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More cash and jobs per illegal drop? The legal and illegal water footprint of the Western Mancha Aquifer (Spain)

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ABSTRACT

In many situations, the overuse of natural resources is aggravated by illegal use. More insights on the drivers and significance of this phenomenon are needed in order to formulate policies that can effectively ease human pressure on the environment. This paper makes use of the water footprint (WF), as a physical indicator of freshwater use, and introduces both economic (water productivity) and social (labour intensity) indicators to understand illegal groundwater use from a multiple perspective. Using data from the year 2000 and from 2007 to 2009, we analyse in detail the case of the Western Mancha Aquifer, in central Spain, where legal and illegal groundwater use take place simultaneously. Results show that nearly 52% of the agricultural blue WF is linked to illegal groundwater use, mostly for vine and vegetable irrigation. Besides this, the illegal share accounts for around 56% and 57% respectively of the gross income and employment generated by irrigation in the area. Therefore, although action to halt illegal withdrawals is a recurrent call to ease pressure on natural resources and ecosystems, these figures reflect the economic and social drivers, which might explain why such action is difficult to implement. In addition, the data presented in this paper provides new insights into some aspects of a public plan recently implemented to regularize illegal use by purchasing and reallocating groundwater rights on the basis of social and environmental grounds, which might be relevant for future public policy measures in situations presenting both over-allocation of water rights and illegal water use.

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1. Introduction

Groundwater use has increased dramatically across the world since the 1960s (Giordano and Villholth, 2007; Shah et al., 2007; Siebert et al., 2010). Although intensive groundwater use has been a major driver for economic development, it has also led to large impacts on groundwater dependent ecosystems (Custodio, 2002; Nevill, 2009). The exponential rise in groundwater use has been linked to the increased access and affordability of drilling machinery and pumping technology, which has allowed many individual farmers to expand irrigation, often in an unregulated, anarchic (Shah, 2008) or illegal (Reis, 2014) way.

Although increasing evidence on the negative environmental and social externalities associated with intensive groundwater use has fostered government intervention, regulations have often been reactive, late in time or not implemented, with groundwater use consolidating over the years (De Stefano and López-Gunn, 2012). The high transaction costs associated with monitoring a resource scattered through space and designing effective sanctioning regimes have also made control of groundwater withdrawals often difficult. All these factors have resulted in a situation of *fait accompli*, which has re-enforced farmers' perception on their legitimate use of groundwater. As a result, illegal use of groundwater resources still remains a key challenge for water governance (Llamas and Martínez-Santos, 2005).

In this paper we examine in detail an informal groundwater economy in order to provide insights into the physical, economic and social dimensions of illegal groundwater use. Following Gavin et al. (2010), we refer to illegal or informal use of groundwater as any use that violates existing regulations. In our study, we consider the case of the Western Mancha Aquifer (WMA) in central Spain. The intensive exploitation of this aquifer for irrigation has become an iconic case documented in numerous publications due to impacts on the 'Tablas de Daimiel' wetland, a National Park and UNESCO Biosphere Reserve (Blanco-Gutiérrez et al., 2011; Bromley et al., 2001; López-Gunn and Zorrilla, 2010; Martínez-Santos et al., 2008; Varela-Ortega et al., 2011, among others). The rise in groundwater use in the Western Mancha is linked to both legal and illegal abstractions. Official sources estimate that nearly 50% of the wells in the Western Mancha are unlicensed (CHG, 2007), suggesting that any attempt to solve the conflict emerging from groundwater use and the resulting ecological impacts in nearby wetlands needs to tackle all water uses, i.e. legal and illegal (Blanco-Gutiérrez et al., 2011).

This study makes use of the water footprint (WF) as a physical indicator of freshwater use (Hoekstra et al., 2011), and introduces both economic (water productivity) and social indicators (labour intensity) as policy-relevant dimensions to understand key drivers for groundwater use. It is worth highlighting that we only assess the blue component of the WF associated to irrigated agriculture in the WMA area from a production perspective, since the main objective of the paper is to understand the local drivers of illegal groundwater use (Hoekstra et al., 2011). We distinguish legal and illegal groundwater use for the years 2000 and 2007–2009 by comparing the crop area data reported by the Castilla-La Mancha regional government for the period 2000–2009 (JCCM, 2012) and remote sensing data generated by the water authority for the period 2007–2009 (Bea et al., 2009; UGC, 2012) with an evaluation of illegal irrigated areas published by the River Basin Authority in 2007 (CHG, 2007). While crop area data from JCCM (2012) is compiled from a range of sources (e.g. cooperatives' statistics, direct inventories, reported area, etc.), remote sensing data offers a more accurate representation of the land use and land cover in the WMA. Gavin et al. (2010) highlight that the study of illegal natural resource uses poses unique methodological challenges due to lack of available data and data collection issues. By combining a range of data sources through a relatively simple methodology, this study offers an alternative approach to the study of illegal water resources use from a physical, economic and social perspective.

The paper is organized as follows. Section 2 describes the evolution of groundwater regulations and groundwater use in the WMA. Section 3 presents the methods and data used in this study and Section 4 reports the main results. Section 5 discusses the implications for policy design and implementation in the area and lastly, Section 6 concludes with some insights that may be useful for other areas across the world facing similar problems over illegal groundwater use.

2. The Western Mancha Aquifer

2.1. Evolution of groundwater use regulation

The Western Mancha Aquifer (WMA) covers an area of around 5000 km^2 in the upper part of the Guadiana River Basin in central Spain (see Fig. 1). This area is characterized by a complex system of interconnected aquifers and groundwater-dependent ecosystems like the 'Tablas de Daimiel' National Park wetland. The region has a semi-arid climate with high rainfall seasonality and annual variability. On average, annual rainfall amounts to 415 mm/year. Irrigation from the WMA currently sustains part of the largest vineyard region in the world, with more than 400,000 ha under production.

Since the 1970s, the WMA has undergone a period of deep socio-economic change, driven by intensive groundwater use, which resulted in the lowering of the water table by 20 to 30 m (Martinez-Cortina et al., 2011). This rising groundwater demand has had important impacts in the nearby 'Tablas de Daimiel' wetland, modifying water inflows, its ecological functioning and the supply of many regulating and cultural ecosystem services. Public policies were thus introduced to curtail and limit intensive groundwater use in the WMA. The temporary declaration of WMA overuse in 1989 by the river basin agency, and its final closure to new uses, was accompanied by the introduction of an annual abstraction limit from 1994, the constitution of groundwater user groups, a ban on drilling new wells and forbidding the deepening of existing wells. The annual abstraction plan at farm level meant restricting water withdrawals up to one quarter of the original 4000 m^3 water rights per hectare. These restrictions, which meant reduced gains at farm level, when combined with the high monitoring and enforcement costs eventually translated into a general lack of compliance.