



Enhanced flow rating using neural networks with water stage and electrical conductivity as predictors

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Streamflow is of fundamental importance to hydrology and water resources management, but it is difficult and/or expensive to measure directly in a continuous manner. Consequently, continuous measurements mostly make use of stage recording, with the values of stage being converted into those of streamflow by means of rating curves (or a digital counterpart). Historically, a major practical advantage of a one input – one output stage-discharge relationship was its straightforward handling in the form of a diagram, but that is no longer relevant. Thus, there is little reason why streamflows should be inferred from stage only, provided an additional input variable proves useful and can easily (and inexpensively) be recorded continuously.

Electrical conductivity (EC) appears as a potentially powerful candidate to serve as a further input variable improving streamflow estimates, and artificial neural networks (ANNs) are well suited to handle more than one input. In alpine streams EC has been reported to be a viable alternative to water level as predictor variable in streamflow estimation (Weijs et al., 2013). The approach advocated here differs from that just cited by using EC in addition to, not in lieu of stage as predictor variable. That way, it is believed that the field of potential application should be wider. In the work reported here, stage and EC data were used to develop a multilayer perceptron type ANN (2-4-1) to estimate flow in a small Austrian stream (Mödling) with a catchment of fairly mixed composition (forested, agricultural and urbanized areas). While the alpine catchment studied by Weijs et al.(op. cit.) probably is at the upper end of EC usefulness in streamflow estimation, the Mödling catchment offers less favourable conditions, with EC being potentially subject to some influence of human activities. In spite of these modest (but not unusual) conditions, the research reported documents that EC improved streamflow estimates. An analysis of the data with the aid of a network interpretation diagram, Garson's algorithm (Garson, 1991) and a sensitivity analysis performed on the two input variables (stage and EC, resp.) shows EC to be a useful additional predictor, with its relative 'importance' amounting to roughly one third of that of stage in this catchment.

References

- Garson, G.D.: Interpreting neural-network connection weights. *Artif. Intell. Expert*, 6, 47-51, 1991.
- Weijs, S.V., Mutzner, R., Parlange, M.B.: Could electrical conductivity replace water level in rating curves for alpine streams? *Water Resour. Res* 49, 343-351, 2013.

