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ANN flood forecasting for early warning and decision making in a karstic watershed: application to the Sec-Iton River (France)

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The rainfall-runoff relationship is often a complex system at basin scale. This is even more complex with karstic behavior. Non linearity is often arising from spatiotemporal uncertainty both in rainfall and karstic feedback. In this hydrogeological context flood forecasting is a challenging issue to prevent society from flood damage especially for early warning alert to local authorities. Nevertheless extreme runoff is a rare event with a low frequency occurrence that often limits classical modeling tools.

Our contribution focus on ANN modeling applied to the Iton watershed (Paris Basin, France). The Iton River has a 1330 sq.km catchment with a topographic energy of 283 m and a clear tectonic influence both in Iton's valley orientations directions and karstic behavior. Each year during late spring till early fall period the Iton surface flow is subject to limited or total dewatering for 5 to 8 km which is locally named "Sec-Iton" (i.e. Dry Iton). These karstic phenomena act as a complex storage system providing a buffering capacity for winter floods. But the karstic behavior of the « Sec-Iton » is not monitored sufficiently even if fluorescein tracing has been carried out several times since the late 19th century. What is well-known from gauge monitoring and local knowledge is that usually the first flood peaks are buffered by the "Sec-Iton" depending on intensity of summer dry conditions. Since the late 19th century (i.e. 1881 flood) few hydrological events has been seen where "Sec-Iton" buffering capacities are overflowed. One can easily understand that "Sec-Iton" downstream floodplain communities depends on the possibility to prevent major flood event by early warning based on robust flood forecasting. This is why this research is conducted in close collaboration with the French flood warning service of Normandy (i.e. SPC 76).

Our contribution addresses the ANN potential to forecast the "Sec-Iton" flood peak at different lag time (i.e. +6h, +12h, +24h, and +48h) based on rainfall-runoff response data set. Our results clearly demonstrate through classical ANN benchmark indicators (i.e. RMSE, MARE, Nash and Persistence criteria) both in training and validating phases that ANN modeling offers a very good flood peak prediction. Moreover ANN model of "Sec-Iton" is hundred percent meeting the needs of early warning thresholds estimations used by the French flood forecast service which is divided in four classes (i.e. from safety green conditions to red flood alert conditions). Our ANN model is thus successful both for flood modeling and early warning decision making.