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Adaptive Response of Water and Human Systems to Water and Agricultural Policies under Climate Uncertainties

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In Mediterranean countries, irrigation agriculture has been a key driver for economic development and social stability. In Spain, the most arid country of Europe, irrigation-based economies that spread along its littoral and rural inland, have relied on groundwater sources for irrigation expansion giving rise to acute water conflicts and rivalry among water users. Within the EU policy context, this research is centered on the analysis of diverse policies meant to conserve groundwater resources and the farming activity in a large aquifer of the Guadiana river basin in Spain's central plateau. Irrigation expansion in the area has mitigated the impacts of the region's once endemic drought and has brought about socio-economic prosperity to the rural communities. Yet, overuse of groundwater induced the overexploitation of the aquifer and the loss of the associated Ramsar-listed wetlands bringing social conflicts and disputes over the course of the past decades. One of the ways to approach this controversial question is the integration of the socio-economic and water domains into a common modeling platform that will allow capturing the complexity of the economic, social and environmental interactions of human and water systems. This constitutes the novelty of this research and has been done by means of the integration of an economic mathematical programming model and a hydrology model WEAP (Water Evaluation And Planning system) together with an ample and continuing stakeholder participation forum. This participatory modeling platform is used to analyze the effects of agricultural policies and water policies under different climate patterns on the rural economy and on the recovery of the aquifer. The analysis is being conducted at different spatial scales, such as the farm and the entire aquifer, and different time spans along the horizon of the WFD implementation. Results illustrate spatial diversity, as different types of farms with varied size, cropping mix and irrigation technologies have a distinct capacity to adapt to water stress conditions. Larger diversified farms show a lesser vulnerability and a more flexible adjustment to water scarcity than smaller single-cropping farms. The water quotas applied currently in the area will not be sufficient to replenish the aquifer although they may, in some farms, contribute to reduce water use locally but will penalize farm income gains. This trend will be accentuated in the case of dry climate in spite of the high resilience of groundwater to climate variability. On the whole, the long-term recovery of the region's aquifer will be attained solely if all measures included in the recently launched regional water plan will be fully implemented (control of illegal mining, purchase of water rights and reforestation). In relation to the integration of the EU agricultural and water policies, results prove that there are clear synergies between them to reach water conservation targets. When CAP payments are fully decoupled from production, more extensive farming takes place with less drastic income reductions across all water policy options, which suggest that a full decoupled scheme acts as a risk shelter for irrigated farming. The study concludes that coordination of water and agricultural policies, together with strong stakeholder participation, will encourage sound water management for balancing nature conservation and human development in water-scarce regions. From a methodological perspective, the integrated modeling framework developed in this study provides innovative governance solutions for policy-makers that have to deal with multifaceted water management challenges. It offers a more comprehensive vision about the economic and social consequences of water management and when developed conjointly with the stakeholders, hydro-economic modeling may also promote a shared understanding of water resources systems and problems and offers a basis for negotiated policy solutions reducing water conflicts