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A Remote Sensing-Based Geospatial Framework for Assessing Crop Water Dynamics

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Abstract

Food security depends on reliable agricultural production, and effective water management is essential for achieving good crop yields. Irrigated agriculture covers approximately 20% of cultivated land and produces about 40% of global food, while agriculture accounts for approximately 69% of global freshwater withdrawals (FAO AQUASTAT). Crop water requirements are commonly estimated using the FAO-56 approach, which uses crop coefficients (Kc) for different growth stages. However, applying this approach across large agricultural areas requires detailed information on crop type and development. This study combines a maize crop map with satellite-based Normalized Difference Vegetation Index (NDVI) data to estimate maize water requirements. The crop map identified maize fields; monthly NDVI described their development. A linear relationship between NDVI and Kc was used to estimate monthly Kc values. Crop evapotranspiration (ETc) was then calculated using Kc and reference evapotranspiration (ETo) and compared with satellite-derived actual evapotranspiration (ETa). The approach was applied to maize-growing areas in Guanajuato, Mexico, from 2021 to 2024 at 30-m spatial resolution. Seasonal Kc patterns identified growing periods. Areas where ETa was lower than ETc were identified as potential crop water deficit areas. Seasonal ETc of 658-792 mm against ETa of 514-567 mm gave mean deficits of 110-226 mm over 91-97% of the maize area. These differences may indicate water stress but do not directly confirm stress because of uncertainties in the input data and water-use estimates. The approach provides spatially detailed information on maize water requirements and potential deficits, supporting improved crop water monitoring and irrigation management.

Keywords: *agriculture; crop coefficient; remote sensing; water*