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Winter Cropping and Soil Salinity Dynamics in Water-Scarce Rice Systems of the Guadalquivir Marshes

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Abstract. Water scarcity and increasing soil salinity constrain rice production in the Guadalquivir River marshes (SW Spain), where seasonal flooding is essential for salt leaching and maintaining soil productivity. During the severe drought of 2023, rice cultivation was suspended and fields were either planted with winter crops (cereals and legumes) or left fallow. The absence of inundation provided a unique opportunity to evaluate how alternative winter management influences topsoil salinity dynamics and potential implications for subsequent rice performance.

A multi-year Sentinel-2 time-series analysis (2021–2025) was conducted across representative farms to assess temporal patterns in soil salinity and crop development. Vegetation indices (NDVI, GNDVI, GDVI) were used to characterise rice growth trajectories, while salinity-related indices (NDSI, ASTER_SI, SAVI) were calculated under bare soil conditions to ensure spectral consistency and minimise vegetation interference. Plot-level temporal trends, interannual variability, and deviations associated with the 2023 non-flooded season were quantified to detect management-related shifts.

Preliminary results indicate measurable interannual variability in surface salinity signals following the interruption of flooding, with contrasting responses between winter cropping and fallow systems. These findings highlight the relevance of satellite-based time-series monitoring as a diagnostic tool for salinity assessment and adaptive management in water-scarce rice agroecosystems.

Keywords: rice systems, soil salinity, water scarcity, winter cropping, time-series remote sensing