

Flood Susceptibility Mapping in the Wadi El Ouaar Watershed Using a New Criterion and Machine Learning Algorithms (Oral)

Rachid El Moumen^{1*}, Mohammed Hssaisoune^{1,2,3}, Sofyan Sbahi^{1,4}, Yassine Ait-Brahim³,
Lhoussaine Bouchaou^{1,3}

¹ *Applied Geology and Geo-Environment Laboratory, Faculty of Sciences, Ibn Zohr University, Agadir, 80035, Morocco.*

² *Faculty of Applied Sciences, Ibn Zohr University, B.O. 6146 Azrou District, 86153, Ait Melloul, Morocco.*

³ *International Water Research Institute, Mohammed VI Polytechnic University, Ben Guerir, 43150, Morocco.*

⁴ *National Center for Studies and Research on Water and Energy (CNEREE), Cadi Ayyad University, Marrakech, Morocco.*

**Corresponding author: rachid.elmoumen@edu.uiz.ac.ma*

ABSTRACT

Floods are among the most destructive natural hazards, especially in semi-arid regions, where intense and irregular rainfall, rugged terrain, and environmental degradation can rapidly generate damaging runoff. This study aims to map flood susceptibility in the Wadi El Ouaar watershed, Morocco, using a non-Euclidean river-distance criterion and machine learning algorithms. A set of environmental conditioning factors derived from topographic, hydrological, and land-surface data was integrated with a flood inventory of inundated and non-inundated locations. Because the initial dataset was imbalanced, the ROSE resampling technique was applied to create a balanced training dataset and improve model learning. Three machine learning models, namely Random Forest, XGBoost, and Gradient Boosting Machine, were trained and tested. Among them, XGBoost achieved the best predictive performance, reaching approximately 99% accuracy, which highlights its strong capability for modeling flood-prone areas in the watershed. Their outputs were further combined through an ensemble learning approach to enhance prediction performance. To reduce bias related to spatial autocorrelation, model validation was performed using spatial block cross-validation rather than conventional random validation. The final outputs include high-resolution flood susceptibility maps expressing flood probability across the watershed, as well as uncertainty information to support interpretation of the predictions. The proposed framework provides a robust and transferable approach for identifying flood-prone areas in data-scarce semi-arid environments and offers useful support for land-use planning, flood-risk reduction, and local disaster management in the Wadi El Ouaar watershed.

Keywords: Flood susceptibility mapping, Machine Learning, Arid environments.