



## **Artificial neural networks and fuzzy logic models in operational hydrological forecasting systems**

M. Matreata

National Institute of Hydrology and Water Management, Romania

marius.matreata@hidro.ro

Damage due to flooding has increase in many countries in the last years, and due to the global climate change, which is now recognized as a real threat, an increase in the occurrence of flooding events and especially of flash flooding events is likely to continue into the future.

In those conditions and because building new flood defences structures for defending vulnerable areas has serious financial implications, the timely forecasting of floods is becoming more important for flood defence and in general for water management purposes.

The complexity of natural systems and of hydrological processes that influence river levels evolutions make the traditional modelling approaches, based on mirroring natural processes with physically based equations very difficult. Despite the fact that in the last decades the Operational Hydrological Forecasting Systems were significantly developed, becoming more and more complex systems, ingesting and processing in real time a great amount of data from automated hydrometrical and meteorological stations networks and high resolution grided data from radars and satellites, together with the use of distributed hydrological models, the warning and forecasts improvements are not very significant, in many cases the performance of the new physically based distributed models being comparable with the “older” conceptual lumped models.

The paper presents an overview of some alternative and complementary modelling approaches, artificial neural networks and fuzzy logic systems, possible applications for the improvements of the Operational Hydrological Forecasting Systems, and pre-

senting also some example of rainfall-runoff modelling implementations.

Artificial neural networks are widely used as an effective approach for handling non-linear and noisy data, especially in situations where the physical processes relationships are not fully understood and they are also particularly well suited to modelling complex systems on a real-time basis.

Fuzzy logic is a generalisation of boolean logic implementing the concept of partial truth or uncertainty, so within the fuzzy set theory an element can have a gradual membership to different sets. To describe a system behaviour with fuzzy logic, you need to define fuzzy sets, fuzzy rules or so called IF-THEN rules and apply a fuzzy inference scheme. The generation of a fuzzy forecast model can be based both on experts knowledge and historical data.

In conclusion, both artificial neural networks and fuzzy logic modelling systems offer the potential for a more flexible, less assumption approach to hydrological processes, and they have already been demonstrated as successfully substitutes for the classical rainfall – runoff models, and also as tools for the real time updating of hydrological forecasting models and especially for the multimodel approach.