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Rainfall Prediction in Karachi, Pakistan: A Machine Learning & Hybrid (ML-HMWA), Approach for Climate Resilience

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ABSTRACT

This study focuses on developing better rainfall forecast models because they support successful water resource methods and agricultural techniques and disaster response during emergencies including floods and dry spells. Reliable rainfall forecasting stands vital for sustainable growth since it reduces the harmful consequences of severe weather conditions such as flooding. This causes extensive loss of life along with health hazards and creates economic instability. Traditional forecasting models find it difficult to produce accurate predictions because rainfall patterns display both unpredictable behaviour and complexity. This study explores the use of machine learning models to develop reliable rainfall prediction systems based on meteorological data sourced from the Visual Crossing platform. The dataset comprises 4,018 records collected from the Defence Housing Authority (DHA) region in Pakistan, spanning the years 2011 to 2023, and includes 29 features 8 categorical and 21 numerical. The data preprocessing steps included eliminating visibility along with solar radiation and UV index because these attributes were not essential for improved dataset relevance and quality.These findings highlight the effectiveness of both Ridge Regression and hybrid ensemble strategies in delivering reliable rainfall forecasts. The study underscores the value of comprehensive preprocessing and hybrid modeling, laying a strong foundation for enhancing weather prediction systems in urban areas like DHA and other similar environments.

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