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Reservoir effects on flood hazard

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The regulation of rivers by reservoirs usually alters the natural flow regime, the geomorphology and the ecology downstream of the reservoir by storing and releasing water volumes in order to meet human needs (e.g., irrigation, water supply, hydropower, flood control, and recreational use). Because of the storage capacity of reservoirs, the post-impoundment flow regime is usually characterized by a reduction in the magnitude of maximum discharges and therefore by an alteration of the downstream flood frequency curve. In the literature, the impacts of reservoirs on floods have been detected and quantified with (i) data-based studies that look at the observed impacts of existing reservoirs (locally or regionally on many catchments), and (ii) continuous simulation analyses. Data-based approaches simply infer the average magnitude of the reservoir impacts on floods by using indexes that correlate with the peak reduction, but they do not explicitly quantify the relative effects of reservoir positioning, size, and operation rules on the flood frequency curve. An alternative approach that allows overcoming this limitation is the continuous simulation approach, consisting usually of a stochastic rainfall generator, a rainfall-runoff model, and a reservoir routing numerical model; however, this is usually performed over few catchments and is not easily generalizable. This work investigates the effects of reservoirs on flood hazard by developing a parsimonious Instantaneous Unit Hydrograph (IUH) method; the method accounts for the presence of one reservoir in the catchment and determines how the peak discharge quantile is attenuated as a function of few dimensionless numbers, which are derived analytically for an idealized natural catchment and account for the position of the reservoir in the catchment, its volume and its spillway.