

Predicting Fallow Land and Water Management Implications Using Advances in AI for California's San Joaquin Valley

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The San Joaquin Valley of California is a paradox. It is highly productive agriculturally, but highly vulnerable to hydroclimatic shocks. A principal means of improving systemwide water management flexibility is strategic land fallowing. To date, however, land fallowing is sporadic, ephemeral, and unpredictable. Understanding patterns and drivers of land fallowing would allow resource managers to better plan for water allocation to cities, farms, and ecosystems. The inability to accurately anticipate the distribution of fallow land hampers the optimization of resource use, thereby affecting both the agricultural economy and regional water management. Thus, forecasting fallow land would allow for more optimum agricultural productivity and water delivery, particularly to vulnerable communities and ecosystems. To address this issue, this study compares state-of-the-art machine learning models with deep learning methods using a rich dataset that includes satellite images, weather patterns, soil properties, historical land use information, and other pertinent geospatial data. We employ an advanced ensemble of machine learning algorithms, i.e., Random Forest (RF), Extreme Gradient Boosting (XGBoost), and Support Vector Machines (SVM), for forecasting fallow land. Additionally, we investigate the use of Convolutional and Recurrent Neural Networks (like ConvLSTM, CNN-LSTM, and GAN) to take advantage of the spatial and temporal relationships contained in the data. Our preliminary findings suggest that deep learning models, with their capacity to capture intricate spatial and temporal correlations within the data, may perform better than more conventional machine learning techniques. As a result, these deep learning models could help water managers, policymakers, and researchers make more precise forecasts about the distribution of fallow land, leading to more optimal use of water resources and agricultural output. The results of this study can not only offer insights for California water managers and policymakers, but also enable practical plans for more optimal resource allocation, sustainable agricultural land use, and long-term water security. Our approach may also be applicable to other agricultural regions facing similar challenges globally.