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Assessing the potential of different rice irrigation strategies in a rice-dominated area in northern Italy by combining QGIS-SWAP-Paddy and MODFLOW-6

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Abstract. In rice-growing areas, irrigation efficiency is linked to groundwater levels, which regulate percolation in fields and canals, as well as discharge flows from springs and in watercourses. In Agricultural Managed Aquifer Recharge (Ag-MAR), fields are intentionally flooded and water is allowed to circulate in channel networks to recharge aquifers. Quantifying ag-MAR benefits remain challenging due to the complex surface-subsurface water dynamics involved, requiring advanced numerical modelling. This study presents a modelling framework for the Lomellina region in northern Italy (125.000 ha, 60.000 ha cropped with rice), where traditional wet seeding and continuous flooding has recently been replaced by dry seeding and delayed flooding or turned-based irrigation. This has led to lower groundwater levels and increased irrigation demand during the central months of the irrigation season. The framework combines QGIS-SWAP-Paddy, a new modelling tool that estimates irrigation demand and percolation rates in agricultural areas (agricultural fields and channel networks), with MODFLOW-6, which models groundwater flow. This integrated approach enables the evaluation of the impact of different rice irrigation strategies, including Alternate Wetting and Drying (AWD), and Ag-MAR interventions. The study is part of PROMEDRICE (https://promedrice.org/; PRIMA-Section2–2022), funded for the Italian partners by the Italian Ministry of University and Research (MUR).

Keywords: QGIS-SWAP-Paddy, MODFLOW, channel irrigation efficiency, rice irrigation management, Ag-MAR