APPLICATION OF MACHINE LEARNING TECHNIQUES FOR AGRICULTURE DROUGHT FORECASTING USING REMOTE SENSING DATA

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ABSTRACT

Agricultural drought is a climatic hazard that has a negative influence on both ecosystems and human civilizations. It can have devastating effects, including dryness, agricultural losses, water scarcity, and deforestation. Many Remote sensing (RS)-based drought indices, such as the Vegetation Condition Index (VCI), Normalized Difference Vegetative Index (NDVI), Enhance Vegetation Index (EVI), Temperature Condition Index (TCI), and Vegetation Health Index (VHI), are being used for agricultural drought monitoring. VCI, VHI, and TCI are vegetation indices that indicate the health of vegetation/crops in a particular area. Reliable and qualitative agricultural drought forecasting using these indices could be effective for planning and decision-making in areas subject to a significant risk of drought. Data-driven techniques especially Machine Learning (ML) are widely used for drought forecasting. However, due to a lack of understanding of model performance, the selection of an appropriate model remains a problem for water resources management.

Hence, this research examined the capabilities of several ML techniques including Support Vector Machine (SVM), Artificial Neural Network (ANN), Random Forest (RF), and Decision Tree (DT) for Agricultural drought forecasting. Preliminary agricultural drought indices i.e., TCI, VCI, and VHI were calculated for the period 2001-2021 from LST, and EVI for 14 districts of South Punjab, Pakistan, and then forecasted using the ML techniques. Statistical indicators were also used to evaluate the performance of the selected ML techniques, including the Nash Sutcliffe Efficiency (NSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Coefficient of Determination

(R^2). The findings showed that all machine learning algorithms were effective in forecasting agricultural drought. However, the performance of SVM and RF was more reliable and effective than that of the other ML techniques with average values of MAE=0.053 and 0.055", RMSE=0.069 and 0.071, NSE=0.77 and 0.84, and R^2=0.85 and 0.84 for VHI respectively. Moreover, the Computation time of RF and ANN was much higher than SVM and DT. According to the study's overall conclusions, the SVM was found the most accurate machine learning technique for forecasting agricultural drought in South Punjab based on performance evaluation criteria and computation time.