Are the uncertainties on mean areal precipitation decisive for flood hydrograph simulations with lumped rainfall-runoff models?

L. Moulin (1), E. Gaume (1), P. Bernardara (1), C. Obled (2)

(1) Centre d'Enseignement et de Recherche Eau Ville Environnement- Ecole Nationale des Ponts et Chaussées, Cité Descartes, 77455 Cedex 2, France [+33 1 64 15 36 39 moulin@cereve.enpc.fr], (2) Laboratoire d'étude des Transferts en Hydrologie et Environnement, P 53, 38041 Grenoble Cedex 09, France

The efficiency of flood forecasts on small watersheds appears to be limited, in particular by the accuracy of Rainfall-Runoff (RR) simulations. In fact, many flood forecasting services do not consider hydrological models to be reliable enough for use in a real-time operational context.

Many authors suggest that the uncertainties associated with spatial rainfall estimation are probably one of the major factors limiting the accuracy of the RR simulations. Most of the previous studies on the assessment of the impact of rainfall estimation uncertainties consisted of propagating into RR models either empirical rainfall estimation errors (obtained through under-samplings of rain gauges in an existing network) or purely theoretical errors (use of uncalibrated rainfall error models). The originality here is the proposal of a rainfall estimation error model calibrated on observed rainfall data. The proposed model is composed of two components: (i) an error model for the hourly point and mean areal rainfall estimates based on geostatistics (kriging), (ii) an autoregressive model to account for the temporal dependence of the estimation errors.

The proposed approach is developed and applied to a given case study: the application of lumped conceptual RR models for the simulation of the floods in eleven watersheds exposed to flash floods, located in the upper Loire region (France) with areas ranging from 20 to 3230 km2. First, the proposed error model and results of its validation will be presented. A cross-validation procedure has been used: the statistical distributions of empirical spatial interpolation errors and modelled interpolation errors have been compared for various rain gages of the network and various rainfall durations. Second, Monte Carlo simulations have been used to generate corrupted rainfall scenarii which were propagated into two lumped hydrological models (TOPMODEL and GR4).

The obtained results confirm the major impact of the areal rainfall estimation uncertainties on RR simulation results despite a relatively dense hourly rain gage network (1/80 km2 on average over the region). For the smallest watersheds the observed discharges generally lie in the uncertainty range of the simulated discharges: i.e. the

rainfall estimation errors alone can explain the differences between simulated and observed discharges. This is not the case for the largest tested watershed, where the spatial pattern of the rainfall events appears to play an important role and the use of at least semi-distributed RR models seems to be necessary. In any case, the awareness of the uncertainty level associated to any RR simulation, which probably will remain non-negligible even if the rainfall observation networks and techniques are improved, should lead to the use of ensemble rather than the standard deterministic RR simulations. The proposed procedure can be used to produce such ensemble simulations.