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GIS and Geospatial Techniques in Analyzing the Influence of Climate Change and Its Consequences on Hydrological and Environmental Systems

This study integrates advanced Geographic Information System (GIS) and geospatial methodologies to analyze the influence of climate change on hydrological and environmental systems across the Western Balkans, with a focus on Serbia and Montenegro. The research combines two complementary approaches: multicriteria GIS decision analysis (GIS-MCDA) for modeling wildfire susceptibility, and digital hydrological modeling for identifying river network types and changes in drainage basins. Open geospatial databases, remote sensing imagery (Landsat, Sentinel, Copernicus DEM), and meteorological data were processed within QGIS and SAGA GIS environments to achieve high spatial precision and reproducibility. In Montenegro, wildfire susceptibility was modeled using the Analytic Hierarchy Process (AHP) and Fuzzy AHP (F-AHP) to evaluate nine natural and anthropogenic criteria, including land cover, slope, temperature, precipitation, and proximity to human infrastructure. Validation through MODIS satellite data confirmed high model accuracy, revealing that over 80% of the studied coastal and mountainous regions fall into high or very high susceptibility categories due to rising temperatures and prolonged droughts.

In Serbia, the analysis of river networks over a 60-year period (1963–2023) showed substantial hydrological transformations driven by climatic extremes and anthropogenic pressures. Using generalized Strahler stream order and geostatistical algorithms, the study identified a 10% reduction in perennial watercourses and an 8% increase in mixed and dendritic network types. These spatial changes correspond with decreased precipitation, drought intensification, and basin reconfiguration in southern and eastern Serbia. The integrated results highlight how GIS-based spatial modeling serves as a powerful framework for assessing climate-driven environmental risks. The combined methodological approach demonstrates that geospatial technologies can effectively support sustainable land and water management strategies in climate-sensitive regions.

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