World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:18, No:09, 2024

Employing Remotely Sensed Soil and Vegetation Indices and Predicting by Long Short-Term Memory to Irrigation Scheduling Analysis

Authors : Elham Koohikerade, Silvio Jose Gumiere

Abstract : In this research, irrigation is highlighted as crucial for improving both the yield and quality of potatoes due to their high sensitivity to soil moisture changes. The study presents a hybrid Long Short-Term Memory (LSTM) model aimed at optimizing irrigation scheduling in potato fields in Quebec City, Canada. This model integrates model-based and satellite-derived datasets to simulate soil moisture content, addressing the limitations of field data. Developed under the guidance of the Food and Agriculture Organization (FAO), the simulation approach compensates for the lack of direct soil sensor data, enhancing the LSTM model's predictions. The model was calibrated using indices like Surface Soil Moisture (SSM), Normalized Vegetation Difference Index (NDVI), Enhanced Vegetation Index (EVI), and Normalized Multi-band Drought Index (NMDI) to effectively forecast soil moisture reductions. Understanding soil moisture and plant development is crucial for assessing drought conditions and determining irrigation needs. This study validated the spectral characteristics of vegetation and soil using ECMWF Reanalysis v5 (ERA5) and Moderate Resolution Imaging Spectrometer (MODIS) data from 2019 to 2023, collected from agricultural areas in Dolbeau and Peribonka, Quebec. Parameters such as surface volumetric soil moisture (0-7 cm), NDVI, EVI, and NMDI were extracted from these images. A regional four-year dataset of soil and vegetation moisture was developed using a machine learning approach combining model-based and satellite-based datasets. The LSTM model predicts soil moisture dynamics hourly across different locations and times, with its accuracy verified through cross-validation and comparison with existing soil moisture datasets. The model effectively captures temporal dynamics, making it valuable for applications requiring soil moisture monitoring over time, such as anomaly detection and memory analysis. By identifying typical peak soil moisture values and observing distribution shapes, irrigation can be scheduled to maintain soil moisture within Volumetric Soil Moisture (VSM) values of 0.25 to 0.30 m^2/m^2, avoiding under and over-watering. The strong correlations between parcels suggest that a uniform irrigation strategy might be effective across multiple parcels, with adjustments based on specific parcel characteristics and historical data trends. The application of the LSTM model to predict soil moisture and vegetation indices yielded mixed results. While the model effectively captures the central tendency and temporal dynamics of soil moisture, it struggles with accurately predicting EVI, NDVI, and NMDI.

Keywords : irrigation scheduling, LSTM neural network, remotely sensed indices, soil and vegetation monitoring
Conference Title : ICERERS 2024 : International Conference on Earth Resources and Environmental Remote Sensing
Conference Location : Paris, France
Conference Dates : September 16-17, 2024