Avaliação de Eventos Extremos de Precipitação-Escoamento através da Integração de Monitorização, SIG e Modelação Hidrológica

Assessing Extreme Rainfall-Runoff Events through Integrated Monitoring, GIS and Hydrological Modelling

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RESUMEN

Extreme climate events are increasing across Europe, particularly in Mediterranean regions, highlighting the need for integrated, local-scale observational and modelling approaches capable of representing microclimatic variability and supporting adaptation and risk-reduction strategies. This study presents an interdisciplinary framework developed within the INTERLAYER project, combining field-based meteorological and hydrological monitoring, GIS-based basin characterisation, and hydrological modelling to assess extreme rainfall–runoff processes in Ribeira da Toutalga and Ribeira de São Pedro, tributaries of the Guadiana basin in southeastern Portugal. A monitoring network was established to provide high-quality input and validation data for hydrological analysis. An operational meteorological station measured precipitation and key atmospheric variables. Stream water levels were monitored using HOBO U20L pressure loggers installed along both riverbeds, recording data at five-minute intervals. Water-level time series were used to derive site-specific stage–discharge curves, synthetically constructed based on field-observed channel geometry and hydraulic characteristics. The resulting discharge series served as observed flow data for hydrological model calibration and validation. Comprehensive GIS-based basin characterisation was carried out using high-resolution Digital Elevation Models (DEMs) and land use/land cover datasets. The workflow included DEM-driven basin and sub-catchment delineation, stream network extraction and validation against military topographic maps, slope and land use analysis. Area-weighted Curve Number (CN) values were retrieved under wet antecedent moisture conditions (AMC III) to better capture soil moisture responses. Hydrological modelling was performed via HEC-HMS, applying the SCS Curve Number method for loss estimation, the SCS unit hydrograph for runoff transformation, and Muskingum routing for channel flow propagation. The models were developed, calibrated, and validated for both Toutalga and São Pedro basins using observations from December 2024 to November 2025, with the highest flow events selected as representative extremes. The model was able to capture the overall flow dynamics and timing of peak discharges. The developed framework provides a robust foundation for subsequent hydraulic modelling, flood hazard assessment, and the identification of Nature-Based Solutions (NBSs) aimed at flood mitigation and climate adaptation in Mediterranean environments.

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