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Event-based approach of downstream Rhône River flood regimes variability since 1982

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Numerous downstream Rhône River floods have been recorded as catastrophic by French inter-ministerial order since the creation of natural disaster state recognition in 1982. Downstream Rhône River flood regimes, influenced by Mediterranean climate, are fundamentally affected by the spatio-temporal variability of rainfall events, especially in case of widespread flooding. Event-based analysis of cumulative rainfall data should allow us to characterise downstream Rhône River flood regimes variability by applying data mining methods to a spatio-temporal hydro-meteorological database.

The first objective of this study is to determine if extreme rainfall events could be considered as geographical events, in other words if rainfall distribution is related to spatial processes. The proposed method is based on the measure of rainfall distribution spatial auto-correlation through the calculation of (i) Global Moran's index and (ii) the significance evaluation of that index with a z-score statistical test and its associated p-value. Secondly, cumulative rainfall data are integrated into a geo-event two-dimensional matrix: (i) cumulative rainfall per sub-catchment in row (spatial base unit) and (ii) cumulative rainfall per catastrophic event in column (temporal base unit). This matrix was co-clustered which allows simultaneous clustering of the rows (sub-catchment) and columns (events) by hierarchical clustering on principal components (HCPC) using Ward's method applying Euclidean Distance as similarity measure.

Computing the Global Moran's index demonstrated a spatial aggregation tendency of rainfall distribution and the associated statistical test (z-core and p-value) noted the improbability of statistical evidence of random spatial pattern. Spatial variability of rainfall distribution is the result of two factors: rainfall event structure and rainfall event scale. The co-clustering geo-event matrix provided two co-clustering maps on two different cumulative rainfall distributions: (i) a reduced centered distribution of cumulative rainfall per sub-catchment (row) and (ii) a reduced centered distribution of cumulative rainfall per event (column). Both co-clustering maps are complementary to define spatio-temporal co-clusters.

The geographical dimension of catastrophic hydro-meteorological events could be assessed by measuring and comparing the spatial auto-correlation of rainfall spatial distributions. These distributions were co-clustered to provide a geo-event typology of downstream Rhône River flood regimes. Moreover, these results show the interest of data mining methods to study spatio-temporal dimension of hydro-meteorological disasters.