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A new hydrological model for estimating extreme floods in the Alps

R.G. Receanu (1), J.- A. Hertig (2), and J. - M. Fallot (3)

(1) Institute of Geography, University of Lausanne, CH-1015 Lausanne, Switzerland (Ramona.Receanu@unil.ch), (2) Hertig & Lador SA, CH-1176 St Livres, Switzerland (hertig@hetl.ch), (3) Institute of Geography, University of Lausanne, CH-1015 Lausanne, Switzerland (Jean-Michel.Fallot@unil.ch)

Protection against flooding is very important for a country like Switzerland with a varied topography and many rivers and lakes. Because of the potential danger caused by extreme precipitation, structural and functional safety of large dams must be guaranteed to withstand the passage of an extreme flood. We introduce a new distributed hydrological model to calculate the PMF from a PMP which is spatially and temporally distributed using clouds. This model has permitted the estimation of extreme floods based on the distributed PMP and the taking into account of the specifics of alpine catchments, in particular the small size of the basins, the complex topography, the large lakes, snowmelt and glaciers. This is an important evolution compared to other models described in the literature, as they mainly use a uniform distribution of extreme precipitation all over the watershed.

This paper presents the results of calculation with the developed rainfall-runoff model, taking into account measured rainfall and comparing results to observed flood events. This model includes three parts: surface runoff, underground flow and melting snow. Two Swiss watersheds are studied, for which rainfall data and flow rates are available for a considerably long period, including several episodes of heavy rainfall with high flow events. From these events, several simulations are performed to estimate the input model parameters such as soil roughness and average width of rivers in case of surface runoff. Following the same procedure, the parameters used in the underground flow simulation are also estimated indirectly, since direct underground flow and exfiltration measurements are difficult to obtain.

A sensitivity analysis of the parameters is performed at the first step to define more precisely the boundary and initial conditions. The results for the two alpine basins, validated with the Nash equation, show a good correlation between the simulated and observed flows. This good correlation shows that the model is valid and gives us the confidence that the results can be extrapolated to phenomena of extreme rainfall of PMP type.