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Data mining of external and internal forcing of fluvial systems for catchment management: A case study on the Red River (Song Hong), Vietnam

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The understanding of river hydromorphological processes has been recognized in the last decades as a priority of modern catchment management, since interactions of natural and anthropogenic forces within the catchment drives fluvial geomorphic processes, which shape physical habitat, affect river infrastructures and influence freshwater ecological processes. The characterization of river hydromorphological features is commonly location and time specific and highly resource demanding. Therefore, its routine application at regional or national scales and the assessment of spatio-temporal changes as reaction to internal and external disturbances is rarely feasible at present. Information ranging from recently available high-resolution remote-sensing data (such as DEM), historic data such as land use maps or aerial photographs and monitoring networks of flow and rainfall, open up novel and promising capacity for basin-wide understanding of dominant hydromorphological drivers. Analysing the resulting multiparametric data sets in their temporal and spatial dimensions requires sophisticated data mining tools to exploit the potential of this information. We propose a novel framework that allows for the quantitative assessment of multiparametric data sets to identify classes of channel reaches characterized by similar geomorphic drivers using remote-sensing data and monitoring networks available in the catchment. This generic framework was applied to the Red River (Song Hong) basin, the second largest basin (87,800 sq.km) in Vietnam. Besides its economic importance, the river is experiencing severe river bed incisions due to recent construction of new dams in the upstream part of the catchment and sand mining in the surrounding of the capital city Hanoi. In this context, characterized by an high development rate, current efforts to increase water productivity and minimize impacts on the fluvial systems by means of focused infrastructure and management measures require a thorough understanding of the fluvial system and, in particular, basin-wide assessment of resilience to human-induced change. . The framework proposed has allowed producing high-dimensional samples of spatially distributed geomorphic drivers at catchment scale while integrating recent and historic point records for the Red River basin. This novel dataset has been then analysed using self-organizing maps (SOM) an artificial neural network model in combination with fuzzy clustering. The above framework is able to identify non-trivial correlations in driving forces and to derive a fuzzy classification at reach scale which represents continuities and discontinuities in the river systems. The use of the above framework allowed analyzing the spatial distribution of geomorphic features at catchment scale, revealing patterns of similarities and dissimilarities within the catchment and allowing a classification of river reaches characterized by similar geomorphic drivers, fluvial processes and response to external forcing. The paper proposes an innovative and promising technique to produce hydromorphological classifications at catchment scale integrating historical and recent available high resolution data. The framework aims at opening the way to a more structured organization and analyses of recently available information on river geomorphic features, so far often missing or rarely exploited. This approach poses the basis to produce efficient databases of river geomorphic features and processes related to natural and anthropogenic drivers. That is a necessity in order to enhance our understanding of the internal and external forces which drive fluvial systems, to assess the resilience and dynamic of river landscapes and to develop the more efficient river management strategies of the future.