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Flood Susceptibility Mapping Using Remote Sensing and Integration of Decision Table Classifier and Metaheuristic Algorithms

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Abstract: Flooding is one of the most prevalent types of natural catastrophes, and it can cause extensive damage to infrastructure and the natural environment. The primary method of flood risk management is flood susceptibility mapping (FSM), which provides a quantitative assessment of a region's vulnerability to flooding. The objective of this study is to develop new ensemble models for FSM by integrating metaheuristic algorithms, such as genetic algorithms (GA), particle swarm optimization (PSO), and harmony search (HS), with the decision table classifier (DTB). The proposed algorithms were applied in the province of Sulaymaniyah, Iraq. Sentinel-1 synthetic aperture radar (SAR) data satellite images were used for flood monitoring (on 27 July 2019), and 160 flood occurrence locations were prepared for modeling. For the training and validation datasets, flood occurrence data were coupled to 1 flood-influencing parameters (slope, altitude, aspect, plan curvature, distance from rivers, land cover, geology, topographic wetness index (TWI), stream power index (SPI), rainfall, and normalized difference vegetation index (NDVI)). The certainty factor (CF) approach was used to determine the spatial association between the effective parameters and the occurrence of floods, and the resulting weights were employed as modeling inputs. According to the pairwise consistency technique, the NDVI and altitude are the most significant factors in flood modeling. The area under the receiver operating characteristic (AUROC) curve was used to evaluate the accuracy and effectiveness of ensemble models. The DTB-GA model was found to be the most accurate (AUC = 0.889), followed by the DTB-PSO model (AUC = 0.844) and the DTB-HS model (AUC = 0.812). This research's hybrid models provide a reliable estimate of flood risk, and the risk maps are reliable for flood early-warning and control systems.

Keywords: flood prediction; satellite imagery; machine learning algorithms; metaheuristic algorithms

1. Introduction

Floods are one of the most catastrophic types of natural events around the globe, after excessive rainfall, persistent rainfall, and snowmelt combined with unfavorable conditions [1]. Floods are influenced by several factors, including climate, human activity, and physical situations [2]. Annual floods harm the lives of around 20 to 300 million people