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Modelling the impact of Alternate Wetting and Drying (AWD) rice irrigation on water resources in northern Italy

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The north-western part of the Padana Plain in Italy is the most important rice district in Europe. Recently, due to an increased frequency of water scarcity periods, the traditional wet seeding and continuous flooding irrigation has been replaced by dry seeding followed by a delayed flooding or by a turned irrigation. Despite the advantages that dry seeding has brought to farmers, this change is leading to unexpected problems, the main of which are: i) the lowering of groundwater levels in the first months of the agricultural season that is reducing groundwater contribution to water discharges in rivers and irrigation networks of the area, limiting the water availability for agricultural areas downstream; ii) a shift to June of the maximum rice irrigation requirement, leading to an exasperated competition between rice and other crops (e.g. maize).

In the contest of the MEDWATERICE (PRIMA Section2-2018) and RISWAGEST project (Regione Lombardia, RDP 2014-20), an experimental platform was set up in the core of the Italian rice area (Mortara, PV) to compare three rice irrigation strategies in the period 2019-2022: i) wet seeding and traditional flooding (WFL), ii) dry seeding and delayed flooding (DFL) and iii) wet seeding and alternated wetting and drying (AWD). Irrigation water use was monitored and all the other soil water balance components were quantified. At the field scale, irrigation use was found to be in the order: WFL > DFL > AWD, without penalizing rice production, while the temporal distribution of irrigation needs and percolation fluxes (i.e. groundwater recharge) changed as a function of the irrigation strategy.

Results achieved in the experimental platform were used to set-up a semi-distributed agro-hydrological model simulating water fluxes and storages of a rice irrigation district (about 1000 ha) close to the experimental platform. The modelling framework consists of three sub-models: i) one for the agricultural area, based on the physically-based SWAP (https://www.swap.alterra.nl/); ii) one for the channel network percolation; iii) one for the groundwater level dynamics. Once calibrated, the modelling system was used to explore the effects on the water resources of 'what-if scenarios' based on the adoption of specific irrigation strategies in the whole rice-cropped area of the district (about 90% of the agricultural surface) for the period 2013-2020. Besides the aforementioned WFL, DFL and AWD, the following strategies were additionally explored: i) dry seeding and fixed irrigation turns of 8 days (FTI) and ii) early seeding for the DFL irrigation

technique (beginning of April). Three indicators were used to support the analysis: i) Water Application Efficiency - WAE, defined as the potential evapotranspiration divided by the irrigation reaching the fields plus rainfall, ii) Distribution Efficiency of the irrigation network - DE, defined as the irrigation reaching the fields divided by the irrigation discharge entering the district, iii) Relative Water Supply - RWS, defined as the irrigation discharge entering the district plus rainfall divided by the potential evapotranspiration. Water fluxes and indicators are calculated and discussed both for the entire agricultural season (April-September) and for the most critical month (June).