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Analysis of sprinkler irrigation management in the LASESA district, Monegros (Spain)

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ABSTRACT

Good management of water in agriculture is essential in semiarid areas, as irrigation is the main user of a scarce resource. The present paper analyses the water use and the quality of irrigation in LASESA (LD), a mature sprinkler irrigation district of the Ebro valley, NE Spain, during the years 2009 and 2010. The water use was studied through field data and water balances by the calculation of several irrigation quality indexes. The results give an annual irrigation volume higher than that of neighbouring irrigated sprinkler districts, which have a slightly different percentage of crops. An average irrigation efficiency of 76% has been obtained. The major problems detected in the irrigation management are low irrigation efficiency for corn (73%) and a high water deficit for alfalfa (16%). In addition, many irrigators follow a fixed pattern regardless of the water requirements of the crops. Average water productivity of irrigation water is 1.69 kg m^{-3}, similar to that obtained in other sprinkler irrigation areas of the Ebro valley. A change of the current irrigation scheduling is proposed in light of a simulation carried out seeking to reduce the underground drainage and the water deficit. The new schedule could improve the irrigation efficiency up to 83%, eliminate the water deficit and reduce drainage values to 4%, but it would require 7% more irrigation water.

1. Introduction

Irrigation in Aragon, located in a semiarid area of the central Ebro valley in northeast Spain, has a history going back more than 2000 years. After intense development during the XX century, the irrigated area today covers approximately 390,000 ha, mostly by surface irrigation. However, sprinkler irrigation covers approximately 30% of the total irrigated area. The first sprinklers were installed in around 1970 directly on the transformation of dry farming areas to new irrigation perimeters. More recently, important efforts have been made at *Riegos del Alto Aragón* (RAA), the most important irrigation perimeter of the Ebro valley, to change from surface to pressurized irrigation areas (MAGRAMA, 2011; Lecina et al., 2010). This is a result of the demands of our society to improve the efficiency of irrigated agriculture for hydrological, environmental and economic reasons.

There are a number of studies on the efficiency of sprinkler irrigation in the central Ebro valley. Several papers present data on irrigation efficiencies, usually higher than 90%, relating to the crop water requirements (potential evapotranspiration minus effective rainfall) and the water applied throughout the total irrigation season (Tedeschi et al., 2001; Cavero et al., 2003; Dechmi et al., 2003; Salvador et al., 2011a; Skhiri and Dechmi, 2012). Other studies, based on daily water balances with the use of the actual evapotranspiration, give values near 70% (Abrahão et al., 2011; Skhiri and Dechmi, 2012). As sprinkler irrigation systems offer flexibility by changing the irrigation scheduling, several recent studies from different parts of the world have focused on this issue (Lorite et al., 2004; Cancela et al., 2006; Chopart et al., 2007; Zapata et al., 2009; Liyuan et al., 2010; Salvador et al., 2011b). There is a general consensus about the importance of on-farm irrigation scheduling as an important factor in crop production.

The general objective of the present study is to evaluate water management in LD, one of the irrigation districts of the central Ebro valley, during the 2009 and 2010 irrigation seasons by means of (1) analysis of current irrigation practices by crop and soil type, (2) evaluation of the irrigation quality and water productivity, and (3) simulation of the effect of a proposed change in irrigation scheduling.

2. Materials and methods

2.1. Area description

Riegos del Alto Aragón, the most important irrigation system in the central Ebro valley, is divided into 60 districts. By surface, the LD

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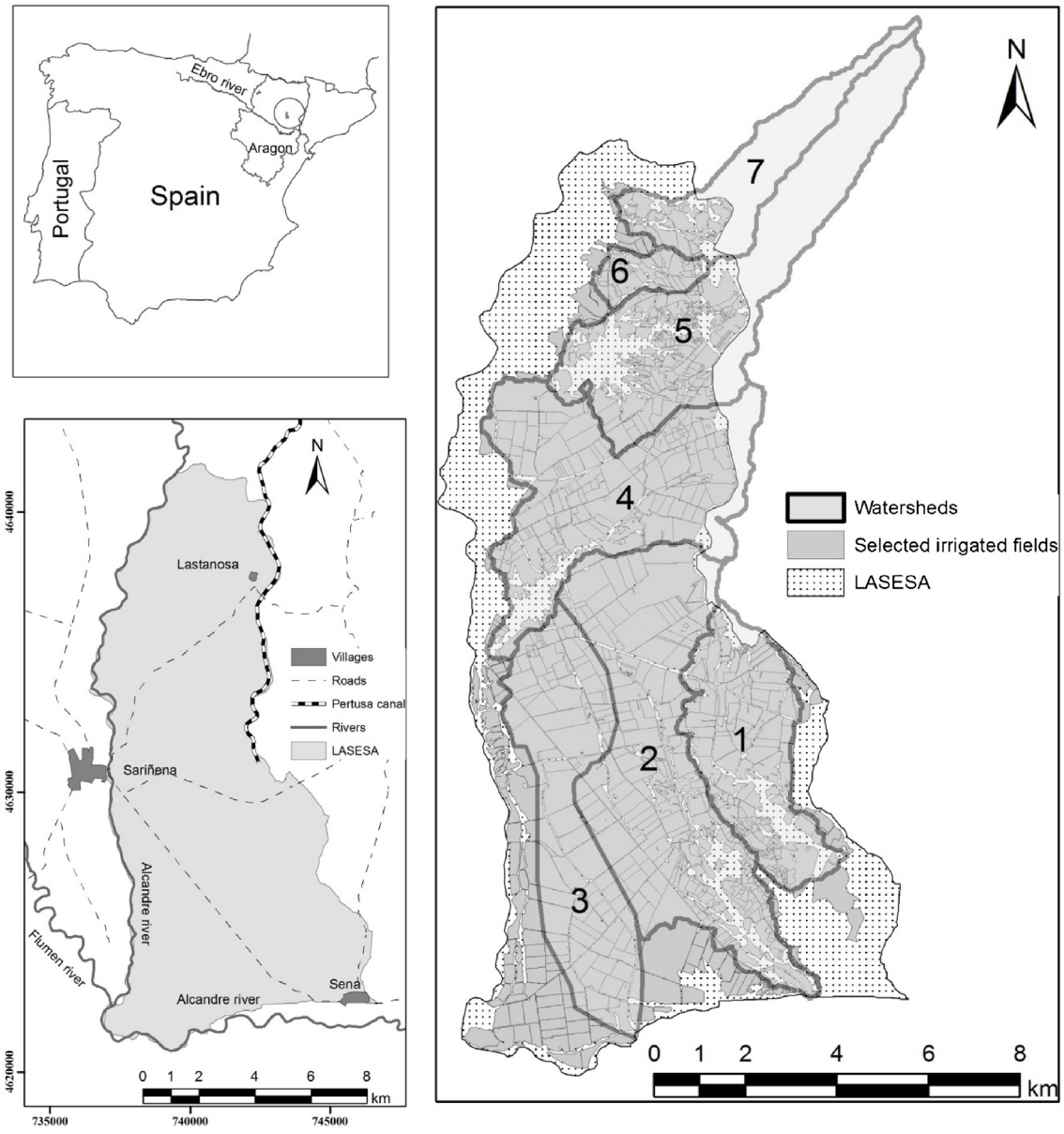

Fig. 1. Location of the LASESA irrigation district, main drainage watersheds and selected irrigated fields.

is one of the largest districts covering 9786 irrigated ha, divided into 5 sectors. It is located in the semiarid area of Monegros, in the central part of the Ebro Valley in northeast Spain (Fig. 1). The perimeter of the LD is bordered in the south and west by the Alcanadre River that collects the drainage of the irrigated area.

Geologically, the LD lies upon sandstones and marls of the continental Miocene of the Ebro valley. Gravel terraces of the Alcanadre River, with a maximum thickness of 10 m, cover significant areas in the west and south of the district. A small aquifer, recharged by irrigation and rainfall, is present at the base of the gravels. The area soils have been initially mapped and characterized by the description of 13 soil profiles, 8 in the terraces and 5 in the non-alluvial areas (Badía et al., 2010). Four soil subgroups were identified: Calcic Petrocalcid, Typic Xerofluvent, Typic Xerorthent and Typic Calcixerept. The available water holding capacity (AWHC) was measured from soil samples and, according to the AWHC values, three soil units were defined: very low AWHC soils (43%; <64 mm), medium AWHC soils (35%; 64–190 mm); and high AWHC soils (22%; >190 mm).

Water infiltration was determined by the double rings method. Sixty two percent of the LD area had a vertical surface infiltration rate over 30 mm h^{-1} and did not show any surface runoff by sprinkler irrigation or normal rains.

The local climate is Mediterranean continental (Salvador et al., 2011a). Mean temperature (2003–2009) is 14 °C. Average wind speed is 2 m s^{-1}. Mean annual precipitation is 366 mm. Mean annual reference evapotranspiration (ET_0), by the Penman-Monteith method, is 1216 mm. Daily data are supplied by the Sariñena agro-meteorological station (Oficina del regante, 2009).

The LD is located in the terminal zone of the Pertusa secondary canal of the Cinca channel. The area was transformed from dry farming to an irrigated area during the 1980s and organized into five independent irrigation sectors. The irrigated area is 9786 ha, comprising 787 fields and 654 owners. It is served by 5 independent pipe networks, one for each irrigation sector. By design, the pipe network has a threshold unitary discharge value of 0.82 L s^{-1} ha^{-1} that totals a volume of 557,300 m^3 day^{-1} for the whole LD. Irrigation water is distributed by 1253 hydrants,