Along-stream assessment of mountain flood dependence on global warming

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Abstract

The characterization of high elevation sites represents a challenging topic, as the hydrological processes are there characterized by a marked seasonality. Due to its reservoir function, the dynamics of snow accumulation and melting largely affects the timing and the volumes of runoff.

In mountainous basins, where the traditional hydrological monitoring techniques are affected by higher uncertainty and few measurement points are available, the exploitation of information on basin morphology can have important implications for the study of runoff formation processes. In this direction, a geomorphoclimatic model of the flood frequency curve in mountainous basins presented in previous papers (Allamano et al., 2009) can provide significant help in assessing changes due to the morphological and climatic characteristics of the basin. The model, called 'FloodAlp', produces flood quantiles based on the within-year variation of the basin contributing area according to variation of the snow level due to air temperature. At the time of occurrence of each precipitation event, a subtractive mechanism reduces the basin-contributing area in runoff production to the fraction of basin laying below the freezing elevation. Based on the rainfall stochasticity, a frequency curve or runoff extremes is found.

The FloodAlp model is revamped here in view of a systematic application over the river network, in search of a geographically detailed representation of possible changes in the flood regime as a consequence of global warming. The model is applied to the Chisone basin, located in North-Western portion of the Piedmont region (Italy) and characterized by geomorphoclimatic features that are suitably representative of the Italian Alps. The river network of the investigated basin was extracted from a Digital Elevation Model at a 50 meters spatial resolution. All sub-basins were derived by fixing an areal threshold of 0.25 km2 and moving along the streams progressively by 500 m. For the resulting 13204 cells belonging to the drainage path, the morphological parameters required for the model application have been derived. Over this rasterized network the variation of the 100-years flood quantile due to different increments of the average air temperature has been determined. The assessment of the relative entity of flood increments prevents us to calibrate the absolute 100-years quantile estimates and allows us to discuss the probable effects over the network with a detail that can be of interest of scientist and practitioners.

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