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Water, agriculture and ecosystem services in climate change vulnerable agricultural regions of Spain and Jordan

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Irrigated agricultural landscapes generate a valuable set of ecosystem services, which are threatened by water scarcity in many arid and semi-arid regions of the world. In the Mediterranean region, climate change is expected to decrease water availability through reduced precipitation and more frequent drought spells. At the same time, climate change, demographic and economic development and an agricultural sector highly dependent on irrigation, will raise water demand, increasing experienced water scarcity and affecting the provision of ecosystem services from water resources and agro-ecosystems. In this context, policy makers face the challenge of balancing the provision of different ecosystem services, including agricultural income and production and also water ecosystem protection. This research explores future scenarios for two water scarce Mediterranean countries, Spain and Jordan, to analyse the potential impacts of climate change and policy scenarios on the provision of services from water and agricultural ecosystems. For this, an integrated bio-economic and hydrologic modelling framework is developed. The bio-economic model is a farm-based non-linear stochastic mathematical programming model that simulates aggregated farmer behavior under a set of structural, technical and policy constraints. The hydrologic model WEAP is a water-balance-based platform that enables the consideration of both the bio-physical/hydrologic system and the socio-economic/management system. It includes an

agronomic module that permits to simulate crop growth processes, fully accounting for the relation between climate, soil, water resources and plant growth. This way, this integrated platform allows for the consideration of a diverse set of ecosystem services including crop productions, agricultural income and employment, crop diversity and water ecosystem maintenance. The simulated scenarios include projections for economic and demographic developments in the selected countries and a combination of water and agricultural specific policies looking at their effects on the provision of different ecosystem services. Results show that sustainability oriented water policies will be key for securing water demands and sustaining socio-economic growth. In Spain, while different socio-economic scenarios will not produce significant changes in water resources, climate change may lead to the water supply substantially failing to meet demands around by the 2040s. In Jordan, however, water policies will be key for securing agricultural production and income and protecting water ecosystems. Restructuring water rights, improving control and removing market distorting elements will be the most effective measures for protecting water ecosystems, but will importantly impact agricultural income and production. In sum, this research demonstrates that different institutional and natural contexts determine the success of water policies in protecting the provision of key ecosystem services.

Keywords: *ecosystem services, irrigation agriculture, Mediterranean countries, water scarcity*

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