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Cellular automata as hydroinformatic tools for simulating the spatial dynamics of flash floods

J. Douvinet (1), D. Delahaye (1), P. Langlois (2), and L. Purdue (3)

(1) GEOPHEN - LETG UMR 6554 CNRS, Geography, CAEN, France (johnny.douvinet@unicaen.fr), (2) MTG - IDEES UMR 6266 CNRS, ROUEN, France (patrice.langlois@univ-rouen.fr), (3) CEPAM - UMR 6130 CNRS, NICE, France (purdue@cepam.cnrs.fr

Cellular-based methods arising from the field of complex systems form a new paradigm for hydrology. These geosimulations, used more and more frequently, are supported by an array of advances both in hydrological sciences and in fields outside of geography. One of the most intriguing aspects of these models is the opportunity they provide for better assessing patterns and processes resulting from environmental interactions by using simple rules. This study evaluates the spatial dynamics of flash floods triggering during spring and summer in the Paris Basin watersheds (France). As hydrological data are lacking on these dry valleys, a specific cellular-automaton model, RUICELLS (RUnoff sImulation on CELlular meSh), was developed to find an alternative method. The latter integrates topography, precipitation, infiltration, land use and capacity of retention. Geosimulations confirm that the intensity of such hydrological events is due to the interaction between high rainfalls, strong morphological efficiencies and cultivated areas which generate high sediment content. Maps of surface flow pathways show that the spatial relations between basin form, organisation of drainage network and slopes, are among the most important factors controlling the dynamics of these floods, while land use and the percentage of cultivated areas aggravate or decrease runoff quantities. The efficiency of the approach has been illustrated with various case studies.