FLOODSENSE: AN IOT-BASED FLOOD MONITORING, RISK PREDICTION AND COMMUNITY EARLY WARNING SYSTEM FOR THE KALU GANGA BASIN, RATHNAPURA

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Abstract

Flood disasters in Sri Lanka's Rathnapura District along the Kalu Ganga Basin cause repeated loss of life and economic damage, while current flood management remains largely reactive, relying on manual observation and delayed response. This paper introduces FloodSense, and integrated IoT-based flood monitoring and early warning system combining real-time environmental sensing, machine learning-based flood prediction, and multi-platform alert dissemination. Prototype sensor nodes using ESP32 Microcontrollers and SX1278 LoRa Radio Modules measure water level, rainfall, temperature, and humidity. A low-power "deep-sleep" technique extended battery runtime to over 60 hours, while RTC Persistent-Memory maintained the Rain-Guage Baseline through power-cycles. The combined dataset comprised 2132 daily station-level observations of water level, rainfall, temperature, and humidity from Ellagawa, Putupaula, and Rathnapura, spanning January 2024 to December 2025. Each station was split chronologically 80/20 for training and testing to prevent temporal leakage, while validation monitoring was used during LSTM training. SMOTE was applied only to training data, reducing imbalance while preserving the independent test partition. The two-stage machine-learning pipeline uses an XGBoost Regression Model to predict future water levels (R^2 = 0.9476 & RMSE = 0.5588 m), followed by an LSTM Classifier for four severity levels: Normal, Alert, Minor, and Major Flood (Accuracy = 94.80%, Macro-F1-Score = 0.6663). Alternative XGBoost and Random Forest classifiers achieved 100% training and test accuracy but were rejected because serve class imbalance indicated overfitting and poor generalization. Results are displayed through a web-based portal with interactive maps and charts, while public warnings are disseminated through a mobile application using Firebase Cloud Messaging Push Notifications with offline capability during network disruptions.

Keywords: flood monitoring, IoT, LSTM, XGBoost, early warning system