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Predictions of flood warning threshold exceedance computed with logistic regression

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A method based on logistic regression is proposed for the prediction of river level threshold exceedance at different lead times (from +6h up to +42h). The aim of the study is to provide a valuable tool for the issue of warnings by the authority responsible of public safety in case of flood.
The role of different precipitation periods as predictors for the exceedance of a fixed river level has been investigated, in order to derive significant information for flood forecasting. Based on catchment-averaged values, a separation of "antecedent" and "peak-triggering" rainfall amounts as independent variables is attempted. In particular, the following flood-related precipitation periods have been considered: (i) the period from 1 to n days before the forecast issue time, which may be relevant for the soil saturation ("state of the catchment"), (ii) the last 24 hours, which may be relevant for the current water level in the river ("state of the river"), and (iii) the period from 0 to x hours in advance with respect to the forecast issue time, when the flood-triggering precipitation generally occurs ("state of the atmosphere").
Several combinations and values of these predictors have been tested to optimise the method implementation. In particular, the period for the precursor antecedent precipitation ranges between 5 and 45 days; the current "state of the river" can be represented by the last 24-h precipitation or, as alternative, by the current river level. The flood-triggering precipitation has been cumulated over the next 18-42 hours, or the previous 6-12h, according to the forecast lead time.
The proposed approach requires a specific implementation of logistic regression for each river section and warning threshold. The method performance has been evaluated over several catchments in the Emilia-Romagna Region, northern Italy, which dimensions range from 100 to 1000 km2. A statistical analysis in terms of false alarms, misses and related scores was carried out by using a 8-year long database. The results are quite satisfactory, with slightly better performances for the higher flood warning threshold.
The optimisation of the method has been performed in a "hindcast" mode, that is observed rainfall represents the flood-triggering precipitation. Using rainfall forecasts as predictor of the flood-triggering precipitation causes a degradation of performance; nevertheless, this performance is similar to that provided by a distributed rainfall-runoff model driven by the same rainfall forecast input.
This computationally cheap technique to estimate flood warning exceedance can be applied to each gauged river section, independently of the availability of a rating curve for that section