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"Reconcile land system changes
with planetary health"

Assessing winter crop effects on soil salinity in andalusian rice fields via sentinel^{-2} imagery

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Abstract

Water scarcity and soil salinity are critical constraints in Andalusian rice production, reducing cultivated areas and causing yield losses. In 2023, no rice was grown, prompting farmers to adopt winter crops—such as cereals and legumes—or leave fields fallow. Without flooding, these practices risk increasing topsoil salinity through capillary rise.

The Guadalquivir River, the primary irrigation source in Isla Mayor, is increasingly affected by seawater intrusion due to declining rainfall and rising temperatures, elevating salinity levels in irrigation water and soils.

Sentinel^{-2} Multispectral Instrument imagery offers valuable tools for monitoring soil salinity. Indices derived from visible, near-infrared (NIR), and short-wave infrared (SWIR) bands provide direct indicators of salinity, while vegetation indices reveal crop stress as an indirect response to saline conditions.

This study uses two categories of multispectral indices following Gerardo & Lima (2022): vegetation indices (NDVI, GNDVI, GDVI) and salinity indices (NDSI, ASTER_SI, and SAVI). While not salinity-specific, SAVI uses red and NIR bands known to be sensitive to saline soil ions (Rengasamy et al., 2003).

Research was conducted on three farms along the Guadalquivir River. Vegetation indices were calculated across ten dates spanning the full rice cycle (2021–2025). Salinity indices were assessed pre- and post-season for rice, winter crops, or fallow, focusing exclusively on bare soil to ensure accuracy.

A time-series analysis was performed to compute percentage variation per plot, allowing detection of changes in topsoil salinity linked to winter cropping practices and their implications for rice development.

The study aims to generate actionable insights for salinity management and guide farmers in selecting sustainable winter cropping strategies that support soil health and long-term rice productivity in vulnerable lowland systems—highlighting the potential of satellite imagery as an efficient, non-invasive tool for diagnosing soil conditions in semi-arid regions and supporting climate-resilient decisions in smallholder agroecosystems.

Keywords: Agroecosystem resilience, climate adaptation, land use change, soil salinisation

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