African Aerial Photography and Remote Sensing (Technology/Methodology)

Machine Learning Models for Climate Prediction and Adaptive Planning in Ghana: An Integrated Approach

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Abstract

Climate change poses significant challenges to agriculture, water resources management, and urban planning in Ghana. Accurate climate predictions are essential for adaptive planning and mitigation strategies. A hybrid ensemble model combining Random Forest (RF) and Extreme Gradient Boosting (XGBoost) was employed. Model performance was evaluated using Mean Absolute Error (MAE) with a 95% confidence interval as uncertainty quantification. RF-XGBoost outperformed baseline models, achieving an MAE of 2.3°C compared to the RF model's 2.8°C and XGBoost's 2.6°C, indicating improved predictive accuracy in climate forecasting for Ghana. The hybrid ensemble approach demonstrated enhanced robustness and precision in climate predictions, facilitating more informed adaptive planning efforts in Ghana. Future research should focus on integrating additional datasets to further refine the models' performance and explore their application across different regions of Ghana. Machine Learning, Climate Prediction, Ensemble Models, Extreme Gradient Boosting, Random Forest Model estimation used $\hat{\{}\theta\}=argmin\{\theta\}sumiell(yi,f\theta(\xi))+\lambda lVert\theta rVert2^{2}$, with performance evaluated using out-of-sample error.

Keywords: *Sub-Saharan, Geographic Information Systems, Ensemble Forecasting, Climate Indices, Machine Learning Algorithms, Data Fusion, Predictive Analytics*

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