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Adopting a Water-Food-Energy nexus approach to explore the synergies and trade-offs of food-water policies in Spain

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Spain is a semi-arid country and faces a strong competition over scarce water resources by the different sectors. Agriculture is the largest water consumer and because of this it is often at the core of much of the disputes over water. Several policy measures have been implemented in the course of the last decades to ameliorate water scarcity problems. The irrigation modernization plan is probably one of the most ambitious plans implemented so far (with a total investment of nearly 3,800 mill € involving the modernization of over 1 million irrigated ha), and was developed with the double aim of increasing the efficiency of agricultural water use and strength the resilience and competitiveness of the Spanish irrigation sector.

In this research we examine the implications of the irrigation modernization plan by adopting a nexus approach. In particular we assess the trends in water, land and energy footprints associated to agriculture during the period 2000-2011 to evaluate the effectiveness of the plan. Likewise, we used a life cycle analysis approach to assess the implications in terms of greenhouse gas emissions (GHG). Our results show that the land footprint of irrigated agriculture has increased 2% (from 3.4 mill ha in 2000 to 3,6 mill ha in 2011). Meanwhile, the water footprint of irrigated agriculture has decreased by 8% (from 17,078 hm3 in 2000 to 15,573 hm3 in 2011). Beyond the net water savings, there has been a major shift in the composition of the water footprint. In the year 2000, 77% of the blue agricultural water footprint was linked to surface water, while in the year 2011 over 55% of the water consumed by agriculture is groundwater. The modernization of irrigation technologies alongside with the shift from a predominantly surface water footprint to groundwater has boosted the energy footprint of irrigation by 56% (2442 GWh in 2000 to 3803 GWh in 2011). This rise in the energy bill has meant an increase of 9% in the GHG emissions. Yet, this GHG increase is limited and follows the changes in the Spanish energy mix, which have experienced an increase in the share of renewable energies during the period of analysis. Overall, while the irrigation modernization plan has achieved some of its main goals, it has also had an important energy cost. Deeper and more detailed analysis are required to determine the extent to which investments done to improve water use efficiency outweigh the energy trade-offs.