EGU24-13138, updated on 02 Nov 2024
https://doi.org/10.5194/egusphere-egu24-13138
EGU General Assembly 2024

Neural Network Driven Early Warning System for Groundwater Flooding: A Comprehensive Approach in Lowland Karst Areas

Ruhhee Tabbussum[1], Bidroha Basu[2], and Laurence Gill[1]
[1]Department of Civil, Structural and Environmental Engineering, Trinity College Dublin, The University of Dublin, Dublin 2, Ireland
[2]Department of Civil, Structural and Environmental Engineering, Munster Technological University, Cork, Ireland

Enhancing flood prediction is imperative given the profound socio-economic impacts of flooding and the projected increase in its frequency due to the impacts of climate change. In this context, artificial intelligence (AI) models have emerged as valuable tools, offering enhanced accuracy and cost-effective solutions to simulate physical flood processes. This study addresses the development of an early warning system for groundwater flooding in the lowland karst area of south Galway, Ireland, employing neural network models with Bayesian regularization and scaled conjugate gradient training algorithms. The lowland karst area is characterised by several groundwater fed, intermittent lakes, known as turloughs that fill when the underlying karst system becomes surcharged during periods of high rainfall. The training datasets incorporate several years of field data from the study area and outputs from a highly calibrated semi-distributed hydraulic/hydrological model of the karst network. Inputs for training the models include flood volume data from the past 5 days, rainfall data, and tidal amplitude data over the preceding 4 days. Both daily and hourly models were developed to facilitate real-time flood predictions. Results indicate strong performance by both Bayesian and Scaled Conjugate Gradient models in real-time flood forecasting. The Bayesian model shows forecasting capabilities extending up to 45 days into the future, with a Nash-Sutcliffe Efficiency (NSE) of 1.00 up to 7 days ahead and 0.95 for predictions up to 45 days ahead. The Scaled Conjugate Gradient model offers the best performance up to 60 days into the future with NSE of 0.98 up to 20 days ahead and 0.95 for predictions up to 60 days ahead, coupled with the advantage of significantly reduced training time compared to the Bayesian model. Additionally, both models exhibit a Co-efficient of Correlation (r) value of 0.98 up to 60 days ahead. Evaluation measures such as Kling Gupta Efficiency reveal high performance, with values of 0.96 up to 15 days ahead for both Bayesian and Scaled Conjugate Gradient models, and 0.90 up to 45 days ahead in the future. The integration of diverse data sources and consideration of both daily and hourly models enhance the resilience and reliability of such an early warning system. In particular, the Scaled Conjugate Gradient model emerges as a versatile tool. It balances predictive accuracy with reduced computational demands, thereby offering practical insights for real-time flood prediction, and aiding in proactive flood management and response efforts.