



OPTIMIZATION OF IRRIGATION WATER IN THE DUERO RIVER BASIN

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Introduction and Objectives

Seventy-five percent of total water resources used in the Duero River basin is applied in irrigation for food production. The demand of water in the basin has risen in recent years due to the increasing food demand due to the population growth thus, it has caused illegal water extractions, principally subsurface water, which increases the energy demand for pumping. In addition, the unprecedented extreme weather and climatic conditions, generating frequent droughts, lead the basin authorities, which manage water resources, to impose restrictions on water for irrigation. This reduces crop yields, in irrigated agriculture in the rural areas where irrigation is paramount to maintain population and to avoid land desertification.

Within this context, the efficiency in the application of irrigation water is essential to guarantee food production, reduce the energy demand and the ecosystem's pressure. The use of remote sensing technologies, which allow crop's monitoring at the parcel scale, are an alternative for irrigation management in the area that will estimate specific crop coefficients (Kc) for each plot. The objective of this study is to evaluate the efficiency in irrigation water in the area, estimation by satellite images of Kc.

Materials and Methods

The study evaluated 949 satellite images from satellites Landsat8, Sentinel 2 A and 2B gathered from 2014-2018, to estimate the Kc in maize plots from NDVI (Equation 1). Maize has the highest water requirements.

$$Kc = 1.25 * NDVI + 0.2 \quad (1)$$

The crop coefficients of 143 maize plots were estimated in four different irrigation districts (IDs, Simancas; Villagonzalo; Toro Zamora and Villalar de los Comuneros. Figure 1).

Acknowledgments

The authors wish to thank to the UPM programa propio for the support of this study.

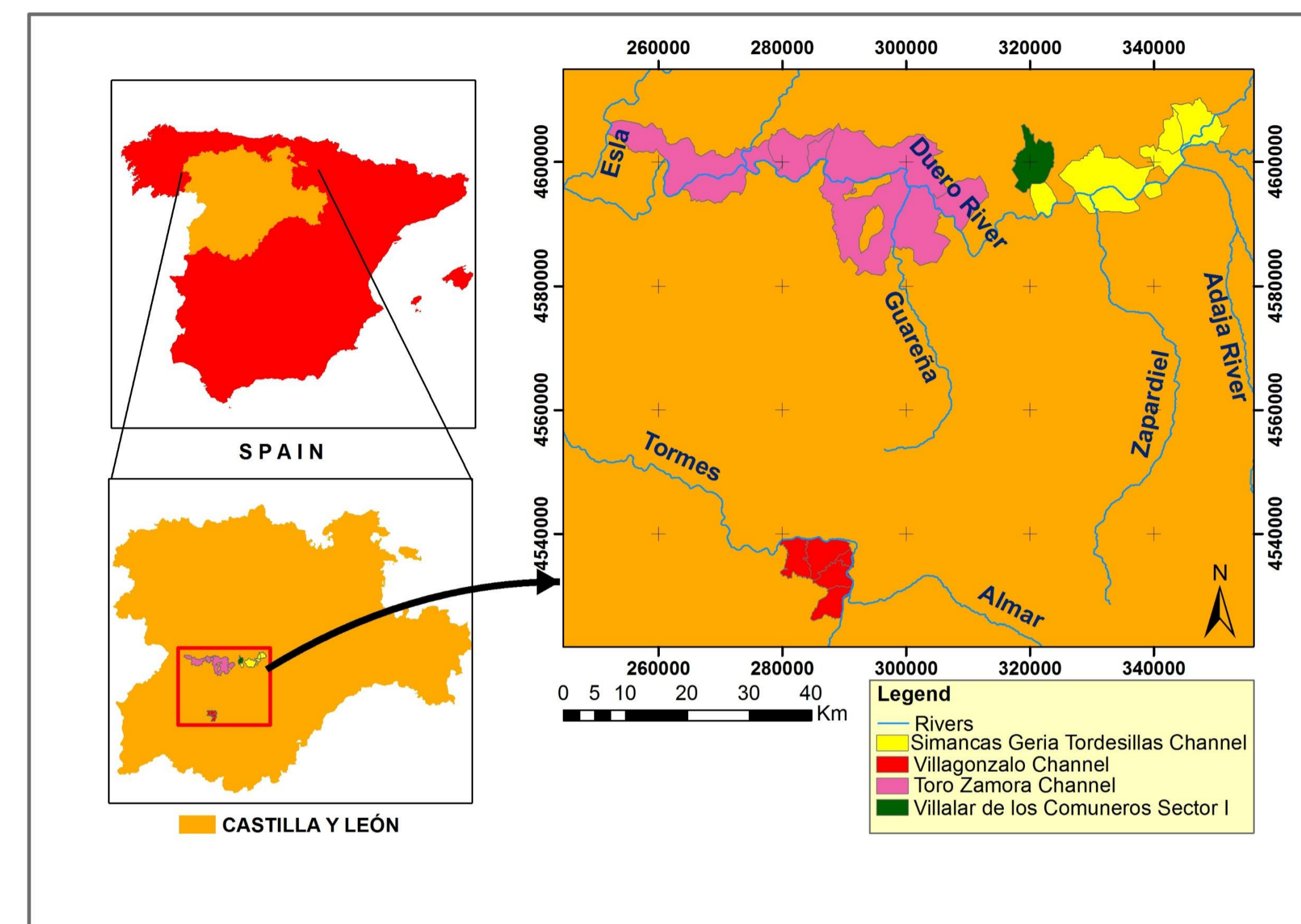


Fig. 1 Location of the irrigation districts in the Duero river basin.

Then, the Kc obtained from the four IDs were used to estimate ET and gross irrigation requirements (GIR, Equation 2).

$$GIR = \frac{ET - Pe * 100}{Ea} \quad (9)$$

GIR were contrasted with the irrigation water supplied (IWS) during the studied years. Likewise, Kc values were contrasted with the Irrigation Advisory Services (ITACyL) and FAO-56 recommended Kc.

Results and Conclusions

Three Kc were obtained for each studied plot at different crop growth stages (Kc-initial, Kc-mid-season and Kc-end) as a mean of all the images and the studied years (Figure 2). A mean Kc-ini = 0.41 ± 0.01, Kc mid = 1.08 ± 0.01 and a Kcend 0.55 ± 0.01. These were slightly different to the recommendations by ITACYL (Kcini=0.45, Kcmid=1.1 and Kcend=0.5). ITACYL values are constant and do not take into account local conditions for each ID.

The variation among plots is described in Table 1 using the variation coefficient CV; were Kc mid presented less variation.

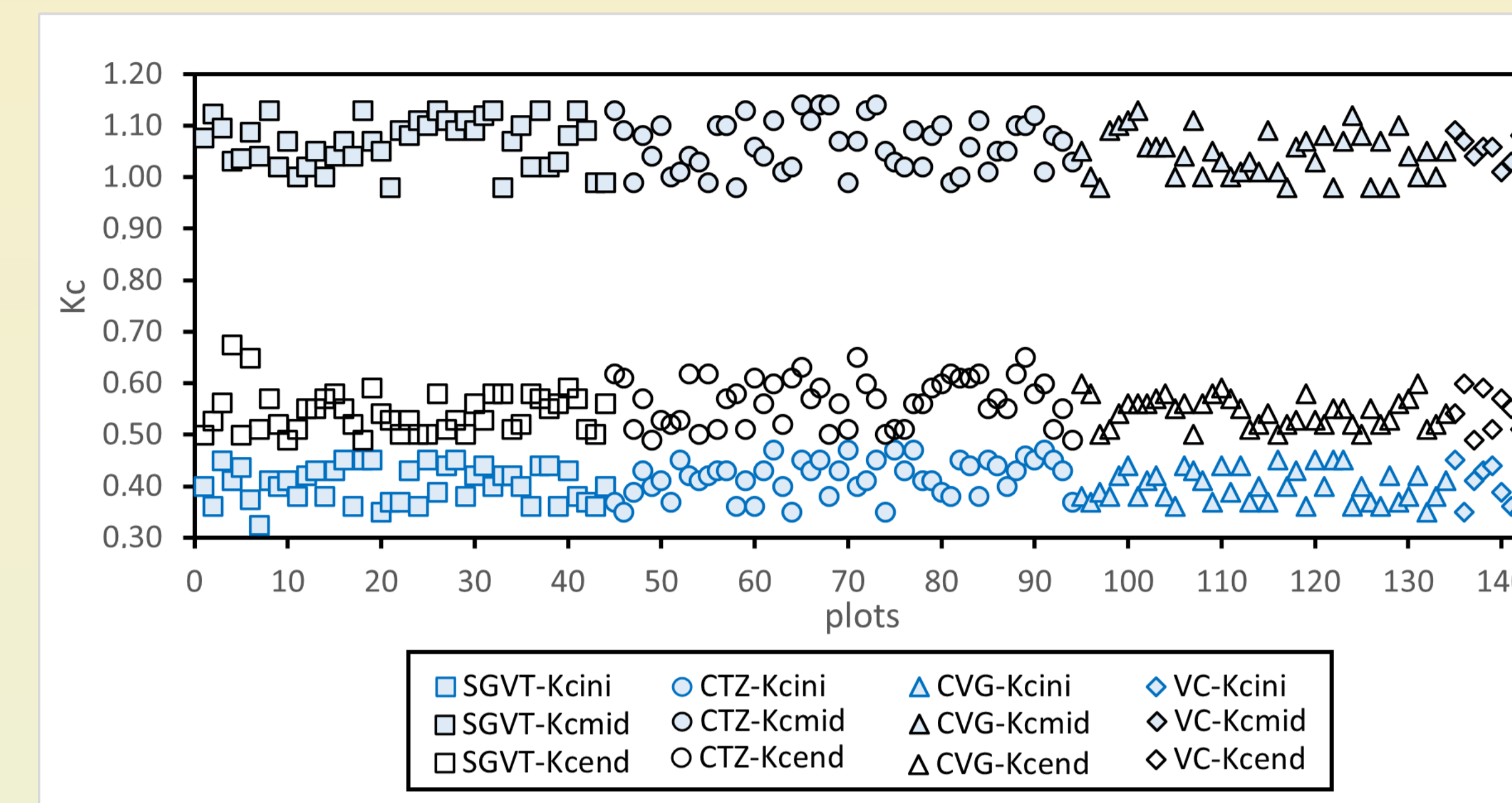


Fig. 2 Estimated Kc values by plots

Kcini	Kcmid	Kcend
8.40	4.53	7.44

Table 1 Coefficient of variation at different Kc among plots

Usually, the IDs perform deficit irrigation in the dry years and either full irrigation or over irrigation in the wet years. However, if the estimated Kc would have been used in each plots, it could have been saved up to 19% of the water applied per year in some IDs. Likewise, the average saving would have been 4.28% in all the plots and years studied, therefore, the study shows that an specific Kc estimation is a key factor to save water, as well as energy in the pressure irrigation systems, in the zone to used for the agroecosystem.

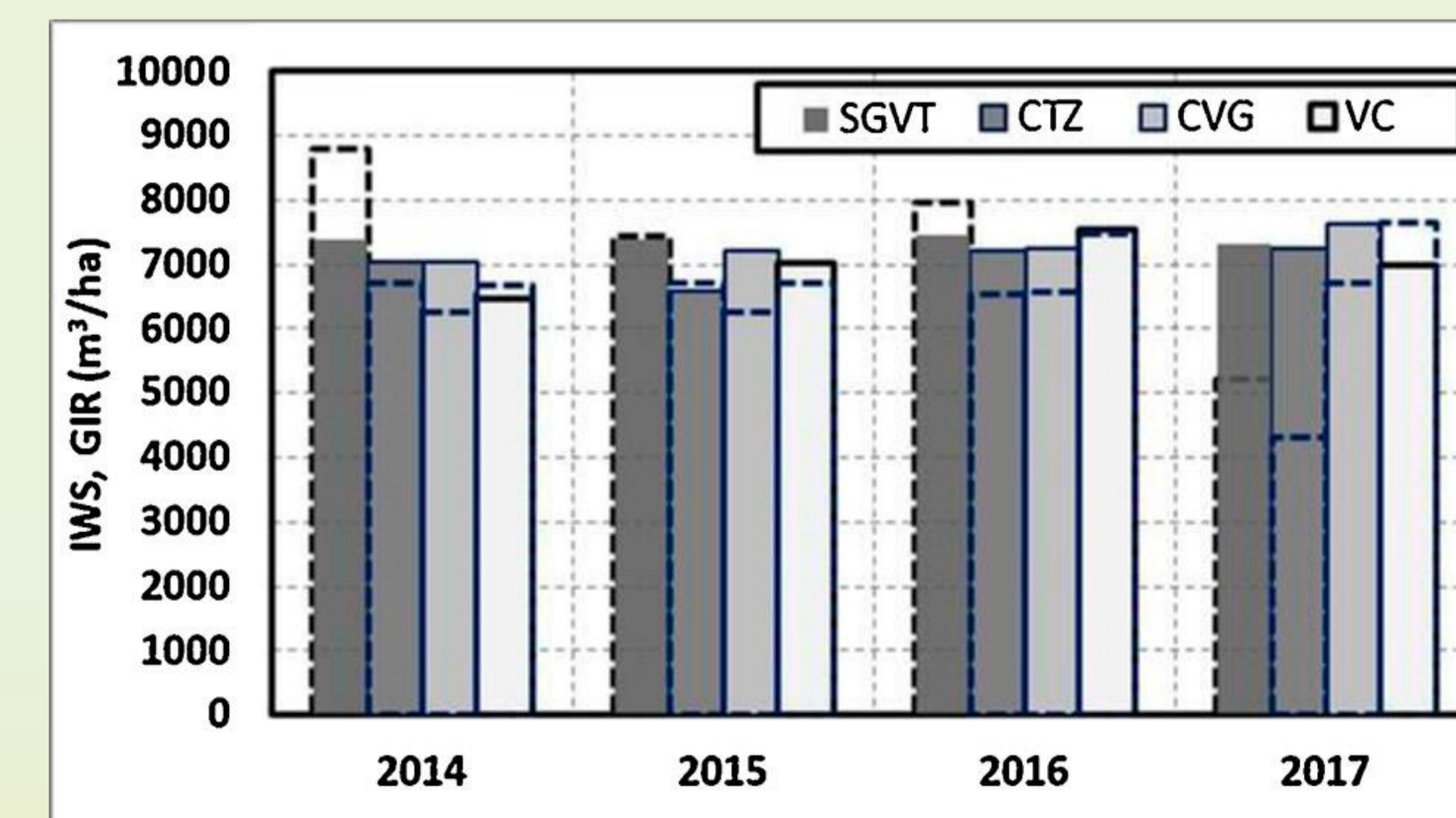


Fig. 3 Comparison between IWS and GIR

References

Segovia-Cardozo, D. A., Rodríguez-Sinobas, L., & Zobelzu, S. (2019). Water use efficiency of corn among the irrigation districts across the Duero river basin (Spain): Estimation of local crop coefficients by satellite images. *Agricultural water management*, 212, 241-251.