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Assessing the effectiveness of Multi-Sector Partnerships to manage droughts: The case of the Jucar river basin

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Key Points:

- Bottom-up institutionalization of entities was developed to manage droughts
- Analysis of the effectiveness of Multi-Sector Partnerships using the capital approach was performed
- Econometric model is used to assess the influence of the water availability and crop prices on drought economic losses in agriculture

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Abstract South-east Spain is a drought prone area, characterized by climate variability and water scarcity. The Jucar River Basin, located in Eastern Spain, has suffered many historical droughts with significant socio-economic impacts. For nearly a hundred years, the institutional and non-institutional strategies to cope with droughts have been successful through the development of institutions and partnerships for drought management including multiple actors. In this paper, we show how the creation and institutionalisation of Multi-Sector Partnerships (MSPs) has supported the development of an efficient drought management. Furthermore, we analyze the performance of one of the suggested instruments by the partnership related to drought management in the basin. Two methodologies are used for these purposes. On one hand, the Capital Approach Framework to analyze the effectiveness of the governance processes in a particular partnership (Permanent Drought Commission), which aims to highlight the governance strength and weakness of the MSP for enhancing drought management in the Jucar River Basin. Through a dynamic analysis of the changes that the partnership has undergone over time to successfully deal with droughts, its effectiveness on drought management is demonstrated. On the other hand, an econometric approach is used to analyze the economic efficiency of the emergency drought wells as one of the key drought mitigation measures suggested by the Permanent Drought Commission and implemented. The results demonstrate the potential and efficiency of applying drought wells as mitigation measures (significant reduction of economic losses, around 50 M€ during the drought period, 2005–2008).

1. Introduction

Natural hazards risk management has become a challenge in recent years. Cascading effects involving impacts from different scopes as economic, social, and human losses, and intensifications due to climate change have increased the challenge. This defiant situation should be not only addressed from one sector or just one actor as the government. The recently adopted Sendai Framework for Disaster Risk Reduction [*United Nations (UN)*, 2015, p. 13] demands for "responsibilities shared by central Governments and relevant national authorities, sectors, and stakeholders," which "requires all-of-society engagement and partnership." Therefore, taking into account that single actors such as governments are unable to sufficiently cope in a single manner with these risks [*Evans*, 2012], Multi-Sector Partnerships (MSPs) represent an alternative form of governance in order to manage the increasingly complex and demanding risk management strategies.

MSPs are understood here as "voluntary but enforceable commitments between public authorities, private enterprises, and civil society organizations across sectors. They can be temporary or long-lasting. They will be founded on principles of sharing the same goal in order to reduce risks and gain mutual benefit. In some cases, they might be enforced by law. Partnerships involve a shift in governance structures and the implied acquisition of competencies typically derived from governmental structure" [*Mañez Costa et al.*, 2014, p. 13]. We understand governance as the self-organization process in which actors coordinate their action to develop common aims supported by a system of rules in order to be effectively pursued [*Rhodes*, 1997; *Fürst*, 2003].

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Frequently MSPs are seen as the ideal pathway to handle currently with multidimensional problems [*Pinkse and Kolk*, 2012]. Nevertheless, MSPs should not be considered as the final solution for all problems in natural risk management [*Surminski and Leck*, 2016].

In this paper, we analyze whether MSPs are effective governance structures to manage risks or in which aspects they could be improved. The focus is to understand the potential positive effects of MSPs on drought management. By effective governance, we understand those structures that have the ability of facing risks, providing good outcomes, e.g., *proper risk management in which the risk is reduced until tolerable level*, and preserving community assets. Meanwhile, ineffective governance bodies have a reduced ability to face and manage risks. The analysis of effectiveness is done by the Capital Approach Framework (CAF) [*Mañez Costa et al.*, 2014], which assist in the assessment of governance performance through focusing and integrating, as well as synergizing, five capitals (social, human, political, financial, and environmental). By focusing we mean the support to concentrate on particular components of the governance structures that do not work. By integrating we mean the different capitals integrated in the CAF that are needed to have a balance management structures. And by synergizing we mean that, including the different capitals, we avoid on the one side redundancy and on the other side to forget important parts of the management structures.

In the governance processes there are aspects included like the structures of the organizations regarding the partners, e.g., *participation*, *communications*, the insight of the civil society, the relevance of the social skills and competencies of partners, the political aspects, e.g., *transparency*, *regulation*, as well as the financial aspects and the environmental strategies. We hold the idea that a balance between capitals would be beneficial for successful governance performance in MSPs [*Department for International Development of United Kingdom (DFID)*, 1999]. That balance consists for us in the equal distribution of effectiveness among capitals.

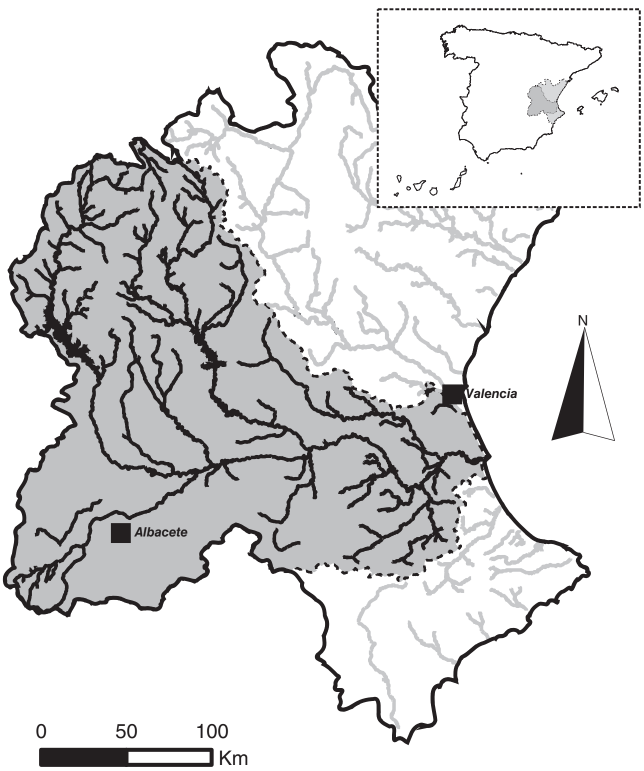

Figure 1. Jucar River Basin.

The presented results are related to the analysis of the Permanent Drought Commission (PDC) of the Jucar River Basin (JRB) (see Figure 1). The JRB territory is shaped by nine Water Exploitation Systems, of which larger systems are the Jucar River system and the Turia River system. The JRB has a complex and diverse system of water-related institutions with strong stakeholder involvement. These institutions emerged in a context of drought vulnerability. The JRB is amongst the most vulnerable areas to drought of the western Mediterranean region, due to several reasons: a semiarid climate, high water exploitation indexes, and very high spatial and temporal variability of precipitation, leading to a highly seasonal and inter-annual variability in the river flows. Droughts in this region are frequent. They can be very intense and last for several years [*Estrela et al.* 2000; *Vicente Serrano et al.*, 2004]. Furthermore, there is a high uncertainty of future water resources availability due to the climate change impacts. Many analyses of future climate change scenarios reveal that this region might suffer important changes in precipitation and temperature. Most of the global and regional climate models predict an increase in temperature, and a decrease in precipitation, with a general increase of variability [*AEMET*, 2008]. Analyses of the effect of climate change on future water resources forecast important reductions in hydrological inflows to rivers [*Chirivella Osma et al.*, 2015] and groundwater recharge [*Pulido-Velazquez et al.*, 2015], resulting in an overall decrease of water availability and more frequent and more intense drought episodes [*Hernández-Barrios*, 2007*; CEDEX*, 2010*; Escriva-Bou et al.*, 2017]. These climate change-related impacts have severe social and economic implications, and create further hydrological problems like the rise of salinity in coastal aquifers and increased water quality problems. But since there are no specific climate projections able to predict droughts, decisions are made under uncertainty in a reactive way. The measures to cope with future events are based on past events. For that reason, uncertainty is not included in the daily management. Droughts are slow onset events managed by MSPs also slowly as the first risks of a drought start appearing. In our case study, droughts are declared by law and that marks the beginning of the working process in the MSP (see Section 2.1.2).

In the history of the JRB, different governance structures have aroused to face these multi-faceted risks. Droughts, as such, cause manifold impacts, e.g., *in water uses*, *environment,* and affect different economic sectors. Therefore, some of the governance structures born in the region have been multi-sector, pursuing risk minimization in a similar way, and bringing-up different sectorial views to enable the management of the diverse consequences of drought risks. In this paper, we highlight and analyze the significance of MSPs in the JRB regulating the water in the basin and specifically dealing with drought management. The historical development of MSPs is described below to show the bottom-up development, regularization, and institutionalization of them.

We explore two aspects of the management and governance performance, analyzing whether MSPs in the JRB and their activities have positive effects on drought risk management. On one hand, we address the effectiveness of the governance processes by implementing the CAF which detects strengths and weaknesses of the MSP's governance practices. On the other hand, we assess one of the measures suggested by the MSP to face droughts: drought emergency wells for irrigated agriculture. As irrigated agriculture was the first use to be impacted by droughts in this system, and were the main economic losses occurred, we used an econometric approach for assessing the contribution of the drought emergency wells. The production value of the irrigated agriculture is used as economic indicator to assess the effectiveness of drought mitigation measures (in this case, of emergency wells) during the latest recorded severe drought event (2005–2008).

2. Managing Droughts Risks in the Jucar River Basin

The JRB has suffered several intense episodes of droughts in the last decades (1983–1986, 1992–1995, 1998–2000, and 2005–2008 [*Confederación Hidrográfica del Júcar*, 2007], and the recently 2015 episode [*Real Decreto 355/*2015 *(RD 355/2015*), 2015]. All of these episodes had significant effects in terms of economic losses in the productive sectors, but also less quantifiable social and environmental impacts on the basin and its territory. Droughts impact different sectors in the region. Impacts normally concentrate on the agricultural and hydropower sectors. Urban water supply and environmentally sensitive areas are protected over other water uses when it comes to shortages due to their higher priority of water use. Nevertheless, economic impacts affect municipalities directly and indirectly, e.g., *municipalities have to pay more to improve the reliability of their supply by purchasing water rights from agriculture*, or to find alternative sources of water. The costs of environmental measures during a drought are also significant for taxpayers.

The JRB has a great range of water-related institutions in which stakeholders play a fundamental role. Some have an internationally recognized history and tradition, such as the Water Court of the Plain of Valencia (*Tribunal de las Aguas de la Vega de Valencia*), which dates from 960 AD approximately [*Borrull i Vilanova*, 1828] and it is considered one of the oldest justice institution in Europe, or the Irrigators Community of the Jucar Royal Irrigation Ditch (*Acequia Real del Júcar*) that holds water rights since the second half of XIII century.

Stakeholders are manifold in the JRB, as, for example, the drinking water supply company of Valencia city and its metropolitan area with about 1.5 million inhabitants; or the Albufera Lake, a shallow brackish wetland that serves as nesting area for hundreds of bird species in their migratory trips and belongs to the RAMSAR wetlands convention [*RAMSAR*, 2014]. Along the rivers of the JRB there are also industrial interests, *e.g., hydropower production and cooling for a nuclear power plant*. Finally, there are irrigation schemes of more recent development (20th century) that obtain their waters from aquifers hydraulically connected to rivers with the consequent affection to surface streamflow.

2.1. Multi-Sector Partnerships Managing Droughts in the Jucar River Basin

The hydrology of the JRB shows a significant shift with respect to the historical pattern from the 1980s. The average availability of water resources has decreased considerably in the last three decades (as compared with the mean for the longer time series since the 1940s). The basin has suffered several drought episodes with significant impacts. For this reason, adaptation to droughts has been a constant objective of people living in this area, and the majority of water users [*Campillo Tomas*, 2006; *Mateu Belles*, 2010]. Adaptation has been carried out by infrastructure development, but also by institutional development through the development of different governance structures as MSPs.

Initially, mono-sectorial partnerships were predominant, e.g., *farmers associations*, in order to build, operate, and maintain irrigation weirs, canals, and ditches, to allocate water, and to organize irrigation turns. Since the beginning of the 20th century, with increasing water stress in the basin, high temporal variability of flows and droughts became a serious societal and economic threat. The diversification of interests due to the different aspects of water planning and management revealed the necessity of dividing the decision-making process among several internal bodies. These have always had the intentionality of including all, or the most, of the voices interested in the topics addressed. The management of droughts in the JRB went through a process of polycentrism [*Pahl-Wostl et al.*, 2007; *Ostrom*, 2010]. Several MSPs were created along the years to deal with the different problems existing in the JRB. In the case of droughts, two entities are currently in action, namely the Jucar River Basin Partnership (JRBP), particularly its Water Council, and a "daughter" MSP addressing every officially (by law) declared drought: the PDC.

2.1.1. The Jucar River Basin Partnership

With the beginning of the twenty century, water users could be differentiated between the existing users, mainly traditional irrigation farmers, and new users attracted by additional resources made available by the development of infrastructures and planning studies. The new users were particularly related to new irrigation schemes and hydropower-related demands.

Under this pressure, in 1936 an MSP, the JRBP (in Spanish *Confederación Hidrográfica del Júcar*) was created including all major sectors of water uses, the main bodies of the central administration related to water, as well as provincial and local representatives. Within the JRBP, the Water Council of the JRB is a participatory body in charge of approving the District Water Plans (and hence, also the plans related to droughts). The JRBP was initially responsible for surface water infrastructure development and had a special emphasis on structural measures dealing with water scarcity and droughts. Thus, from the very early stages of the JRBP there has been an interrelation between all the stakeholders of the basin. During the 20th century stakeholders of the basin increased not only in numbers but also reflecting new societal preferences beyond the use of water for purely economic purposes. The JRBP included also among its objectives protection against floods, and general protection of the so called public water domain, controlling all human actions on rivers (water intakes, wastes, arid extraction, etc.). Finally, after the new Spanish water law of 1985 was enacted, groundwater management was also included under the MSP. At that time, in addition to the stakeholders related to groundwater, other stakeholders were included in the JRBP, namely the representatives of the autonomous region's governments and the environment.

The JRBP has developed significant knowledge of the risk associated to droughts. They have collected data for almost the whole 20th century and there are studies being developed on past droughts based on historic data (trees rings studies, historical archive research including churches' archives). The objectives of the JRBP have been growing, advancing aspects that were later considered by the European Union's Water Framework Directive [*European Communities (EC)*, 2000], such as environmental objectives, economic recovery of costs, and integrated basin planning and management. This is reflected in the early development of basin plans like the one started in 1992 that includes a list of the so-called "plan agents" [*Confederación Hidrográfica del Júcar*, 1997]. More recently, after the transposition of the WFD to Spanish legislation, two more basin plans have been developed for the periods 2009–2015 [*Confederación Hidrográfica del Júcar*, 2014] and 2015–2021 [*Confederación Hidrográfica del Júcar*, 2015a]. We can conclude that nowadays JRBP is a MSP including most sectors and interests related to water in the basin.

2.1.2. The Permanent Drought Commission

Even though the diminution of drought vulnerability has been an objective of planning activities and infrastructures development along the history of the JRBP, past drought episodes have been managed mostly in a reactive manner. For instance, in the 1990–1995 drought episode, it was already late when emergency measures were decided, and thus the infrastructures were not available until the drought had almost ended. This is why from year 2001, the Spanish Law of the National Hydrological Plan requires all river basin partnerships (JRBP in this case) to develop Special Drought Plans (SDP) in order to turn the traditional reactive crisis management approach into a proactive approach. The drought plans for JRBP territory includes monitoring for early drought detection, drought stages definition, and the measures to be applied in each of the stages [*CHJ,* 2007]. These SDP are also incorporated to the Water Plans of the District, and therefore, are approved by the Water Council of JRBP.

In addition, the management system for the different drought scenarios established in the SDP of 2007 requires, for the first time in a normative document, the creation of the PDC when the emergency scenario is reached. A Royal Decree of Exceptional Situation, which is passed by the National Government, establishes then the PDC. From that moment, this commission assumes the control of the management of the operation systems affected by the drought within the territory of the JRBP, and is in charge of complying with the regulations established in the plan for drought impacts prevention, minimization, and mitigation. The Royal Decree gives the PDC additional competencies and special powers leading to a better management of the drought episode.

The relevance of the PDC relies on its decisions on the management and mitigation of drought episodes, when high potential damages and risks to the economy and human safety can materialize. The decision-making process of the PDC during emergency situations, as well as the drought office of the JRBP before the PDC is convened, is supported by the outcomes of a risk assessment methodology based on a water resources model of the basin and a portfolio of mitigation measures. The measures in the portfolio are proposed by the PDC and tested with the water resources model in order to assess the possible future state of the resources in the basin (normally by the end of the hydrological year) [*Andreu et al*. 2007, 2009, 2013].

In addition, during the normality phase, the management of the JRB is done according to the Basin Plan (whose last official version is from January 2016 for the period 2015–2021). The plan also accounts for uncertainty (mostly hydrologic but also demand based) by evaluating different future scenarios and allocating water to demands accordingly. However, there is low uncertainty in the daily management (short period scenarios).

The water resources models, used by the JRBP for the development of its basin plan and for informing the PDC, were initially agreed by all the stakeholders within the basin in a public participation process.

More in depth, the competencies of the commissions are to survey available water resources management, to establish priority criteria for water supply to the different uses, to accelerate the water assignment processes to the priority uses, to order small water abstraction and transportation works, to establish water saving guidelines for all sectors, to coordinate the actions of all the administrative bodies with competencies on water and to reduce or suspension of any water facility or activity with a water pollution potential.

Despite the normative requirement of creating a PDC occurred in 2007 for the first time, there is historic evidence that such commissions have been created during previous important drought episodes in the context of the JRBP. Their composition has changed over time from purely administrative commissions in the 1980s to the highly representative ones (see Figure 2), which depicts the time evolution of the governance structure of these two MSPs, and also of the drought management approaches, from 1936 to present days.

The PDC was constituted for the first time in 1981, during the dry period of 1978–1986, it was neither an MSP, nor derived from JRBP. A Royal Decree [*RD 18/*1981] established the creation of a commission formed by the Civil Governors of the affected provinces, the Chief Commissar for Water, the National Government Delegate, the Hydraulic Services Chief from JRBP, and representatives of ministries of Internal Affairs;

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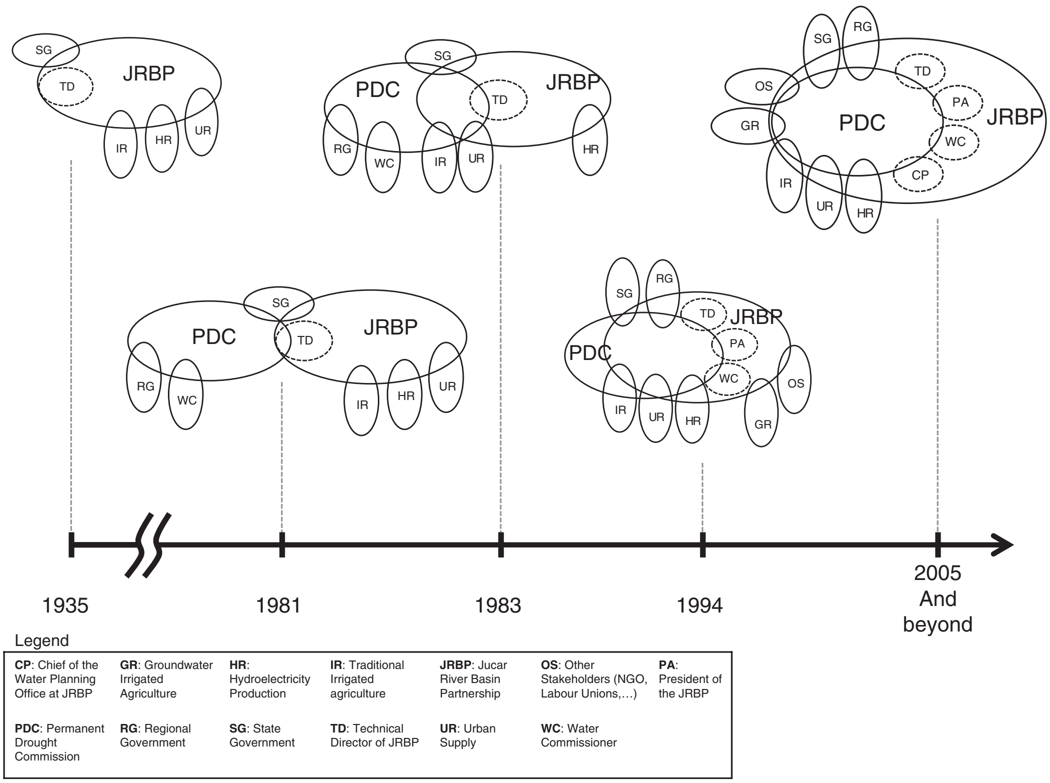

Figure 2. Historic evolution of stakeholders composition of Jucar River Basin Partnership (JRBP) and Permanent Drought Commission (PDC).

Public Works and Urbanism; Agriculture, Fisheries and Food; and Industry and Energy. Following Royal Decrees in 1983, 1984, and 1994 introduced more actors in the drought commission, especially from out of the administrative environment, making it more accessible and participative. It was in 1994 [*Real Decreto 134/*1994 *(RD 134/1994)*, 1994] when the official term "Permanent Drought Commission" appeared for the first time. Finally, the drought commission drew by Royal Decree [*Real Decreto 1265/*2005 *(RD 1265/2005)*, 2005] can be considered a "daughter" MSP of JRBP, although with more power to manage and mitigate extraordinary droughts. Both, the JRBP and the PDC, has evolved from decisionist-technocratic approaches to an integrated participative approach [*Andreu*, 2014]. Decisionist-technocratic approaches consider stakeholders as mere recipients of the decisions of the policy-makers based or not in scientific evidence. While, in an integrated participative approach policy makers, experts, and stakeholders negotiate to set together the policy goals. In this kind of approach, management decisions are defined by consensus on what it is scientifically justifiable (considering available information and tolerable risk) as well as socially and politically acceptable.

2.2. Drought Event 2005–2008 in the Jucar River Basin

The drought occurred between 2005 and 2008 was one of the most intense droughts in recent times. It started at the Jucar River system in early 2005, extended to the Turia River system a year later in 2006, and finalized by the end of 2008 in both systems. In the Jucar River system, the annual natural streamflow of years 2005–2008 were among the 10 worst years since records started in 1940, with year 2006 becoming the historic minimum. Annual natural streamflow in the Turia River system was in the lower quartile, with year 2006 being the ninth lower historical record.

Figure 3 shows the evolution of the drought index for the Jucar River system, which reproduces five levels of restriction risk: significant or very high (red), high (orange), moderate (yellow), low, and very low (green). The latest drought period for the Jucar River system was 2005–2008. This drought index is assessed using storages, piezometric head, natural inflow, and areal rainfall data [*Confederación Hidrográfica del Júcar*, 2017].

A complete evaluation of this drought spell and its effects was done by the JRBP [*Confederación Hidrográfica del Júcar*, 2010] according to the management plan included in the SDP [*CHJ*, 2007]. It requires a post-drought analysis where the governance process is evaluated critically and the measures in the SDP are updated. In the following sections, we summarize the main outcomes of relevant to the work presented in this article, operation of the PDC and economic impacts [*CHJ*, 2010].

2.2.1. Operation and Decisions Made by the PDC

The PDC was established in December 2005 following a Royal Decree regarding the adoption of exceptional administrative measures to manage water resources and cope with the effects of drought in several river basins in Spain [*RD 1265/*2005, 2005]. As mentioned previously, the PDC was in charge of defining and monitoring the implementation of the measures oriented to mitigate the effects of drought. The PDC was integrated by representatives of the different water use-related sectors and gathered 30 times between December 2005 and the end of 2008.

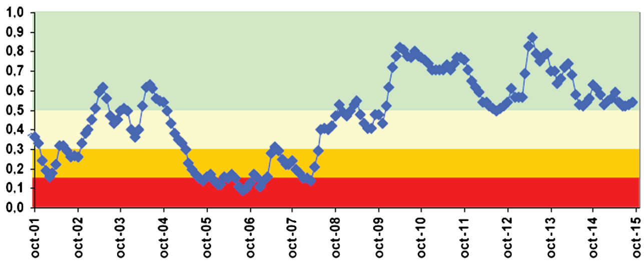

Figure 3. Drought index Jucar River system [Source: *Confederación Hidrográfica del Júcar*, 2015b].

The measures approved by the PDC belong to four general working lines: (1) Measures for environmental protection (ensuring the continuity of streamflow and protecting the drought vulnerable wetlands); (2) measures for management and control of water resources (supporting the decision making in the PDC through the use of stochastic forecasting models to estimate future volume stored in reservoirs [*Andreu et al.* 2007, 2009, 2013], and use of forecasted scenarios to estimate the evolution of the systems); (3) measures for water saving plans (improving the efficiency of water distribution systems and the establishment of irrigation turns adopted by urban and agricultural users); and (4) alternative water sources and generation of additional resources (including the use of the drought wells, recirculation of irrigation returns back to the head of the system, and reuse of treated wastewater from the urban area).

The PDC received the support of the "Droughts Technical Office," a technical body expressly created to coordinate studies and tasks necessary to implement and monitor all the measures included in the SDP.

2.2.2. Economic Evaluation

The post-drought report issued by the JRBP in 2010 analyzed the main socio-economic impacts of the latest drought period in the JRB (from 2005 to 2008), classified into three categories: (1) losses in productive sectors, e.g., *agricultural or industrial sectors*, (2) investments and expenses, and (3) exoneration of fees and charges [*CHJ*, 2010].

1. Droughts involve economic losses in the main productive sectors: agriculture, industry, energy, and service sector. Concerning the energy sector, the total hydropower production was estimated to be reduced roughly a 40% in 2006 and 2007 compared to average years in the rivers constituting the JRB. During the same drought period, the gross domestic product of agriculture, livestock, and fishing sectors decreased with regards to the previous years, e.g., *reduction of 16–19% in the Valencia province* [*CHJ*, 2010].
2. The monitoring of the droughts and the implementation of the mitigation measures also requires certain investments and expenses. The costs of investments for emergency measures were assumed by the beneficiaries through charges and fees. These costs of the emergency measures associated to the drought period 2005–2008 were estimated as 74.86 M€. Among these emergency measures are the drought wells, which were activated from 2006 to 2008 in order to provide extra water resources for mitigating drought impacts. For example, 40, 40, and 25 mm^3 were pumped in the years 2006, 2007, and 2008, respectively, to supply water to the irrigation districts at the lower part of the Jucar River (Riberas del Jucar). The district in this area is included among the most important agricultural areas within the JRB irrigation district.

The investments on improving the control, vigilance, and management on drought conditions have been estimated to be 2.1 M€ during the last drought period (2005–2008), including starting-up and controlling the specific drought monitoring network (0.27 M€), controlling the abstraction for drought deliveries (0.43 M€), monitoring groundwater bodies (0.66 M€), and running the technical drought office (0.14 M€).

During the 2005–2008 drought period, there were three public offers for the temporary acquisition of water rights (in a similar way to the drought water banks in California, e.g.) with the aim of reaching certain environmental objectives: to preserve certain ecological flow in the Jucar reaches more affected by streamflow depletion from intensive pumping in La Mancha Oriental aquifer. This has been an innovative instrument to deal with droughts with a positive environmental impact: unlike the 1994–1995 period of the mid 1990s drought in which certain reaches of the river were completely dried up, in this case the ecological flows were preserved. The total cost of this instrument was estimated to be 18.48 M€, with a total reduction of water abstractions in Mancha Oriental of 58.52 mm^3 [*CHJ*, 2010]. The economic compensation was set based on the estimated economic loses for the farmers (mainly maize and winter cereals), ranging from 0.19 to 0.25 €/m^3. The purchase was only offered to those farms in which pumping was having a significant impact on streamflow depletion, which was assessed by defining pumping influence functions on river flow using a groundwater flow model of La Mancha Oriental that simulates stream–aquifer interaction [*Sanz et al.*, 2011].

3. In the Spanish water law [1981*RD-Law 1/2001*], users have to pay back the investment of the different administrations on the hydraulic infrastructure (both for regulation and for conveyance) they benefit from, through certain water tariffs designed for cost-recovery over a payback period of 50 years. But according to the drought legislation, when the deliveries during drought periods are 50% lower than those corresponding to the wet years, the affected users are waived of the water tariffs. In that drought period, several irrigation districts beneficiated from that waive of tariffs, approved in several decree-law.

3. Methods

To assess the effects of MSPs on risk management and judge the benefits of the governance mechanisms detailed above, we focused our analysis on the PDC, which is the MSP resulting from the declaration of a drought. The PDC aims to minimise the environmental, economic, and social impacts caused by a drought event [*RD 355/*2015, 2015]. Nevertheless, the previous work of the JRBP to prevent the emergency situation and to promote the PDC is very relevant for this assessment on risk management effectiveness.

The analysis is based, on one hand, on stakeholders' insights, knowledge, and perceptions. These stakeholders are involved in the JRBP as well as some of them also in the PDC. For this first part of the analysis, we use as methods semi-structured interviews and the CAF. This latter allows categorizing the governance effectiveness of the MSPs. On the other hand, we explore the efficiency of one of the measures suggested by the PDC analyzing the influence of water availability and crop prices in the economic efficiency of the basin through econometric and mathematical programming methods.

In that way, the assessment of effectiveness on managing droughts is conducted by three perspectives: (1) stakeholders droughts management knowledge capture by means of semi-structured interviews, (2) the indicators of effective governance in the PDC under the CAF implemented through stakeholder workshops and expert knowledge; and (3) the econometric model used to assess the effectiveness of the measures implemented by the PDC looking at the influence of different factors on the irrigated agriculture production in the JRB (specifically drought wells).

3.1. Stakeholders Interviews

The involvement of stakeholders in the planning and implementation processes provides different perspectives and interests to take into account [*Künkel et al.*, 2011]. In most cases, these benefits are to increase the quality of the decision-making processes through achieving an increased acceptance of the decisions and the implemented tools or techniques [*Edelenbos and Klijn*, 2005; *Luyet et al.*, 2012]. In our analysis, we consider *stakeholder* as any actor-institution having a clear role or with an interest in the drought management process [*Organisation for Economic Co-operation and Development (OECD)*, 2000]. They are representatives of institutions dealing with water management and most of them are represented in the PDC, e.g., *partnerships of water users (representatives of irrigation associations) and NGOs (representative of environmental associations)*.

In order to understand how risk is perceived and identify the culture of risk management, we conducted semi-structured interviews with nine different stakeholders in the basin. They represented different levels of responsibilities as well as different interest groups, e.g., *head of drinking water treatment plant*, *representative of Jucar users' partnership, head of the office of Hydrological Planning*, *etc*. Our interest was to analyze their risk understanding, droughts management as well as to know their knowledge and existing beneficial governance processes. Those opinions and perspectives included expert knowledge for providing inputs to propose criteria to develop indicators for the implementation of the CAF. Furthermore, this expert knowledge offers awareness to extend the assessment of the effectiveness beyond the indicators.

3.2. Capital Approach Framework and Indicators of Effective Governance

The CAF is developed based on the concept of capitals [*Smith*, 1776; *Goodwin*, 2003; *Organisation for Economic Co-operation and Development (OECD)*, 2008] and the linkage between capitals and sustainability [*Serageldin and Steer*, 1994; *Scoones*, 1998]. The main aim of its application to the PDC is the analysis of governance performance. The five capitals for the PDC are defined as following:

1. Social capital involves the relationships between the members of the PDC coming from different institutions and sectors. It includes meetings, forms of communication, as well as the shared norms and values. The interactions of the members have an effect on the partnership decisions and activities and influence the well-being of the PDC.
2. The human capital encompasses the addition of the individual skills — capabilities — and knowledge — learning — of the PDC's members with a number of 16–18 individuals by 2015 [*RD 355/*2015, 2015].
3. Political capital focuses on the governmental processes within the PDC, led by the president of the PDC (the same as the JRBP) and performed by the members of the PDC (12–14 members with right to vote and voice; plus 4 members with no right to vote). That capital includes laws, rules, and norms coming from the government.
4. The financial capital is covered by the resources allocated to the administrative bodies and public organizations represented in the PDC (that no alter to the public spending). The PDC might penalize the users who does not obey the water restrictions.
5. Environmental capital comprehends the actions and decisions to favor the quality of land and water (crops productivity, water consumption, care of environment, e.g., *protected areas*).

Within the CAF, indicators allow us to measure governance. The indicators are divided in groups of factors that described the characteristics of the capitals. This analysis resulting from the implementation of the CAF supports the identification of strengths and weaknesses of the implemented droughts management. For our analysis, we use 46 indicators, which are related to 13 factors (see Appendix A). The CAF has five columns representing: the capitals, the factors related to the capital, the indicators linked to those factors, their assessment and the comments obtained from the stakeholders while implementing the CAF.

This list of 46 indicators helps us to assess the governance performance in the PDC. These indicators respond to the necessities and characteristics of the basin thanks to the previous cited interviews conducted with the stakeholders and a corroboration workshop celebrated in Valencia in November 2015. The workshop participants were stakeholders of the basin who have knowledge and experience on drought management in the basin. The audience included different representative of irrigator's partnerships, e.g., *USUJ (Unión Sindical de Usuarios del Júcar)*, *JCRMO (Junta Central de Regantes de la Mancha Oriental)*; public organisms, e.g., *Valencia city council*, *and JRBP*; private enterprises, e.g., *urban water supply, hydroelectricity production;* and an agronomic insurance company.

Through a participatory exercise, we obtained accurate responses for each indicator in the list. We had the possibility to observe and discuss with them the evaluation criteria in order to categorize the responses in a very precise way. The aim of applying the set of indicators in this exercise was to include the voices of the stakeholders in the study and to verify the answers given for each indicator in the previous round using experts' interviews. Non-members of the PDC were also involved in the workshop.

For the evaluation of each indicator, the responses were categorized into three kinds of unit of measurement: binary ("yes or no"), ordinal (grading and percentages), and cardinal (natural numbers). The responses were divided into three possible answers corresponding to three categories: (1) effective governance—green colored; (2) moderately effective governance—yellow colored; and (3) ineffective governance—red colored (see Appendix B for detailed information).

3.3. Economic Assessment of Drought Management

Droughts produce direct, e.g., *crop production losses*, and indirect impacts, e.g., *employment losses*, requiring a portfolio of mitigation measures. Drought can produce different economic, social, and environmental impacts. For instance, during prolonged droughts the ecological streamflow can be reduced with the criteria of assuring a minimum of 30% of the maximum potential habitat, which would certainly produce some environmental impact. Nevertheless, in this section, since irrigated agriculture is the first use to be impacted by droughts in this system, and the main economic losses in the last drought happen in the agricultural sector, we have selected the change in the production value due to reduced irrigation to represent the contribution of economic effectiveness of the main drought mitigation measure. The total cost of a drought is the sum of the economic losses plus the cost of the portfolio of mitigation activated measures. We present an economic analysis of the effectiveness of the main applied measure to cope with the drought from 2005 to 2008 in the lower JRB: the emergency drought wells.

Different methods and approaches have been applied to drought cost assessment [*Logar and van den Bergh*, 2012]. Most assessments of drought direct impacts focus on losses in the agricultural sector, the most vulnerable. This is usually based on crop production functions (to estimate crop yield reduction) and crop market prices, to translate the reduced production into economic losses. Macroeconomic effects are often measured on Gross Domestic Product (GDP) or Gross Value Added (GVA), among other indicators [*Benson and Clay*, 1998]. Indirect costs have been estimated using either input–output analysis or computable general equilibrium analysis [*Berrittella et al.,* 2007]. Finally, nonmarket welfare losses include environmental damages and the cost of household water restrictions, and have been estimating using different nonmarket valuation techniques [*Martin-Ortega et al.*, 2012]. Economic losses from reduced supply in the urban sector have been also assessed as the consumer surplus losses using urban economic demand curves [*Jenkins et al.,* 2003]. Finally, hydroeconomic models allow assessing the economic impacts of droughts and different water supply options with a wider, basin-wide perspective [*Booker et al.* 2005*; Harou et al.* 2009*; Ward and Pulido-Velazquez*, 2012].

Econometric and mathematical programming methods have been applied to assess the direct economic impacts of droughts [e.g., *Calatrava and Garrido,* 2005; *Gil-Sevilla et al.,* 2011]. The econometric modeling allows assessing the influence of different factors (explanatory variables) on the dependent variable.

With the aim of providing more insight about the effectiveness of the applied mitigation actions during the drought period 2005–2008, an econometric modeling approach was applied to evaluate the economic effectiveness of one of the key drought management measures in the JRB, the emergency drought wells. The production value of the irrigated agriculture was used as an economic indicator to evaluate the economic value (as saving of losses) of the emergency drought wells used in irrigated agriculture:

$$\mathrm{Pv}_j = \sum_{c=i}^{n} S_c \cdot Y_c \cdot P_c \tag{1}$$

where "*j*" represents each irrigation district, "*c*" the crops of each irrigation district ("*i*" represents each crop), "*S*" is the crop area, "*Y*" is the crop yield, and "*P*" is the crop price.

Once the dependent variable has been selected, we have to choose the explanatory variables to explain the changes on the production value due to external and internal factors. Water availability (surface and/or groundwater) and crop price have been selected as explanatory variables. Crop price is introduced as an independent variable in order to separate the effect of price changes (volatility) from the consequences of reduced water delivered for irrigation. The econometric model is set as [based on *Gil-Sevilla et al.,* 2010]:

$$\mathrm{Pv}_j = a + b \cdot W_j + c \cdot G_j + d \cdot \mathrm{Ip}_j \tag{2}$$

where "*W*" represents the surface water deliveries, "*G*" represents groundwater deliveries, and "Ip" is the crop price index.

Surface water availability is accounted through time series of surface water deliveries. Groundwater availability is split into two components: groundwater abstractions in normal conditions and additional pumping during droughts (emergency wells). Thus, the approach allows simulating the economic impact of a portfolio of mitigation measures for coping with droughts, such as drought emergency wells that consists in increasing the groundwater abstractions.

4. Results

During the interviews, droughts were unanimously selected as the main risk to manage in the basin, while there were different opinions with regard to other risks perceived by stakeholders. These later depend on the type of stakeholder, the use they give to water, their geographical location, and their position within the water rights scale. For instance, these risks represent among others economic losses related to loss of production (loss of crops) caused by water restrictions and business losses triggered by the changing in the whole chain of production.

4.1. Governance Performance Analysis

The analysis of the indicators for governance performance pointed out a slight effectiveness imbalance between capitals. Considering the range from 0% to 33% as (1) ineffective in governance; (2) the range from 34% to 66% as moderate effective in governance; and (3) the range from 67% to 100% as effective in governance, we can observe in Figure 4 that most of capitals represent effectiveness in governance. However, two of the capitals, the social and the financial capital, are cataloged as moderate effective in governance performance. In spite of that, all five capitals are over the 50%, with a mean of 74.1% between the five capitals. Therefore, we can consider the governance in the PDC as effective. Nevertheless, the analysis shows some needs for improvement that we can see in detail looking at the factors figure (see Figure 5) and more specifically at the indicators valuation (see Appendix A).

The financial capital is the one with the lesser effectiveness governance (56.25%). These deficiencies are due to the lack of insurance offered for irrigated crops and not related to public and private investments or rights of compensations offered by the government. In Spain, only rainfed agriculture can be insured. This capital was considered the most important for the stakeholders due to the fact that risk is perceived higher when it has economic impacts.

On the opposite end, we find the human capital, which presents a 90% of effective governance. The skills and competencies of the PDC members are characterized by high degree of educations and innovation capacity with an enterprising spirit. The high percentage of trained members in drought management provides a qualified commission for governing droughts, as well as the high level degree of members with working experience in water management.

The political capital in the PDC has 80.36% of effective governance. One of the ineffective aspects in political capital is related to the insurance obligation, as well as in the financial capital, due to the non-protection of irrigated land in the face of droughts. We considered in the assessment criteria of the CAF the equality to vote in the processes of formal voting as a proof of effective governance. But in the case of the PDC, the stakeholders assured that the non-equal right to vote is not a proof of ineffective governance. That conviction arises from the fact that they had never needed to exercise the vote because until now all the decisions have been made by consensus. The decisions within the PDC are always made through the discussion and the consideration of the opinions of all members, who all have voice in the decision-making process, even though they might have no right to vote. The PDC is a transparent organism which updates the information regarding the submission of new regulations related to the protection against droughts and its management as well as its revision periodically.

For the political capital, results are similar to the environmental capital with 80% of effective governance within the PDC. There is a low percentage of public investment in protection strategies. The different land use types to minimize drought losses and the protected area within the basin also represent a medium-low percentage. The effective assessed indicators of the environmental capital are the high percentage of action

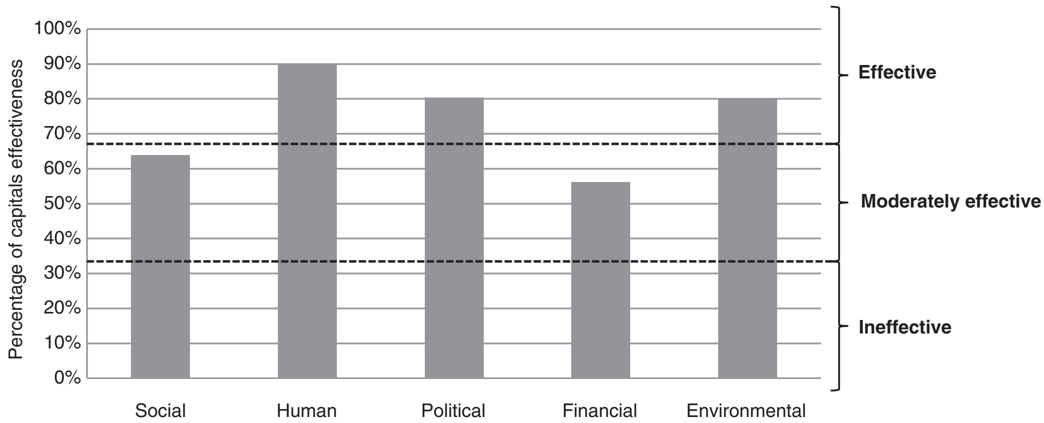

Figure 4. Governance effectiveness in the five capitals.

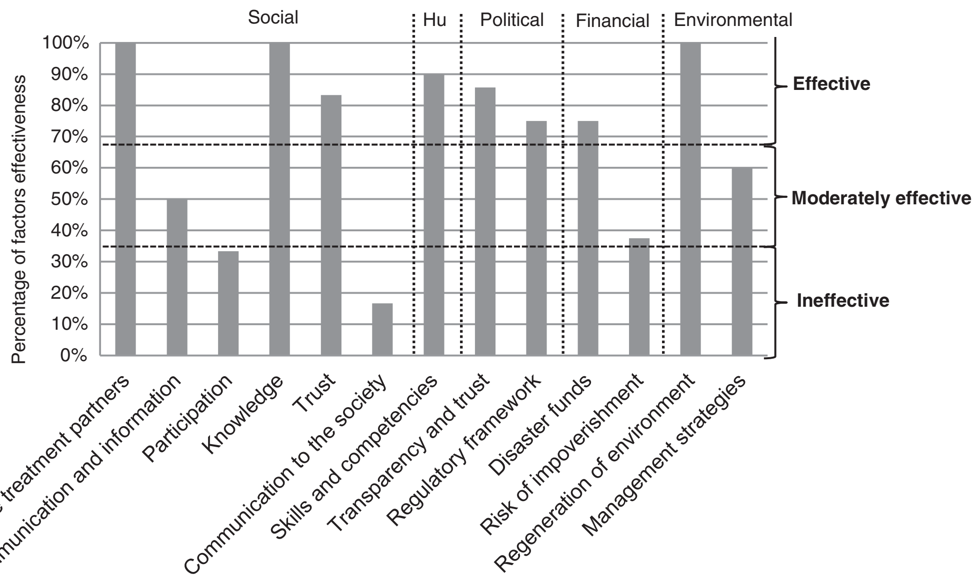

Figure 5. Effectiveness of the factors included in the five capitals.

taken by the PDC to regenerate the environment after a drought, the legal regulation regarding environmental planning, and the strict schedules for implementing drought management policies.

The social capital is assessed as moderately effective, being not completely effective (63.89%). Social capital is quite important in that MSP. That capital includes the factors of participation, trust, knowledge, and communication, which are considered as a rather significant in the management. The participation is equal for all members in the decision-making processes. The existence of transparent communications processes guaranties the flow of information in the PDC. The historical drought events management has created awareness and knowledge increasing the trust on the management of new events. The fact of being a longstanding co-operation (since 1981) encourages also trust even though that has been considered moderately effective by the stakeholders, perhaps by the changing members involved from one event to another. The weak point of the PDC regarding the social capital is the communication with the society as well as the existence of platforms or networks for exchanging information. The strength within the relation to the society is the open access to the registers of last drought events in the basin, available for the general public in the JRBP.

There is a need to strengthen the weak points in the PDC governance performance, such as insurances to cover losses from droughts; the communication with the society, e.g., *information available in other languages, educational programmes more than information campaigns*; the promotion of platforms to exchange

Table 1. Crop Area Distribution (ha) in the Riberas del Júcar

	Rice (ha)	Mandarin (ha)	Orange (ha)
2002	11,477	10,035	13,877
2003	11,477	9,816	13,778
2004	11,458	10,719	16,980
2005	11,658	11,601	16,683
2006	11,662	11,237	16,905
2007	11,898	11,381	17,397
2008	11,814	10,446	17,601
2009	11,683	10,791	17,901
2010	11,657	10,933	18,534

information; more investment in protection strategies to benefit the environment; and the increment of periodic formal meeting within the commission to improve the well-functioning.

4.2. Economic Evaluation of Drought Mitigation Measures Implemented by the MSP

Apart from looking at the governance performance of the PDC, we analyze the economic efficiency of the emergency drought wells as the main mitigation measures used to cope with irrigation needs during the drought episode of 2005–2008 in the lower Jucar River system. In particular, the analysis has been carried out in the Riberas del Júcar irrigation district. The total groundwater pumped is estimated as 40, 40, and 25 mm^3 during the years 2006, 2007, and 2008, respectively [*CHJ*, 2010].

For our analysis, we apply the econometric model described in the previous section. Time series of crop prices, yields and crop areas (2002–2010) were obtained from the technical reports and inventories of the Ministry of Agriculture of Spain. In order to compare the prices and production value of irrigated agriculture, nominal prices have been transformed into constant prices (baseline 2010) considering inflation through the GDP deflator index. In this agricultural district, the main crops are rice, orange, and mandarin fruits (see Table 1). During the drought period 2005–2008, the crop areas did not decrease as compared to the previous years (2002–2004).

Figures 6 and 7 show the evolution of crop yield and prices of the main crops in the Riberas del Júcar from 2002 to 2010. During the drought period 2005–2008, the crop prices present a rising pattern, in general, as expected during a drought period. Whilst, the crop yield pattern presents some fluctuations: during 2008 both, mandarin and orange, have the minimum yield values while their prices reach the maximum ones. Moreover, the rice yield has been stable during the selected period of time.

The production value of irrigated agriculture (Pv) has been obtained through equation 1 based on existing data (crop yields, prices, and area distribution). Figure 8 shows the Pv distribution for each crop and the total and the average Pv value of the previous wet years (2002–2004). The production values during the drought years are lower than those corresponding to the previous wet years. In year 2007, the economic losses reached the lowest value, 7 M€, due to the high crop yields. After the drought, in years 2009 and 2010, the production value continues going down due to the crop price volatility.

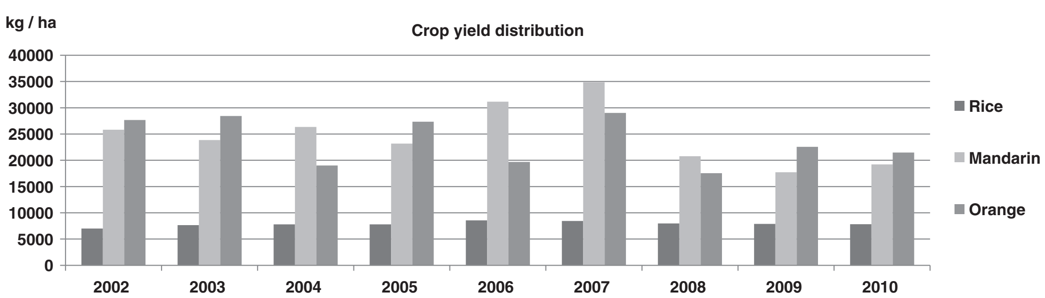

Figure 6. Crop yield in Riberas del Jucar.

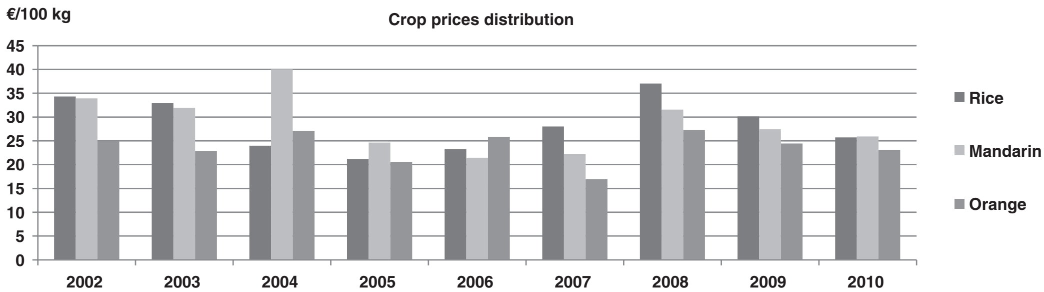

Figure 7. Crop prices in Riberas del Jucar.

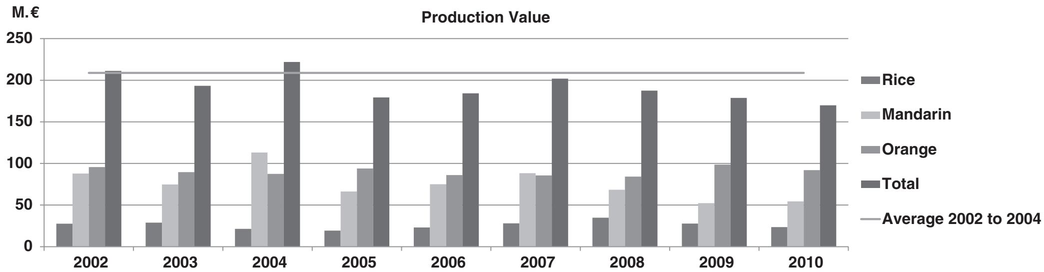

Figure 8. Production value.

Table 2. Fitted Impact Model

	P value	Coefs
W	0.0082	283.84
G	0.0033	1484.98
Ip	0.0421	275,923

The econometric model, with the functional form shown in equation 2, is fitted using the historical time series of water deliveries (surface and groundwater), index of crop prices and production value of irrigated agriculture.

Equation 3 shows the fitted equation:

$$\text{Pv} = 283.84 \cdot W + 1484.98 \cdot G + 275{,}923 \cdot \text{Ip} \quad (3)$$

As Table 2 shows, all the dependent variables are statistically significant (P-value <0.05). Thus, the fitted model allows simulating the production value taking into account these variables with a high grade of accuracy (R^2 value of 99%).

Finally, based on the interpretation of the fitted coefficients of equation 3, it is possible to assess the economic impacts of the emergency drought wells in the last drought period. These coefficients represent the change in the production value when the associated dependent variable varies in one unit. The total additional groundwater pumping for drought was estimated as 40, 40, and 25 mm^3 during 2006, 2007, and 2008 [*CHJ*, 2010]. According to this model, this additional pumping has reduced drought losses in 59, 59, and 37 M€, respectively, to the users (as compared with the scenario in which this mitigation measure where not implemented). This drought pumping did not suppose any additional cost to the stakeholders, since the pumping cost was supported by the other Jucar users receiving surface water deliveries, in agreement with the conditions of the Alarcon treatment.

5. Conclusions

The purpose of our study was to analyze the governance performance of MSPs as polycentric system and their related participatory governance mechanisms, and in particular to understand the potential positive effects of MSPs on drought management. We did this by evaluating the effectiveness of the MSP with the CAF and by assessing the economic effectiveness of one of the "star" mitigation measures proposed by the PDC, the emergency wells for irrigated agriculture.

In spite of the important changes in precipitation and temperature showed by the climate projections, which could increase uncertainty of future water resources availability, those uncertainties do not influence the management reactions to droughts by the analyzed MSPs, because their reactions are made mainly ad hoc. This means that actually there is no long-term climate adaptation planning, due to the non-existence of good climate change predictions of droughts neither seasonal nor decadal. Therefore, the managers and stakeholders of the JRB do not include this information in their everyday business.

Our findings indicate that the PDC, and its related polycentric mechanisms have positive effects in the face of extreme drought events. An example of the positive impacts of MSPs and their decisions, often made in the context of a response to a drought emergency, is analyzed from an economic perspective, showing how sharing the costs of emergency measures between the river basin users avoid drought losses on the order of magnitude of 50 M€. Although only one drought period (2005–2008) is explored from this perspective and a single risk mitigation measure, i.e., the costs of emergency wells, is analyzed, we find the methodological framework used as applicable to other settings in which extreme events management might need of the emergence of such governance structures.

The positive effect of MSPs on drought management is clearly supported by the consensus found in the PDC about water management decisions when an extreme drought event is declared. The transparency of the PDC compensates certain imbalances created by the relatively high role of the political capital on the effectiveness of governance.

By analyzing the weaknesses and strengths of current MSPs and their historical trajectory, this study has moved forward our understanding on how to enhance water management at the river basin scale. In the current context of increasing resource scarcity, our study has clear implications for drought management at the EU and global scales. The preamble and article 14 of the European Water Framework Directive [*EC*, 2000] mention the necessity of water authorities to involve "all interested parties" in the development and implementation of river basin management plans. This study presents a successful polycentric governance structure that is example of the WFD premises. The constant evolution of water-related institutions managing general water scarcity and extreme droughts events in Valencia and the JRB dates back to the 9th century.

The vast diversity of drought impacts in the JRB has supported the creation of such polycentric governance systems, as are the JRBP and the PDC. These governance structures have emerged to tackle complex drought cross-sectoral impacts and the diversity of users. Such multi-actor and multi-level responses are seen as providing polycentric order and aligning centres of decision making that are formally independent of each other [*Galaz et al.*, 2011]. Using the CAF, we provided as well a way of analyzing the governance performance of polycentric systems. The key dimensions of CAF might have a degree of correlation, shading to a degree the usefulness of the results of our study due to contextual circumstances. Besides, other pertinent issues like the factors that facilitated the evolution of the institutional settings (see Figure 2), thereby improving risk management, and the contextual links of this evolution could not be explored in-depth with this framework. More in-depth research is needed about the process of institutional evolution and up-scaling, and particularly about the determinants behind the evolution of institutional settings dealing with risk management. A comparative approach including diverse polycentric governance structure would shed more light on this respect.

In spite of these weaknesses, our contribution helps to understand the value added to societies by improved risk management through polycentric governance structures as MSPs. Besides, it supports that the described process of expansion of such polycentric mechanisms have a great potential for other geographies in need of environmental governance structures to cope with an increase of extreme events triggered by global change.

Acknowledgments
We acknowledge the project ENHANCE (Grant Agreement number 308438) for the financial support to this research. As well as, we thank the Jucar River Basin stakeholders for providing the help to get data for the analysis. The data used are listed in the references, tables, and Appendix A.

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Appendix A

Table A.

Factor	No.	Indicator Related to the Factor	Evaluation Criteria	Assessment	Notes
		Social capital			
Equitable treatment of all partners	1	All members are equal in decision-making processes	Y/N		
Communication and information	2	Existence of a transparent and well established communication process (e.g., *periodic reports, meetings*, etc.) that guarantees the flow of information	Y/N		
	3	Existence of platforms, committees, and networks where all representatives can join the process of information exchange	Y/N		
Participation	4	Co-operation of partners from different sectors such as public, private and civil, as well as agricultural, energy, tourism, etc	Y/N		
	5	Amount of periodic formal meetings held between members of the commission	1–4 yearly 5–9 yearly +10 yearly		
	6	Implementation of monitoring processes (e.g., *internal or external audits*)	Y/N		
Knowledge	7	Percentage ofindividual members of the commission or institutions represented in the commission trained in droughts and prevention management	68–100% 33–67% 0–32%		
	8	Existence of registration of past drought events in the basin. Access to these registrations for all members	Y/N		
Trust (other members)	9	Evidence whether knowledge gained from historical events in the basin has influence over the increase in trust to lead new drought events	Y/N		
	10	Existence oflongstanding co-operation between the same members which encourages trust (teamwork during years)	Years 1–4 5–9 +10		a
	11	Experiences of conflict and problem resolution	Y/N		
Communication and relation to the society	12	Existence ofinformal boards/groups resulting from cultural-historic development	Y/N		b
	13	Existence of educational programs in relation to the droughts promoted by the Commission and/or awareness campaigns addressed to civil society	Y/N		
	14	Access by civil society to the last drought events registered in the basin	Y/N		
	15	Information material on drought management. Presented through different information channels and available in different languages where appropriate	Y/N		
	16	Launching of donation initiatives promoted by the Commission to aid in covering losses caused by natural disasters	Y/N		
	17	Mobilization of volunteers in the face of risk	Y/N		

Table A. (continued)

Factor	No.	Indicator Related to the Factor	Evaluation Criteria	Assessment	Notes
		Human capital			
Skills and competencies	18	Level of education (average academic degree of Commission members)	High[c] Medium Low		
	19	Innovation capacity of the commission members. Enterprising spirit	Y/N		
	20	Valuation of the social skills of the members (e.g., *assertiveness, active participation and listening, decision making, conflict resolutions*, etc.)	High Medium Low		
	21	Percentage of membership with training on drought management	68–100% 33–67% 0–32%		
	22	Level of member's experience in drought management	High Medium Low		
		Political capital			
Transparency and trust in political actions	23	Information updating regarding the submission of new laws or decrees related to droughts	Y/N		
	24	Equal vote of all commission members in processes offormal voting	Y/N		d
	25	Equal participation (the right to have voice) of all Commission members in decision making	Y/N		
	26	Percentage of members taking part in internal elections of the commission (voting participation)	68–100% 33–67% 0–32%		
	27	Existence of statistical surveys published reflecting the opinions of the actors (commission members and external representatives of drought management partnerships) in regards to the governance of the commission	Y/N		
	28	Existence of comprehensive anti-corruption policy	Y/N		
	29	Existence oflaws/declarations, etc. in order to provide legal basis that promote the freedom of media	Y/N		
Regulatory framework: formal rules and norms	30	Periodic revision and updates oflaws and regulations concerning the protection against droughts and the management of drought disasters	Y/N		
	31	Existence of emergency plans	Y/N		
	32	Existence of obligation to obtain insurance for protection in the face of disasters	Y/N		
	33	Existence and open access (whole public) to risk maps (promoted or not by the commission)	Y/N		
		Financial capital			
Disaster funds	34	Percentage of the drought expenses covered by the government	68–100% 33–67% 0–32%		
	35	Proportion of public and private investments on drought funding	68–100% 33–67% 0–32%		

Table A. (continued)

Factor	No.	Indicator Related to the Factor	Evaluation Criteria	Assessment	Notes
Risk of impoverishment	36	Existence of rights of compensation (offered by the government) to affected population	Y/N		
	37	Percentage oflosses covered by these compensations if they exist	68–100% 33–67% 0–32%		
	38	Percentage of households/institutions that have insurance related to the specific threat in basin (e.g., *droughts, floods*, etc.)	68–100% 33–67% 0–32%		
	39	Percentage of damages that were covered by insurances during the last drought event	68–100% 33–67% 0–32%		
		Environmental capital			
Regeneration of environment	40	Percentage of ecologic compensation per total area	68–100% 33–67% 0–32%		
	41	Percentage of actions taken by the commission for environmental regeneration after a disaster	68–100% 33–67% 0–32%		
Management strategies and planning processes	42	Existence of climate change studies for preparedness for potential increment of drought events	Y/N		
	43	Binding deadlines/schedules for implementation of drought management processes	Y/N		
	44	Existence of big infrastructures that affect the environment (e.g., *diversion of water*)	Y/N[e]		
	45	Percentage of different land use types within the basin (in order to implement targeted strategies/actions to minimize droughts)	68–100% 33–67% 0–32%		
	46	Percentage of protected area within the total basin area	ha[f] 27–100% 14–26% 0–13%		

PDC, Permanent Drought Commission.
[a]Considered by the PDC not green the longstanding co-operation between same members. The structure of the PDC changed in the last years.
[b]The Water Court of the Plain of Valencia (Tribunal de la Aguas de la Vega de Valencia) it is not here considered as example ofinformal group as result from cultural-historic development. It is considered formal and more related to water management than drought.
[c]High: University degree. Medium: Technical education. Low: General Certificate of Secondary Education.
[d]Considered by the commission not red to have only the right to voice instead voice and vote for decision-making processes (marked as green). They have never needed to vote.
[e]Attention: Here YES answer is considered red and NO answer is considered green (generally, this kind of constructions causes a big environmental impact in land and fauna).
[f]Number of hectare (expressed in %) destined to protected area within the total area in risk.

Appendix B
Calculation Table

For the indicators calculations, each indicator has a value with regard to the five capitals and the factors related to each capital. From the total (100%), each capital gets the same weight (20%). Within each capital several factors are included, but not all the capitals have the same number of factors. The sum of all the factors values within one capital must be 20, e.g., *social capital has 6 factors then 3,33 will be the value of each of them since the sum of all six is 20*. Following this line, the indicators within a factor will also have values which all of them sum up the factor value (last column). But depending on the color, the value will vary. The indicators categorized as green will be a multiply of its indicator value one time, the indicators categorized as yellow will be a multiply of 0.5 times, and the indicators categorized as red will not count, its value will remain zero, e.g., *Management strategies and planning processes factor (the last one of the list) related to environmental capital which has a factor value of 10 and an indicator value of 2 will be calculated as 6 taking into account that factor has 2 indicators in green ($2\times2=4$), 2 in yellow ($2\times0.5=1$), and 1 in red ($1\times0=0$).*

Table B.

Factors Related to Capitals	Value	Number of Indicators	Indicator Value: Green (Fv/Ni)	Yellow (G*0.5)	Red (G*0)
Social capital	20.00	17			
Equitable treatment partners	3.33	1	3.33	1.66	0.00
Communication and information	3.33	2	1.66	0.83	0.00
Participation	3.33	3	1.11	0.55	0.00
Knowledge	3.33	2	1.66	0.83	0.00
Trust	3.33	3	1.11	0.55	0.00
Communication to the society	3.33	6	0.55	0.27	0.00
Human capital	20.00	5			
Skills and competencies	20.00	5	4.00	2.00	0.00
Political capital	20.00	11			
Transparency and trust	10.00	7	1.43	0.71	0.00
Regulatory framework	10.00	4	2.50	1.25	0.00
Financial capital	20.00	6			
Disaster funds	10.00	2	5.00	2.50	0.00
Risk of impoverishment	10.00	4	2.50	1.25	0.00
Environmental capital	20.00	7			
Regeneration of environment	10.00	2	5.00	2.50	0.00
Management strategies and planning process	10.00	5	2.00	1.00	0.00

Fv, factor value; G, Green; Ni, number of indicators.

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