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Evaluation of a geomorphology-based conceptual IUH in a mountain watershed

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Hydrograph generation at a point in the drainage network, as a watershed response to a rainfall event, is a complex process that depends on watershed and storm characteristics. Among the available methods for hydrologic design, the unit hydrograph (UH) is one of those most widely used. It is a conceptual model which assumes the linear systems theory and incorporates the rainfall characteristics in the simulation process.

There is, obviously, a close relationship between the geomorphologic characteristics of a watershed and its hydrologic response. During the past years hydrologists and geomorphologists have worked together in a joint effort to characterize the global average watershed response as a function of its geomorphologic properties. Since Rodríguez-Iturbe and Valdés presented the Geomorphological Instantaneous Unit Hydrograph (GIUH) there have been many attempts to propose an Instantaneous Unit Hydrograph (IUH) that incorporates the geomorphological properties of the watershed. Also, linear reservoir models were, and are still, very frequently used for simulating rainfall-runoff processes and, more precisely, for determining the unit hydrograph of a watershed.

The fundamental aim of this work is to present and evaluate an Instantaneous Unit Hydrograph based on a cascade of linear Reservoirs obtained by taking the Geomorphology of the watershed (IUHGR). The geomorphological association of reservoirs in this IUH is characterized by means of the sub-basins into which the watershed is divided starting from the drainage network. The formulation of this IUH, obtained from the one set up by López *et al.,*(2005), has been carried out both for the case of the spatial uniformity of the sub-basins and for that of considering their spatial variability. Also, this model's evaluation was made based on a detailed analysis of it and on a comparative study. For the latter, some IUHs with some similar characteristics to the one proposed and which were sufficiently vouched for in the literature were selected. These were: the Nash IUH, a linear reservoir cascade model; the Chutha and Dooge IUH, an interpretation of the GIUH of Rodríguez-Iturbe and Valdés describing the water pathways as cascades of unequal linear reservoirs; and the Troutman and Karlinger IUH, with a geomorphologic foundation, based on the assumption of linear flow through topologically random channel networks.

The experimental watershed of 23.42 km^2, is located in a forested area of the Ebro River basin, at the southwestern end of the Pyrenees, in the northeastern part of the Navarre province, (Spain). Several rainfall-runoff events have been selected for the analysis. The effective rain hyetograph was estimated using the curve number method, adjusting the value of the curve number and the initial abstraction coefficient for the different events.

The validation of the model was performed by means of the model's evaluation, in which the factors influencing its formulation are analyzed, and a comparative study made with other IUHs with similar characteristics to the one proposed and which are sufficiently vouched for in the literature.

The model's evaluation is performed, firstly, with a sensitivity analysis of the only uncertain parameter on which the model depends, k, and, secondly, with the analysis of the possible effect of the degree of division of the watershed into subwatersheds or order, n.

The parameters of the different IUHs were obtained by fitting the computed hydrographs resulting from the convolution with the respective formulations: IUHGR(u), IUHGR(v), Nash (NIUH), Chutha and Dooge (CDIUH), and Troutman and Karlinger (TKIUH), and the computed effective rain hyetographs, to the recorded hydrographs.

The fitting was carried out using the Rosenbrock algorithm, with the difference between the unity and the Nash-Sutcliffe index, as the objective function. The goodness of the fit for the validation was evaluated again with the Nash-Sutcliffe efficiency index, *Ei*, equation.

The results indicate its satisfactory performance, with good fits to the observed hydrographs and a lower number of identifiable parameters.