

## Article

# Spatial Analysis of Flood Hazard Zoning Map Using Novel Hybrid Machine Learning Technique in Assam, India

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**Abstract:** Twenty-two flood-causative factors were nominated based on morphometric, hydrological, soil permeability, terrain distribution, and anthropogenic inferences and further analyzed through the novel hybrid machine learning approach of random forest, support vector machine, gradient boosting, naïve Bayes, and decision tree machine learning (ML) models. A total of 400 flood and nonflood locations acted as target variables of the flood hazard zoning map. All operative factors in this study were tested using variance inflation factor (VIF) values (<5.0) and Boruta feature ranking (<10 ranks) for FHZ maps. The hybrid model along with RF and GBM had sound flood hazard zoning maps for the study area. The area under the receiver operating characteristics (AUROC) curve and statistical model matrices such as accuracy, precision, recall, F1 score, and gain and lift curve were applied to assess model performance. The 70%/30% sample ratio for training and validation of the standalone models concerning the AUROC value showed sound results for all the ML models, such as RF (97%), SVM (91%), GBM (97%), NB (96%), DT (88%), and hybrid (97%). The gain and lift curve also showed the suitability of the hybrid model along with the RF, GBM, and NB models for developing FHZ maps.

**Keywords:** flood susceptibility; hybrid machine learning; Boruta techniques; AUROC; NDVI



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## 1. Introduction

In tropical countries, flooding, a natural hazard, occurs very frequently and causes tremendous damage to both the human ecosystem and environmental diversity [1]. Floods can also cause severe disturbances to public health infrastructure and personal property. Nearly 2 billion people were affected by floods from 1998 to 2017 worldwide [2]. These flood events have caused absolute losses in Asian countries, such as China (USD 492.2 billion), India (USD 79.5 billion), and Thailand (USD 52.4 billion) from 1998 to 2017 [3]. Lack of early warning systems and proper awareness of flood risks cause collateral damage, particularly in developing and poor countries. Since 1953, India has been the world's fifth-largest host to deaths caused by floods. The National Disaster Management Authority, Government of India, reported that nearly 7.5 million hectares of land area were affected by floods, costing around INR 1805 billion and 1600 valuable human lives annually [4].

Major floods occur more than once every five years due to heavy precipitation in the rainy season, mostly due to the southwest monsoon. Northeastern India, along the

# Hazard Zone A Novel

**Arturo Cuomo**



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