Geophysical Research Abstracts
Vol. 16, EGU2014-7804-1, 2014
EGU General Assembly 2014
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A comparative hydro-morphometric approach for modelling rainfall variability impacts during hydrological extremes: Application to 2002 and 2003 catastrophic events in the Lower Rhône valley, France

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Recent catastrophic floods (2002 and 2003) in the Lower Rhône valley (LRV) demonstrated that hydrological extremes are caused by the addition of tributary flood peaks to the Rhône River overall volumetric flow rate. Flood regimes in the LRV, which is southward increasingly influenced by Mediterranean climate, are fundamentally affected by the hydro-meteorological variability of tributary catchments, especially in case of widespread flooding.

This study aims to assess the relationship between the geographic variability of recent extreme rainfall events and tributaries contribution to hydrological extremes. We propose a comparative modelling approach in order to analyse the contribution rainfall/flow relationship using an automatic hydro-morphometric classification at the hydrosystem scale. The study was led between the right-bank confluences of the rivers Ardèche and Gard, separated from 60 km. This comparative approach should be able to highlight the correlation between the morphometry of the tributary catchments, extreme rainfall event variability and hydrological contribution of the tributaries, combining automated geoinformatic tools (GIS and statistical computing).

Firstly, the spatial distribution of September 08-09, 2002 storm over the Cévennes (300-600 mm), November 13-18 and 23-25, 2002 rainfall events over the Provence Prealps (150-300 mm), and December 01-05, 2003 widespread rainfall event (200-300 mm), was integrated into a geographic database. Secondly, the contribution of tributary flood peaks was computed from flood hydrographs using a Gumbel distribution adjusted frequency flood-flow model. The last pre-processing step concerns the hydro-morphometric classification of the catchments combining 33 empirical morphometric indices of form (14), volume (11) and network (7). These indices were calculated and integrated into the geographic database. Tributary catchment hydro-morphometric classification was computed by hierarchical clustering on principal components method (HCPC). Finally, the correlation of the three pre-processing results is calculated by principal components analysis (PCA): rainfall, hydrological contribution and hydro-morphometric indices as quantitative variables and the HCPC classification as an illustrative variable.

First results indicate a high degree of redundancy of hydro-morphometric index calculation results. For this reason, it is necessary to summarise data by compressing these indices. Current research focuses on rainfall and hydrological data integration in the geographic database in order to study the correlation between the comparative hydro-morphometric analyses (synthetic indices and HCPC classification).

Computation and compilation of empirical hydro-morphometric indices may be interesting for a comparative analysis of tributaries catchment contribution – in terms of volume and probability – to the Rhône flood regimes. This research might be useful to conduct a systemic study of the hydrological risk in LRV.