Geophysical Research Abstracts
Vol. 16, EGU2014-8125-2, 2014
EGU General Assembly 2014

The role of the forest cover on the definition of runoff coefficient in a regional flood frequency analysis applied to Mediterranean catchments

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Flood frequency is fundamental for planning and design structural and non-structural mitigation strategies against land degradation. Flood frequency analysis aims at estimating the probability distributions of flood peaks, so that the flood magnitude for any design return period can be easily determined. The approach commonly employed in engineering hydrology in ungauged catchments is the regional analysis, which exploits the hydrological similarities among catchments and the scaling properties of flood statistics for exporting the information available in gauged catchments to ungauged catchments. One of method most widely applied by hydrologists and engineers is the index flood method, based on the identification of homogeneous regions, where the probability distributions of the annual maximum floods are assumed invariant except for a site-specific scale parameter known as the index flood. The index flood is generally assumed coincident with the mean of annual maximum of flood peaks and is estimated by indirect methods. An indirect estimation method largely applied is based on a conceptual model structured according to the well-known rational formula. A key parameter of the rational formula is the runoff coefficient, which can be interpreted as a probabilistic factor controlling not only the position but also the slope and the curvature of the flood frequency curve. Provided that vegetation patterns can have a significant influence on the catchment antecedent conditions as well as on other rainfall runoff processes in rural catchments, in this study we explore to what extent forest cover can be employed to predict the runoff coefficient, in the framework of a regional flood frequency analysis based on the rational formula coupled with a regional analysis of annual maximum rainfall depths. The results of a k-means cluster analysis applied to a data set of 75 catchments distributed from South to Central Italy, evidenced that the second component of the runoff coefficient can be partly explained by the forest cover fraction, scaled with the corresponding critical areal rainfall depth. We proposed a linear regression model to improve the prediction of the runoff coefficient, exploiting the ratio of the forest cover to the catchment critical rainfall depth as dependent variable, with just one additional empirical parameter. The proposed regression enables a significant bias correction of the runoff coefficient, particularly for those small mountainous catchments, characterised by larger forest cover fraction and lower critical rainfall depth.