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Simulation of the impacts of land use/cover and climatic changes on low flow characteristics at the mesoscale

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The prediction of low flow regimes in a mesoscale catchment has been one of the main concerns in hydrology not only because of the considerable impacts that they may have on the society as a whole, but also due to the compelling evidence that the current disruptions of the environment originated by anthropogenic activities are significantly modifying their expectation of occurrence in a given period of time. In this study, non-linear generalized models were used to predict low flow characteristics estimated semiannually for a set of sub-catchments. Among these characteristics are: the maximum drought duration, the total drought duration, the maximum drought intensity, and the cumulative specific deficit considered. As explanatory variables many physiographic, land cover, and climatic characteristics were employed, for instance: mean slope, aspect, elevation, type of geological formations, shares of a given land cover, and many composed indicators relating antecedent precipitation index and an atmospheric circulation pattern index. Each model was calibrated and selected with a method that chose a robust nonlinear model by solving a constrained multiobjective optimization problem, whose solution space is composed of all feasible combinations of given explanatory variables. The significance of each variable was afterwards assessed by a nonparametric test. The magnitude of the effects of the hydrological consequences of land use/cover and climatic changes was assessed in a probabilistic way by a sequential Monte Carlo simulation provided four different development scenarios. The proposed method was calibrated in 46 sub-catchments belonging to the Upper Neckar River covering an area of approximately 4000 km^2 during the period from 1961 to 1993. The results of the study clearly indicate the effects of anthropogenic changes on the low flow regime. The application of this method to other catchments is possible.