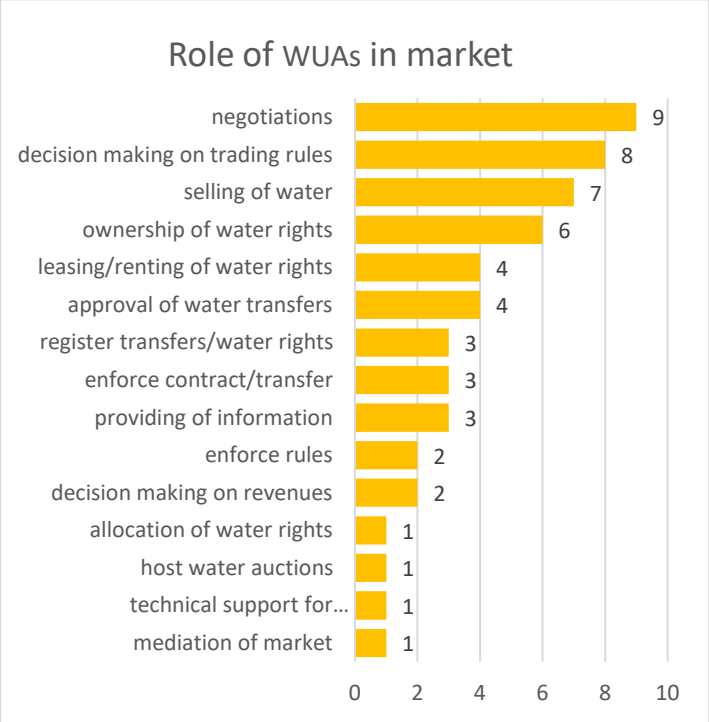

Figure 10: Role of WUA in the water market (i.e., market specific WUA activities)

2015; Imache et al., 2009; Kloezen, 1998; Liu et al., 2018; Sanchis-Ibor et al., 2019; Zheng et al., 2009). Also, several cases indicate that a WUA makes decisions on market rules (8), sells water (7) or is the owner of the water rights (6). In lesser cases, a WUA is responsible for the leasing or renting of water or water rights (4), approving of water transfers (4), registering the transfer of water or water rights (3), enforcing contracts (3) and providing of information (3). In very few cases, WUAs enforce (market) rules (2), make decisions on revenues (2), encourage market activities (1), host water auctions (1), give technical support for contract making (1) and mediate the markets (1).

4.4.2 Factors influencing the functioning of markets

The following graphs (Fig. 11, Fig. 12) show positive and negative factors influencing the functionality of WMs, that are explicitly mentioned by the authors. Several of them have already been mentioned in the figures of the functional characteristics of WUAs (see Fig. 9) and markets (see Fig. 7), confirming the importance of evaluating them before analyzing the outcomes of a hybrid governance model.

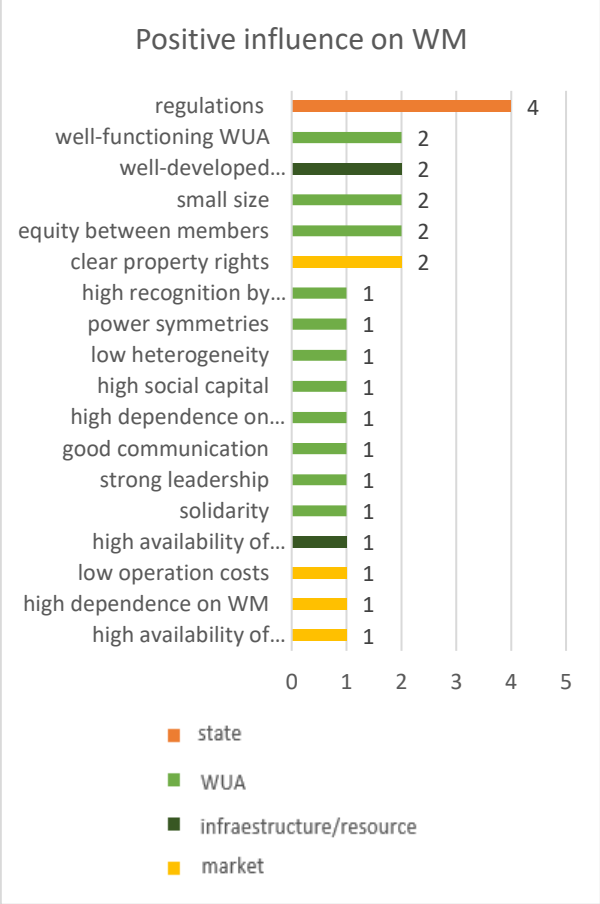

Figure 11: Activities or characteristics of state, WUA, markets, and infrastructure or resources with a positive influence on water markets

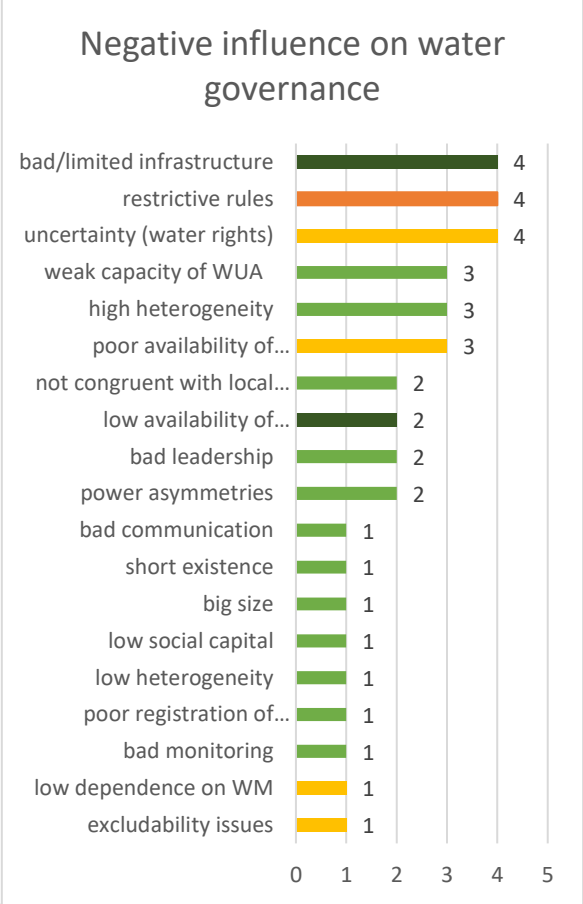

Figure 12: Activities or characteristics of state, WUA, markets, and infrastructure or resources with a negative influence on water markets

Thus, the WUA characteristics of ”size” and “heterogeneity” are negatively and “leadership”, and “recognition” positively correlated to the functioning of water markets. A positive correlation holds

for general performance or capacity of WUAs and the market characteristics “clear water rights”, “dependence on WM” and “availability of information”. Further characteristics, which are evaluated in this study as an outcome of hybrid systems, “power symmetries” and “(distributional) equity between members” are also positively correlated. Notably, “regulations” can have both a positive and negative influence on the functioning of water markets. Some regulations, such as the separation of land and water (Borzutzky & Madden, 2013; Gross & Dumaresq, 2014) or the charging of the non-use of water (Borzutzky & Madden, 2013) is evaluated to have a positive impact on water markets, increasing market transactions. Whereas restrictive rules limiting the free trading system by e.g., only allowing transfers to “equivalent or higher priority” (Palomo-Hierro et al., 2015, p.655) or maintaining the property rights over water in public hands (Donohew, 2009), are considered by the authors to have a negative impact on water markets, decreasing water transactions. Another variable that appears in a contradictory manner is “heterogeneity”. Whereas” high heterogeneity” is evaluated in 3 cases of having a negative influence on water markets, one case evaluates “low heterogeneity” as having a negative influence on water markets. Mukherji (2007) comes to this conclusion, as the WUA consists of only medium and large farmers, who instead of selling their water from a collective tube well buy more land, leaving small farmers with even more disadvantages in the water market (Mukherji, 2007). Further explanation also needs the variable of “resource availability” appearing as a positive influence being high and a negative influence being low. The theory is that the scarcer a resource is, the more active will be the water market (Donoso, 2012; Svensson et al., 2021; Winchester & Hadjigeorgalis, 2009). The study of Nicol & Klein (2006) seems to confirm this theory, indicating that there are no market activities in non-drought years (Nicol & Klein, 2006). However, in figure 11 market transactions appear to decrease due to low availability of resource. This is the case described by Hu et al. (2014), where "only 3.6% of the households traded their irrigation water rights within their communities. As irrigation water quotas continued to shrink, farmers who use groundwater for irrigation had no surplus water to trade, and the trading events were the result of social, not economic, considerations" (Hu et al., 2014, p. 165).

4.5 Outcomes of the hybrid governance forms

I analyze the 36 case studies, firstly, on the overall performance of the hybrid governance form, capturing the conclusion the author makes on its sustainability, some case studies focusing more on social, others on economic and others on environmental impacts. Secondly, I look at the activity of markets, which can give an idea of the impact of the hybrid governance form on markets. And lastly, I analyze the social, economic and environmental outcomes of the hybrid governance form. Social outcomes look at the variables of “cooperation”, “social capital”, “flexibility”, “power asymmetries”, “equity in resource distribution” and “social relation to water” within or between WUAs, between WUAs and outsiders or individual WUA members. Economic outcomes look at the variables of “economic profit”, “transaction costs”, “the implementation of technologies”, “allocation of water towards the highest use value” and “externalities on stakeholders”, analyzing the economic outcome of the hybrid system for individual WUA members, WUAs as a group or between WUAs and outsiders. Environmental outcomes focus on the possible change in “water use” by WUA members or WUA organizations and the “impact on the environment”.

4.5.1 Overall performance

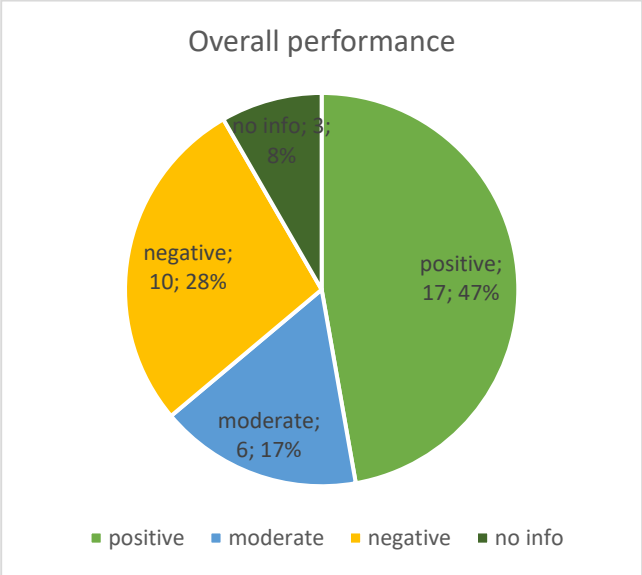

Figure 13: Overall performance of hybrid governance form

In almost all cases (33 out of 36) the author concludes with an overall evaluation of the performance of the hybrid governance system presented in their cases. In 17 cases (47%) this evaluation is "positive", in 10 (28%) "negative" and in 6 (17%) "moderate". The criteria of evaluation were various. Some cases focusing more on social sustainability, e.g., analyzing the impacts of water markets on community life (Carrasco, 2016), evaluating water transfer systems based on farmers satisfaction (Lange et al., 2008) on equity of distribution and benefits between all resource users (Mukherji, 2007). Other cases include multiple sustainability criteria in their evaluation. Al-Marshudi (2007) and Al-Marshudi (2008), for example, evaluate the performance of the traditional falaj system in securing water supply in arid regions like Oman. The same for the case of Hanemann (2014) about the American West. Garrido (2011), Gastélum et al. (2009), Rawal (2002) and Sekri Al-Marshudi (2008) are looking at equity and efficiency issues and others have a more general approach, focusing on the (re-) allocation of water to where it is needed (Borzutzky & Madden, 2013; Libecap, 2016; Liu et al., 2018; Mandal, 1987). G. Huang, (2015) explicitly analyze the effects of the governance system across the three dimensions: society, environment and economy. Svenson et al. (2021) and Palomo-Hierro at al. (2015) are making their overall evaluation based on the trading activity, or number of market transactions, and Hearne & Easter (1997) and Zheng et al., (2009) on economic and financial gains from a water trading system.

4.5.2 Market activity

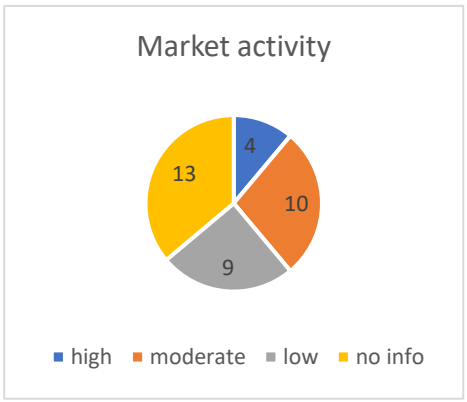

Figure 14: Level of market activity

By capturing the activity of markets, or number of market transactions, I attempt to measure the impacts of the hybrid governance form on markets. Independently of the reasons, may it be the WUA characteristics, the market characteristics or the interplay of both governance forms, this variable shows to which degree the market is used by water users, allocating water to where it is needed. The results show that market activity is in general not very high. From the cases that provide information on this variable, 9 are "low" and 10 "moderate. Only 4 cases state a "high" market activity. "Low" market activity is present in cases where the water amount being traded is relatively low compared to the water available (Donohew, 2009; Hu et al., 2014; Kloezen, 1998) or where trading concentrates in the hands of a few, limiting the number of market transactions (Mandal, 1987; Palomo-Hierro et al., 2015).

4.5.3 Social outcomes

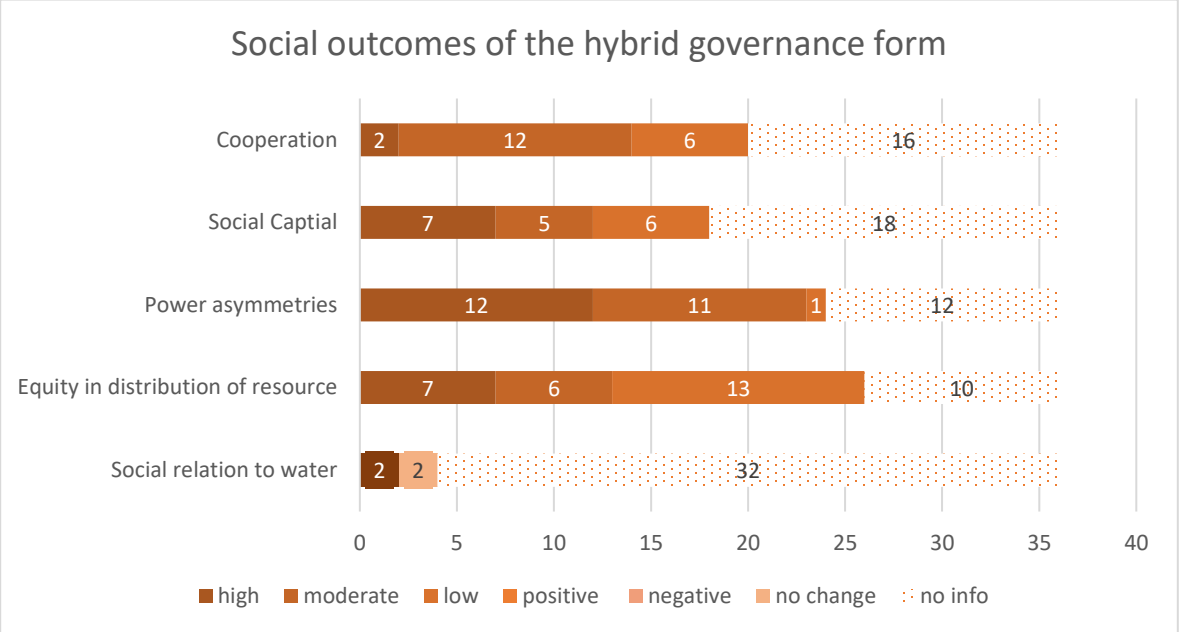

Figure 15: Social outcomes of the hybrid governance form

The level of "cooperation" between WUA members or WUAs and outsiders (individuals, state or other WUAs) is mainly "moderate". From the 20 cases that provide information on the topic, 2 are evaluated as "high", 12 as "moderate" and 6 as "low". My results show that "high" "cooperation" is only given in WUAs where community life is based on cooperative structures, as in the cases of the Atacameño community in Chile (Carrasco, 2016) or the village of Taiyuan in China (Svensson et al., 2021). However, the implementation of water markets within traditional systems, in some cases lead to a deterioration of cooperation e.g., in the case of Garrido (2011), where "in the places where a water market appeared the community continued to own and operate the physical infrastructure. But as a result of being too big, on those *huertas* there were fewer stimuli to cooperate and the community members who did not hold water rights did not usually make any kind of payment towards improvement and upkeep" (Garrido, 2011, p. 525). The problem of unequal access to water leading to low levels of cooperation is also detected in the case of Mandal (1987) in Bangladesh, stating that "these [hybrid] institutional approaches also demand high level of cooperation from the command area farmers, but given the highly unequal access to land, power, and other resources such cooperation is highly unlikely" (Mandal, 1987, p. 254). The case of Pincus & Shapiro (2008) insinuates not only a decrease in the stimuli of cooperation through the implementation of water markets, but also an increase in the stimuli of non-cooperation: "some irrigators may prefer delaying [collective decision-making], in order to obtain prices higher than others are prepared to sell for. This may drag out the process for years" (Pincus & Shapiro, 2008, p. 306). Although, water markets do not necessarily lead to low levels of cooperation. In the case of Al-Marshudi (2007) levels of cooperation are still "moderate", as the WUA still cooperates in collective decision processes e.g., electing the leader of the WUA or deciding on drought prevention rules. The difference to highly cooperating WUAs is, that in this case the WUA does not do as much collective operational actions, such as the maintenance of infrastructure. These activities are now executed by an employed WUA leader, paid from the revenues of water leasing.

Similar to “cooperation”, high “social capital” is given in WUAs with long-standing social relationships based on trust or reciprocity (see Al-Marshudi, 2007; Kloezen, 1998; Lepper & Freeman, 2010; Mukherji, 2007). In the case of Kloezen (1998) it is strong enough that "the price that is paid and the opportunity to allocate water to higher value uses are considered less important than the social and political arguments that WUAs use to maintain the level of solidarity in order to be able to effectively negotiate with CNA and other agencies in the public and private sector" (Kloezen, 1998, p. 452). “Low” social capital is usually put in relationship with market-produced rivalry and differences between farmers, as in the case of Urquiza & Billi (2020), where mistrusts “tends to be mainly from small owners and directed towards those farmers or companies with a larger amount of water stock” (Urquiza & Billi, 2020, p. 1942). Hamamouche et al. (2020) explains how social capital counteract effects of rivalry: "Despite the increased rivalry, the social dimension of water was not completely absent, even for the private water sellers. Some of them sell water at a lower price to their family and close friends, for instance" (Hamamouche et al., 2020, p. 164).

“Power asymmetries” are highly present in case studies reviewed. From 24 cases that provide information on the topic, 12 are evaluated as “high”, 11 as “moderate” and only 1 as “low”. Power asymmetries were found in the participation in decision-making processes between WUA members and especially in the market participation between WUAs and outsiders. The power asymmetries are, first, due to political dominance structures e.g. in the case of G. Huang (2015), where WUA leaders “were either village committee heads or village cadres” (G. Huang, 2015, p. 8956) or in the case of Mosse (1997), where “the interests of poorer, lower caste or tail-end farmers and women farmers are poorly encoded in official rules" (Mosse, 1997, p. 481) and “few farmers were able to manipulate publicly endorsed codes of water allocation to divert common water to meet personal needs" (Mosse, 1997, p. 482) or second, due to financial dominance structures, where markets are dominated by private companies (Gross & Dumaresq, 2014) or large farmers (Urquiza & Billi, 2020).

The variable of “equity in resource distribution” is closely related to “power asymmetries”, focusing on dominance structures within the distributional process of water between WUA members or between WUA members and outsiders. 7 cases were evaluated as “high”, indicating a fair distribution of water to WUA members according to the amount of irrigation area, amount of water rights or costs such as labor, materials or cash input. During drought and scarcity conditions water access is guaranteed to all WUA members (Hanemann, 2014; Kloezen, 1998; Lepper & Freeman, 2010). Several cases (6) indicate that both, equal and unequal distributions are present e.g., equal distribution within WUA, but unequal distribution between WUA members and outsiders (Carrasco, 2016; Mukherji, 2007). And in 13 cases, half of all cases providing information on this topic, some farmers/sectors/companies meet their water demands, while others receive very little or no water. This is because the latter don´t have water rights or water rights with less priority, they are outsiders to the WUA, or sell their water rights due to financial pressures (Garrido, 2011; Gross & Dumaresq, 2014; Hearne & Easter, 1997).

Little information is provided on “social relation to water”. This variable is negatively influenced by the implementation of a hybrid governance system in the case of Carrasco (2016), where the indigenous community starts to perceive water, instead of being a sacred domain, as a commodity and in the case of Gross & Dumaresq (2014), where private enterprises buy water only due to taxation benefits. In other 2 cases (Imache et al., 2009; Lange et al., 2008) it is mentioned that there

is no change in how the community perceives water, the rest of the cases (32) don´t provide information on this variable.

4.5.4 Economic outcomes

The variables I found most information on are "economic profit" and "transaction costs" (both 17). I was able to evaluate these cases according to "high", "moderate" or "low" levels, while other variables, "implementation of technologies" (12), "efficient use of resource" (10), "water allocation towards highest value use" (14), "externalities on third parties" (15) and "externalities on environment" (11) can only be evaluated between "yes" (exists) and "no" (doesn't exist).

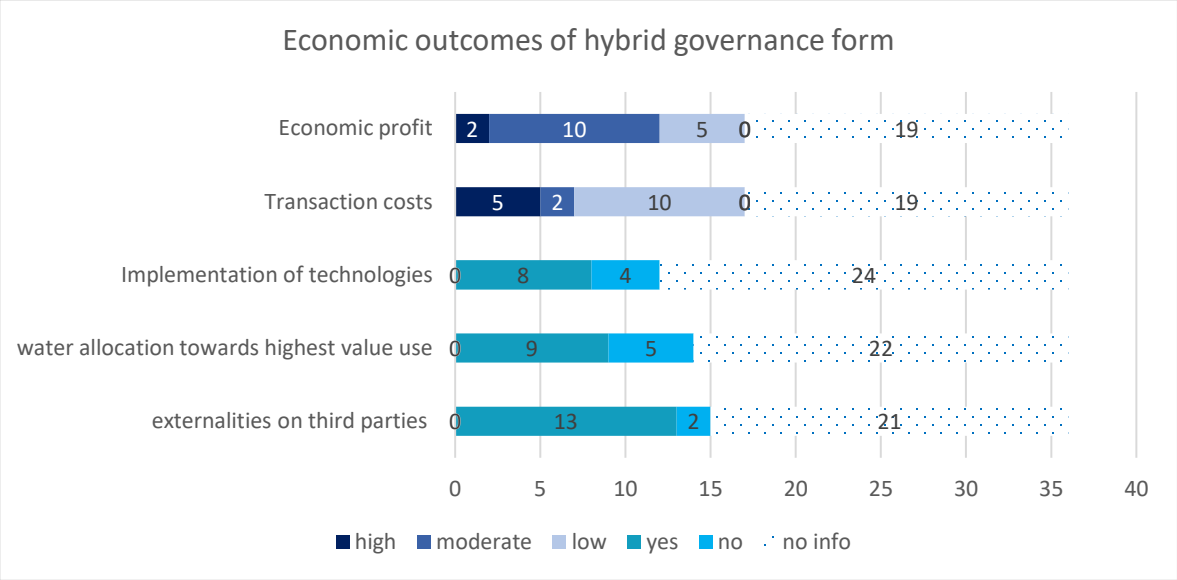

Figure 16: Economic outcomes of the hybrid governance form

"Economic profits" are present to some degree, high or moderate (12 out of 17), indicating an increase in the Gross Domestic Product (GDP), an increase in revenues to water sellers or buyers, or an increase in the income of WUA members in most cases. I also included the reduction of water costs for WUA members as an increase in "economic profits". "Transaction costs" are high (5) mainly due to high costs of negotiation (C. C. Huang et al., 2007), information gathering and providing (Borzutzky & Madden, 2013; Donohew, 2009), slow bureaucracy (Lange et al., 2008), as well as court costs(Carrasco, 2016). 10 cases have "low" levels of "transaction costs" mainly thanks to well-functioning WUAs, which provide services such as registering (Urquiza & Billi, 2020), transferring water (Kloezen, 1998) or conflict resolution (Lepper & Freeman, 2010).The variable of "implementation of technologies" refers to the modernization of WUAs or WUA members. In 8 cases water saving technologies, monitoring technologies or an irrigation system were implemented. 9 cases present a shift of "water allocation towards higher value use", where the crop mix shifts towards water saving crops (Hu et al., 2014; G. Huang, 2015), higher value crops with higher profits (Gross & Dumaresq, 2014; Hearne & Easter, 1997) or from agricultural to urban uses (Donohew, 2009; Palomo-Hierro et al., 2015), whereas 5 cases state that no shift or even a downgrading shift towards less agricultural activity and fallow land has taken place. The latter is the case in Carrasco (2016), where "irrigation of the terraces was significantly reduced, and the sustainability of [the communities] agriculture collapsed" (Carrasco, 2016, p. 140) after private

mining companies have claimed the water that has traditionally been used by the community, or in the case of Garrido (2016), where land had to be fallowed “as a consequence of the disparity between the large surface area with a right to be irrigated and the little water that was available” (Garrido, 2011, p.526). In 13 cases I found references on the existence of negative “externalities on third parties”. Third parties being WUA members, community members or outsiders, which are affected by the selling of water due to reduced water access (Lange et al., 2008), reduced return flows (Libecap, 2016), reduced agricultural activity (Gross & Dumaresq, 2014) or increased prices of WUA services (Pincus & Shapiro, 2008).

4.5.5 Environmental outcomes

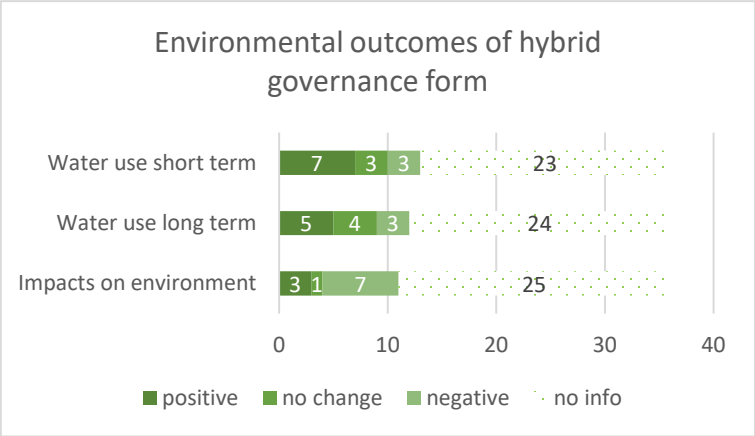

Figure 17: Environmental outcomes of the hybrid governance form

The majority of cases do not provide information on change in water use by WUAs or WUA members. However, in the cases that do, the outcome is rather “positive”, indicating a reduction in water use due to restrictions on extractions, reduction of irrigation area or water conservation activities. Lastly, 7 cases show negative impacts on the environment, namely groundwater over-exploitation, depletion (G. Huang, 2015; Imache et al., 2009) and threatening the water balance (Isselhorst et al., 2018). Although, this does not always have to be the case. Some hybrid governance form, as described by Al-Marshudi (2007) “recognizes the need to maintain a sustainable environment" (Al-Marshudi, 2007, p. 72). In the case of Lepper & Freeman (2010) there is even a positive effect on the environment, augmenting groundwater levels, and in G. Huang, (2015) “170 ha of cultivated farmland were converted back to wetland (…) [and there] was the revival of one of the terminal lakes, East Juyanhai, which dried up in 1992 but now has a surface area of more than 40 km2” (G. Huang, 2015, p. 8957).

5. Discussion

This section answers the research questions of the study, based on the results of the systematic review of the 36 cases. The data collected gives an overview on how a hybrid system of water markets and water user associations work, emphasizing the many facets a hybrid governance form can have. Not only do the results work out the differences in characteristics of each governance form - water markets and WUAs - but also demonstrates how they interact and influence each other. Saying this, this study confirms the theory of Meinzen-Dick, R. (2007) that there is no panacea, or one-fit-for-all solution, when deciding between the governance forms of state regulations, market or CPR. It demonstrates that there is no single good governance form, but also that there is no single hybrid governance system for managing water. Within hybrid governance forms, there are many characteristics that differ based on political, social, economic and physical conditions of the locality.

Moreover, the data shows that preconditions for the well-functioning of (water-) markets and CPRs (WUAs) are mainly given. This information is important, as the performance of one governance form influences the outcomes of the hybrid governance form. Finally, the analysis of the outcome variables partially confirms and partially contradicts the hypothesis of hybrid systems of water markets and WUAs being complementary.

5.1. What are the main differences found in water market and WUA characteristics?

On the market side, big differences were found in the characteristics of formal vs. informal water markets. There is a clear tendency that informal water markets evolve due to a limited access or availability of surface water. Moreover, power asymmetries between WUAs and outsiders are relatively high in informal markets. By owning collective tube wells, receiving state subsidies or state recognition, or having a well-developed infrastructure, WUAs expand their market power and have advantages over outside farmers, who are not part of the organization.

Another big difference present in the analyzed case studies is the ownership of property and water use rights. While in most cases the state is the owner of water resources, water use rights lie in the hands of different actors, mostly private or collective entities, but also a mix of public, private and collective entities. Analyzing those cases, no clear pattern on where and why specific water use rights where allocated is discernible, indicating again, that local and case-specific circumstances define the allocation of water use rights.

The main similarities between the analyzed markets were found in where and how water is traded. Firstly, in most cases trading takes place solely within the agricultural sector, within or beyond WUA organizations. This might be because my search focused on WUAs as agricultural irrigation communities. Another reason could be that water markets (still) mainly focus on agriculture, as it consumes the biggest share of freshwater (IPCC, 2021). However, rapid urbanization make water transfers from rural to urban areas increasingly important (Dustin Garrick et al., 2019). Accordingly, a relatively large number of cases present both, trading within and beyond the agricultural sector, namely towards the domestic/urban and industrial sector. The agricultural sector always being the selling party – i.e., water right holders – and the urban and industrial sector always purchasing water. Secondly, water is traded mainly temporarily. Information found on the reasons for this tendency supports the theories, that little information on the availability of the resource (Muradian & Rival, 2012; Winchester & Hadjigeorgalis, 2009) and high transaction costs (Acheson, 2006; Kloezen, 1998; Leonard et al., 2019) negatively influence markets. Although, in this sense markets have found a good solution for these two barriers by introducing temporary trading (leasing/renting) of water, allowing farmers to keep their water use rights in case they need them in a water-scarce future and to bypass the high cost of information gathering and bureaucracy often present in permanent trading.

Many WUAs carry out similar activities, namely the operation and maintenance of infrastructure and the overview of water allocation and deliveries. However, the characteristics of WUAs, as well as their role in the market, also depend on local circumstances. Thus, the size of WUAs differs depending on whether they have developed on a group or village level (small size) or whether they have been implemented on an irrigation district level (large size). Heterogeneity increases due to differences in the socio-economic background of its members, as well as whether a priority system has been implemented (by the state). Good leadership in China (Hu et al., 2014; G. Huang, 2015)

and India (Mosse, 1997) is achieved by an authoritarian approach, while in the USA (Lepper & Freeman, 2010) and Oman (Zekri & Al-Marshudi, 2008)it is democratic. Also, the role of WUAs in the market primarily depends on the regional or local circumstances. Thus, it depends on the autonomy and the responsibilities the state transfers to WUAs, allowing WUAs to sell or lease water (depends on whether they have collective water rights), make trading rules, and approve or register water transfers.

5.2 Are the preconditions for markets and common property regimes fulfilled?

The preconditions for well-functioning markets and common property regimes are mainly fulfilled: The functional characteristics of WUAs (Fig. 9) show a clear tendency towards high levels of leadership, dependence on irrigation agriculture and recognition by state authority. Heterogeneity, which is negatively correlated to the functioning of CPRs, shows moderate and rather low levels. Only the size of WUAs does not show any tendency towards high or low levels. The functional characteristics of markets (Fig. 7) are less clear, but still inclined towards high levels in the cases of clear property rights and availability of information, and moderate levels in the case of dependence on the water market.

5.3 How do the two governance forms of the hybrid system influence each other?

The results of figures 11 and 12 confirm the theory of Ostrom and colleagues that the functional characteristics of WUAs and markets influence the performance of water markets. However, there are a few examples, where the same variable is evaluated differently. While 3 case studies evaluate "high heterogeneity between the WUA members" of having a negative influence on water markets, Mukherji (2007) evaluates the same variable as positive: Low heterogeneity between WUA members leads to a decrease in market activity "since the joint ESB [electric submersible tube well] was owned by a group of large and medium farmers who already owned and operated 65 per cent of the village land, this ESB was barely sufficient to meet their own irrigation needs. Quite naturally, the shareholders of the ESB refrained from participating in water markets as sellers and prospective water buyers got no access to irrigation" (Mukherji, 2007, p. 2548). This example suggests that the same characteristic can lead to different outcomes.

At this point it is also important to emphasize the role of the state in a hybrid system by e.g. providing a legal framework and allocating initial water rights, as well as giving water governance authority to WUAs and ratifying regulations. For an evaluation of these regulations see figures 11 and 12. The state always is an actor in the hybrid governance form, in some cases more actively, as in China, providing services like monitoring, registering, maintaining infrastructure or providing information (Liu et al., 2018; Zheng et al., 2009), and in others more passively as in the USA, where the state only provides the legal framework for water markets and WUAs (Lepper & Freeman, 2010; Wagner et al., 2007). Even informal water markets can be influenced by the state when it does not provide a legal framework for trading. This limits water markets and the hybrid system to informality.

5.4 How does the hybrid governance form perform and what are the social, economic and environmental outcomes?

The overall performance of the hybrid governance systems of water markets and WUAs are rather positively evaluated by most authors. However, market activity, is rather low. Motives for this were found in the concentration of water transfers in the hand of a few (Mandal, 1987; Palomo-Hierro et

al., 2015) or in the reluctancy of water sellers (Donohew, 2009; Hu et al., 2014; Kloezen, 1998), indicating monopolistic tendencies of the market or barriers for the market. The following outcomes can be influenced by this fact.

In the gathered data of the hybrid governance form, the social variables are rather positive than negative, indicating that WUAs are positively or, at least not negatively, affected by the hybrid system. Analyzing the variables in detail some evidence for the hypothesis on hybrid governance forms being complementary was found, as is the case of "cooperation" and "social capital". Some cases show a negative impact of water markets on these variables. Unequal access and distribution of water and water use rights being the main reason for the reluctance of WUA members or WUAs to cooperate. Moreover, operational and collective choice actions decrease, as the revenues of water trading cover the costs for the maintenance of infrastructure or the wage payment for leaders. Although this suggests otherwise, results show relatively high levels of cooperation and social capital. I conclude, that WUAs with long-standing cooperative structures counteracted the negative social impacts of markets. This conclusion does not hold for the highly present "power asymmetries" in decision-making processes and market participation, either produced by unequal financial means (Gross & Dumaresq, 2014; Urquiza & Billi, 2020) or the reproduction of political or religious power structures (G. Huang, 2015; Mosse, 1997). In the case of Mosse (1997), market mechanisms even seem to aggravate power imbalances as the dominant caste has the political power to manipulate the water allocation to suit their private interests. This example contradicts the hypothesis that hybrid governance forms neutralize the weaknesses of each other (Lemos & Agrawal, 2006). In this case they seem to intensify the deficiency of CPRs: The reproduction of power asymmetries. However, it is noteworthy, that the variable of "power asymmetries" is the only one which is evaluated as a deficiency on both sides: The theory is that markets tend to concentrate power in the hands of big and wealthy market participants (Sumpsi et al., 1998, in Pujol et al., 2005), whereas CPRs tend to reproduce social and cultural power asymmetries (Acheson, 2006). Also, the results on "equity in resource distribution" only partially confirms the hypothesis on hybrid governance forms. In 73% of the cases that provide information on the topic, individuals or groups receive less water than others, due to priority water right systems or the accumulation of water in the hands of large and wealthy farmers. By analyzing the individual cases it seems that WUAs are able to distribute water equally within the organization but create inequalities between WUA members and outsiders. One example is the case of Mukherji (2007), where WUA members, medium and large farmers, share water equally between each other. However due to their increased financial power they buy land and water rights from small farmers, aggravating market imbalances.

Also, the economic outcomes of the hybrid governance form are rather positively evaluated. In theory, economic and efficiency gains are the main strengths of the market (Acheson, 2006, Donoso, 2013, Meinzen-Dick, 2007, Kloezen, 1998). Analyzing the hybrid system of water markets and WUAs this is only partially true. The gathered data on economic outcomes show a tendency towards an increase of economic profits, as well as efficiency gains by the implementation of technologies and water allocation towards the highest value use. However, it is important to mention, that there are cases where the opposite occurs and agricultural land had to be fallowed due to water being claimed by outsiders (Carrasco, 2016), or the size of the agricultural land was too big in relation to the water available (Garrido, 2011). Both cases are the product of market failures. In the first case, due to an

unfair process of water rights allocation and in the second case, due to water right holders trying to increase the demand for water by increasing agricultural land.

A deficiency of markets are high transaction costs, decreasing market activity (Leonard, 2019; Williamson, 1985, in Pujol et al., 2005). This theory has been confirmed by the variable on permanent and temporary trade, where farmers bypass the high transaction costs of permanent trading by trading water temporarily. However, the low level of transaction costs present in the case studies might also indicate that WUAs help to diminish them. In several cases low levels of transaction costs have been linked to well-functioning WUAs, providing services such as registering, controlling water transfers or resolving conflicts (Kloezen, 1998; Lepper & Freeman, 2010; Urquiza & Billi, 2020).

5.5 General remarks

It is important to point out the limitations of this study. The results are biased by "no information" responses, which might be suggestive for being not important or not necessary to mention, meaning that no problem or outstanding factor has been detected by the author. Nevertheless, the variables might be present in the case studies. Also, the number of case studies that have been included in this study can only give a limited overview of the functioning and outcomes of the hybrid governance form. It has been surprising that despite high search results, the cases providing actual information on a hybrid system of water markets and water user associations have been very sparse. I found many papers, in which water markets are assessed but no information on WUAs or irrigation communities is provided. Although the cases show that in practice, there is almost always some kind of irrigation community present in a water market, as the transfer of water depends on collective or public infrastructure and some local level organization, with the exception of private tube wells. Even rarer are the cases where information is provided on how water markets and water user associations interact. This speaks about the need for further primary research on hybrid governance forms and the market-CPR interaction. Challenging is also the evaluation of hybrid governance forms, as there are multiple factors influencing their outcomes. As described in detail, it is not only the interaction of the two governance forms, but also the characteristics of each one of them that define the success of the system. Especially, the differences in water market characteristics are various, making it recommendable to analyze the performance of hybrid governance forms with different types of water markets separately e.g., formal and informal markets and groundwater and surface water markets.

6. Conclusions

In this study I analyze, via a systematic case study review, the characteristics and the performance of the hybrid system of water markets and water user associations, based on the theory on markets and common property regimes and the hypothesis that this hybrid governance form can build on the strengths and neutralizing deficiencies of water markets and water user associations, leading to social, economic and environmental sustainability.

The study confirms the theories of Meinzen-Dick (2007), that there is no panacea in water governance and of Lemos & Agrawal (2006), that in reality it is a wide array of hybrid governance strategies that are practiced. The study presents an overview of the main differences of the characteristics of water markets and water user associations, indicating that the nature of the hybrid governance form depends on political, social, economic and physical conditions of the locality. It also demonstrates that institutional and functional characteristics of each system, as well as external factors of infrastructure and resource, influence the functioning of the system. Although, depending on the local conditions of the market, not every characteristic has the same impact.

The hypothesis of the complementary nature of hybrid governance forms (Lemos & Agrawal, 2006), is partially confirmed in this study. From the results I conclude that the negative impacts of markets on the cooperation and social capital was neutralized by WUAs with long-standing traditions of cooperation. Also, in the case of high transaction costs, as a deficiency of markets, WUAs seems to have a positive impact by providing operational services. In the cases of equity in distribution, as a strength of common property regimes, as well as economic and efficiency gains, as strengths of markets, the hypothesis only holds for some cases. The study detects equity in water distribution for WUA members, but not for external market participants, and economic and efficiency gains in most cases, but leading to exactly the opposite in few others. In the case of power asymmetries, the hypothesis does not hold. The deficiencies of markets, the accumulation of resources in the hands of a few individuals, and the deficiencies of WUAs, the reproduction of social power asymmetries, are not neutralized by acting in a hybrid system. The deficiencies even seem to intensify.

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7. Annex

Table 2: Overview of analyzed case studies, year and country

In text citation	Author(s)	Title	Year	Country
(Al-Marshudi, 2008)	Al-Marshudi, A.S.	Economic instruments for water management in the Sultanate of Oman	2008	Oman
(Al-Marshudi, 2007)	Al-Marshudi, A.S.	The falaj irrigation system and water allocation markets in Northern Oman	2007	Oman
(Borzutzky & Madden, 2013)	Borzutzky, S., Madden, E.F.	Markets awash: The privatization of chilean water markets	2013	Chile
(Carrasco, 2016)	Carrasco, A.	A Biography of Water in Atacama	2016	Chile
(Donohew, 2009)	Donohew, Z.	Property rights and western United States water markets	2009	USA
(Garrido, 2011)	Garrido, S.	Governing scarcity. Water markets equity and efficiency in pre-1950s eastern Spain	2011	Spain
(Gastélum et al., 2009)	Gastélum, J.R., Valdés, J.B., Stewart, S.	An analysis and proposal to improve water rights transfers on the Mexican Conchos basin	2009	Mexico
(Gross & Dumaresq, 2014)	Gross, C., Dumaresq, D.	Taking the longer view: Timescales	2014	Australia
(Hamamouche et al., 2020)	Hamamouche, M.F., Kuper, M., Hartani, T., Bouarfa, S.	Overlapping Groundwater Service Markets in a Palm Grove in the Algerian Sahara	2020	Algeria

(Haneman n, 2014)	Hanemann, M.	Property rights and sustainable irrigation-A developed world perspective	2014	USA
(Hearne & Easter, 1997)	Hearne, R.R., Easter, K.W.	The economic and financial gains from water markets in Chile	1997	Chile
(Hu et al., 2014)	Hu, X.-J., Xiong, Y.-C., Li, Y.-J., Wang, J.-X., Li, F.-M., Wang, H.-Y., Li, L.-L.	Integrated water resources management and water users' associations in the arid region of northwest China: A case study of farmers' perceptions	2014	China
(C. C. Huang et al., 2007)	Huang, C.C., Tsai, M.H., Lin, W.T., Ho, Y.F., Tan, C.H., Sung, Y.L.	Experiences of water transfer from the agricultural to the non-agricultural sector in Taiwan	2007	Taiwan
(G. Huang, 2015)	Huang, G.	From water-constrained to water-driven sustainable development-A case of water policy impact evaluation	2015	China
(Imache et al., 2009)	Imache, A., Bouarfa, S., Kuper, M., Hartani, T., Dionnet, M.	Integrating "invisible" farmers in a regional debate on water productivity: The case of informal water and land markets in the Algerian Mitidja plain	2009	Algeria
(Isselhorst et al., 2018)	Isselhorst, S., Berking, J., Schütt, B.	Water pricing following rainfall distribution and its implications for irrigation agriculture: A case study from Vélez Blanco	2018	Spain
(Kloezen, 1998)	Kloezen, W.H.	Water markets between Mexican water user associations	1998	Mexico
(Lange et al., 2008)	Lange, M., Winstanley, A., Wood, D.	Drivers and barriers to water transfer in a New Zealand irrigation scheme	2008	New Zealand
(Lepper & Freeman, 2010)	Lepper, T., Freeman, D.	Comparing forms of common property resource and collective goods organizations operating	2010	USA

		water markets in the Colorado lower Arkansas river basin		
(Libecap, 2016)	Libecap, G.D.	Institutional path dependence in climate adaptation: Coman's "some Unsettled Problems of Irrigation"	2016	USA
(Liu et al., 2018)	Liu, Y., Li, P., Zhang, Z.	Resilient or Not: A comparative case study of ten local water markets in China	2018	China
(Mandal, 1987)	Mandal, M.A.S.	Imperfect institutional innovation for irrigation management in Bangladesh	1987	Bangladesh
(Mosse, 1997)	Mosse, D.	The symbolic making of a common property resource: History	1997	India
(Mukherji, 2007)	Mukherji, A.	Implications of alternative institutional arrangements in groundwater sharing: Evidence from West Bengal	2007	India
(Nicol & Klein, 2006)	Nicol, L.A., Klein, K.K.	Water market characteristics: Results from a survey of southern alberta irrigators	2006	USA
(Palomo-Hierro et al., 2015)	Palomo-Hierro, S., Gómez-Limón, J.A., Riesgo, L.	Water markets in Spain: Performance and challenges	2015	Spain
(Pincus & Shapiro, 2008)	Pincus, J., Shapiro, P.	Between forced resumption and voluntary sale: A mechanism for the collective sale or transfer of irrigation water	2008	Australia
(Rawal, 2002)	Rawal, V.	Non-market interventions in water-sharing: Case studies from West Bengal	2002	India
(Sanchis-Ibor et al., 2019)	Sanchis-Ibor, C., García-Mollá, M., Torregrosa, T., Ortega-Reig, M., Sevilla Jiménez, M.	Water transfers between agricultural and urban users in the region of Valencia (Spain). A case of weak governance?	2019	Spain

(Svensson et al., 2021)	Svensson, J., Wang, Y., Garrick, D., Dai, X.	How does hybrid environmental governance work? Examining water rights trading in China (2000–2019)	2021	China
(Urquiza & Billi, 2020)	Urquiza, A., Billi, M.	Water markets and social–ecological resilience to water stress in the context of climate change: an analysis of the Limarí Basin	2020	Chile
(Wagner et al., 2007)	Wagner, M., Kaiser, R., Kreuter, U., Wilkins, N.	Managing the commons Texas style: Wildlife management and ground-water associations on private lands	2007	USA
(Zekri & Al-Marshudi, 2008)	Zekri, S., Al-Marshudi, A.S.	A millenarian water rights system and water markets in Oman	2008	Oman
(Zheng et al., 2009)	Zheng, H., Wang, Z., Liang, Y., Calow, R.C.	A Water Rights Constitution for Hangjin Irrigation District	2009	China

Table 3: Contextual variables and description

		Variables	**Variable description**
Geographical information		Country	In which country does the case take place?
		Country region	In which country region does the case take place?
Case information		Name of WUA	What is the name of the WUA?
		Number of WUAs	How many WUAs are part of the WM?
Market information	Institutional characteristics	Formal/ informal	Does WM function within legal framework provided by state authorities? Or is WM an informal market?
		Within/beyond sector	Is trade taking place within the agricultural sector, or beyond (i.e., between agriculture, urban, industry sectors)

		Within/beyond organization	Is trade taking place within the same WUA organization or beyond? (i.e., between WUAs or WUAs to other sectors)
		Surface/ground water	Water market trades surface water, groundwater or both?
		Permanent/temporary rights	Is water traded permanently or temporarily (fixed period)
		Property rights	Who holds the property rights?
		Water use rights	Who holds the water use rights?
	Objectives	Objectives of WM	What are the objectives for the implementation of the WM?
	Functional characteristics	Dependence on WM	How dependent are WUA members on the WM? Is the WM the only way to access water or are there any other sources or precipitation?
		Clear property rights	Are property rights clearly defined?
		Availability of resource and market information	Is information provided on resource availability and market (price, seller and buyers, etc.)
		Market activity	How active is the WM? How many transactions are carried out?
WUA information	WUA activities	Services of WUA	What services provides WUA? All services independent to its relation to WM.
	Functional characteristics	Size	How many members does the WUA have?
		Heterogeneity	How heterogeneous are WUA members? Could be religious, socio-economic, caste, etc., as well as differences in treatment (senior vs. junior rights)

		Dependence on irrigation agriculture	How dependent are the WUA members (as a social group) on irrigated agriculture? Does their livelihood depend on irrigation agriculture activities?
		Leadership	How is the level of leadership within the WUA? Do WUA members trust their leaders?
		Recognition by state authorities	Is the right of the WUA to devise operational, collective choice, constitutional choice arrangements recognized by governmental authorities?
Hybrid information	Role of state	Role of the state within the hybrid governance form (explained and assessed)	Which role does the state play in the hybrid system? Assessed: How does the state perform in its role in the hybrid system? Does the state impact the WUA(s) and/or WM(s) positively or negatively?
	Role of WUA in the WM	Role of WUA within the WM (explained and assessed)	How is the hybrid system community-based? Which role does the WUA play in the implementation/execution of the market/transfers? Assessed: How well does the WUA perform in its role in the market?
	Influence of governance forms on each other	Influence of WUA characteristics on WMs	Does any of the WUA variables mentioned above have an impact on the performance of the market? How?
		Influence of WM characteristics	Does any of the WM variables mentioned above have an impact on the performance of the market? How?