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Cooperation in common property regimes under extreme drought conditions: Empirical evidence from the use of pooled transferable quotas in Spanish irrigation systems

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ABSTRACT

The success of a common property regime can be partially judged on the basis of its ability to handle extreme events that stress its capacity for cooperation. This paper compares the performance of 38 irrigation associations in a large irrigation area in Spain during a severe drought as a test of hypotheses derived from property right theories. The case is particularly interesting because it contains a transferable quota institution that can potentially strengthen the effectiveness of common property regimes in scarcity conditions. According to the results the use of transferable quotas across associations can contribute to cooperation and drought performance. In this context, performance is higher when the associations enjoy (1) effective monitoring systems, (2) experience and legitimate leaders, and (3) facilitative biophysical conditions like soil water holding capacity. The analysis also suggests that biophysical properties like soil water holding capacity may compensate for weaker monitoring or leadership, and vice-versa.

1. Introduction

Theory on natural resource management has notably evolved in the last decades. Traditional economic theory long prescribed the need for public authorities to enforce public or private property rights in order to avoid the overexploitation of common pool resources (CPRs) like pastures, fisheries and irrigation systems (Gordon, 1954; Hardin, 1968). More recently, evidence has highlighted the existence of cases where direct users have achieved enough cooperation to self-regulate their use of those resources through common property regimes (Agrawal, 2001; Poteete et al., 2010). As a result, attention has turned to identifying the conditions under which different property right regimes, either alone or in combination, can contribute to successful management (Abbott and Wilen, 2011; Cole, 1999; Costello et al., 2008; Zhang et al., 2013). This line of inquiry has become particularly relevant in the context of climate change (Allan, 2011; Overpeck and Udall, 2010). Under which conditions can common property regimes be successfully combined with other regimes to cope with extreme events like droughts? Which cooperation factors contribute to the success of common property regimes in those conditions?

Voluntary and incentive-based approaches to policy making are receiving increasing attention as supplements to regulations in the field of environmental policy (Dietz and Stern, 2002). Natural resource management scholars have also pointed to the complementary strengths of common and private property institutions, suggesting that regimes that combine both types of institutions may work better than otherwise (Dietz et al., 2003; Ostrom, 2010; Rose, 2002). Empirical tests of this argument are, however, only nascent (Dietz and Stern, 2002).

The Spanish case is particularly appropriate to assess the performance of common property institutions under severe drought conditions as well as the potential contribution of complementary institutions. On the one hand, Spain has been internationally recognized for its dependence on water for economic growth (Cazcarro and Sánchez Chóliz, 2009; Cazcarro et al., 2013), and centenary tradition of its common property-based irrigation associations (Glick, 1970; Ostrom, 1990). On the other hand, an increasing number of Spanish irrigation associations have started to implement private property-based mechanisms to cope with droughts, including water markets and transferable quotas (Arriaza et al., 2002; Pujol et al., 2006).

Methodologically, the study compares drought performance across 38 Spanish irrigation systems. Drought performance is measured as the ability of an irrigation association to adjust its crop water needs to the decrease in water availability. In the context of common property regimes, such ability requires cooperation. Farmers may not be willing to reduce their acreage or cultivating low instead of high water-

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demand crops during droughts in order to conserve water that they cannot own privately. Additionally, irrigation organizations in Spain and other countries have very limited authority over crop decisions by farmers, which makes the need to promote cooperation vis a vis those decisions particularly puzzling.

2. Background

2.1. Cooperation Problems and Theory in Common Pool Resource Contexts

An irrigation system is an example of a common pool resource (CPR), i.e., it is difficult to partition for private consumption and can be depleted (Ostrom and Ostrom, 1977). In CPRs, sustainable management is usually tied to the resolution of cooperation problems. Cooperation problems in CPR contexts have been traditionally associated to the "tragedy of the commons" (Hardin, 1968). In the "tragedy of the commons", CPR users do not have the incentives to self-restrain resource extraction because they cannot exclude others from the benefits of such effort, so the resource is overexploited and may collapse. The persistence over time of many irrigation systems around the world shows that farmers can reach equilibrium between water demand and supply in the long term. However, that does not mean that farmers are able to sustain that balance when confronted with a drastic disruption in demand or supply. In the event of a drought, farmers need to adapt their cropping patterns to reduce collective water demand. In the context of a common property regime, that requires cooperation. Farmers may not be willing to decrease their irrigated acreage or switch from higher to lower water demand crops[1] if they cannot prevent other farmers from free riding on such effort.

Some of the most cited cooperation factors within common pool resource theory (CPR theory) are monitoring, small group size and leadership (Ostrom, 1990). "Monitoring makes those who do not comply with rules visible to the community, which facilitates the effectiveness of rule enforcement mechanisms and informs strategic and contingent behavior of those who do comply with rules" (Cox et al., 2010). In many cases, monitoring emerges at a low cost through informal interactions among resource users. In some cases monitors like field guards are also hired. The effectiveness of monitoring depends on how widespread non-compliant behavior is, as well as on the cost–benefit balance for monitors to carry their duties effectively (Coleman and Steed, 2009).

Group size can increase monitoring costs and reduce the chances of cooperation (Ostrom et al., 1994). Additionally, coordination and decision making in large groups may entail high information and negotiation costs, thus discouraging users from collaborating (Lubell et al., 2002; Poteete and Ostrom, 2004).

Finally, leaders can help resource users to form agreements, rules or strategies to cope with the resource conditions, as well as perform more general functions such as trust building, conflict management, knowledge diffusion, and mobilization of users for change (Folke et al., 2005; Meinzen-Dick et al., 2002; Subramanian et al., 1997). A leader's authority can be based on education and experience (Meinzen-Dick et al., 2002), differences in wealth (Baland and Platteau, 1999; Velded, 2000) and/or formal organizational position (Pielstick, 2000). In all cases, however, it is important that leaders are accountable to users, as power misuse can weaken trust in the regime and its effectiveness (Theesfeld, 2009).

2.2. Irrigation Management and Drought in the Riegos del Alto Aragon Irrigation Systems (Spain)

The irrigation systems under study are located in northeastern Spain, and expand throughout the inter-basin of the Gállego and Cinca rivers, mostly within the province of Huesca (region of Aragon). The Pyrenees mountain range, which is located at the north of the irrigable area, supplies most of the available water through snowmelt, as precipitation in the area is limited to roughly 350 mm. About 66% of the available water in the province of Huesca is used directly in the agricultural sector (Cazcarro et al., 2010), which makes the allocation the Pyrenees' water a crucial task to guarantee agricultural production (Cazcarro et al., 2010). The irrigation systems under study rely on a series of reservoirs located in the Gallego and Cinca basins for that purpose. Water from the reservoirs is delivered to the systems via a network of main and minor canals. Ground water is almost inexistent in the irrigable area.

In the last 40 years, the area under study has suffered from a negative precipitation trend (López-Moreno et al., 2010) and an increased climatic uncertainty caused by rapid changes between wet and dry periods (Vicente-Serrano and Cuadrat-Prats, 2007). The most recent evidence of these trends was the drought of 2005 and 2006 (see Fig. 1).

As shown in Fig. 1 and Table 1, water availability in 2005 was 60% lower than the average availability in the 1970–2003 series ($p < 0.001$), and 55% below the sum of water use rights in the area. In 2006, water availability was 30% lower than the series average ($p < 0.001$) and more than 20% below the sum of water use rights. By 2007 water entries were not significantly different than the series average.

2.2.1. Soil Characteristics

Two geomorphologic units with different soil characteristics can be distinguished in the area of study: platforms and alluvial terraces. Most common soil types in the platforms are Xerosol Gypsic and Xerosol Calcic, which tend to have low available water holding capacity (AWHC) and high infiltration. These soils can be highly productive, but only if enough water is available (Playán et al., 2000). Alluvial terraces are located at lower altitudes and are dominated by Fluvisol Eutric soils, which have poor drainage but high AWHC. These hydric soils can perform better than the soils in the platforms during periods of water scarcity (Playán et al., 2000). The higher productivity of hydric soils under drought conditions is expected to mitigate the impact of water scarcity crises and in turn decrease the collective action efforts required to readjust water demand to the decreased supply in the systems.

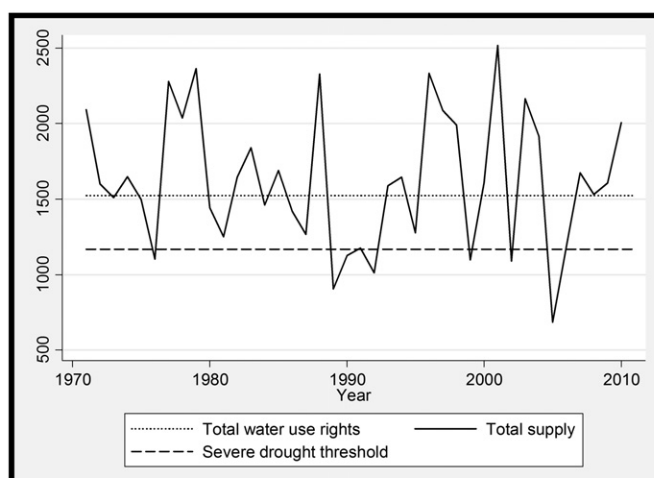

Fig. 1. Series of water availability (hm^3) in the area of study (1970–2010). Note: Series calculated according to water entries in the main reservoirs of the area of study during each irrigation cycle (from October to September of each year). Total water use rights are calculated as in 2000 and equal to 1,523 hm^3 (CHE, 2000). As per the information provided by the GCRAA and CHE officials, those water use rights were stable under the period of study. The severe drought threshold is calculated as one standard deviation below the average availability and equal to 1640 hm^3 (Hisdal and Tallaksen, 2000; Hisdal et al., 2001). Source: Ebro Basin Agency.

[1] Higher water demand crops like corn or alfalfa tend to yield higher economic returns than lower water demand crops like wheat or barley (Lecina et al., 2010). Irrigation modernization and water conservation in Spain: The case of Riegos del Alto Aragón. Agricultural Water Management 97, 1663–1675.