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Assessing vulnerability in stream channel evolution in relation with morphological transformations and hydrodynamic behavior. Case Study: the Subcarpathian Prahova Valley, Romania

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The objective of the study is to analyze the relationship between morphological transformations observed during the last 200 years along a 20 km reach of Prahova river, and hydrodynamic behavior during high intensity flood periods, in the context of erosion-control works and environmental changes. Along this sub-Carpathian reach, Prahova is a typical mountain river, partially regulated, flowing under fluvial and torrential regime and having a mean thalweg slope of about 1%. Riverbed material consists in cobbles and boulders. Its valley has gradually been cut; therefore four terraces may clearly be identified in the subbasin areas of Breaza and Câmpina.
The Holocene floodplain is asymmetrical, and during the last decades an incision of about 3-4 m has clearly been observed in the main channel. This also led to an evolution from an anabranching river aspect to a meandering one along the studied reach. Reasons to explain these changes are a positive neotectonic background coupled with an increased anthropic component (granular material extraction, channel regulation for construction purposes of roads, bridges, railways, layout of gas and oil pipelines, vegetation cutoff etc.).
The data obtained from 1900-1980 topographical maps and 1997-2002 satellite images and orthophotos were coupled with topo-bathymetric surveys carried out in 57 cross-sections, in order to obtain the DTM of the studied area. These cross-sections were used to build up the geometry of a 1D hydraulic model by using the HEC-RAS software (USACE, version 3.1.3). Simulations were obtained under steady flow conditions for 1% and 2% return periods (360-400 mc/s and 450-500 mc/s). Calibration of Manning roughness factors was performed on stages measured at the two upstream and downstream gauging stations. High values of computed shear stresses and velocities show areas of potential erosion leading to morphological changes, bank collapsing and incision observed during the last decades and predicted for the near future. Three main areas of erosion were identified, where the river has cut real gorges, up to over 4m depths. These findings where correlated with geological, morphological and land use data in a complex vulnerability approach, incorporated in a Geographical Information System. The results obtained could be very useful for local authorities when developing risk mitigation programs.