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Modeling tools for water management

Editorial

Dear Reader

Water and river basin management are based on the understanding of complex aquatic ecosystems and respective models. A model is an abstraction of reality. But what is behind this abstraction? Science has developed various concepts of models such as the physical model (for example in experimental hydrology), the dynamic and stochastic model (as used for random natural processes), the deterministic model (based on probability theory), the regression model (based on mathematical relationships), and conceptual models (linking different functions). Any of these models help to understand the function of complex aquatic ecosystems such as lake metabolism, dynamic river processes or food-web interactions. However, although models became technically more sophisticated (for example, hydrological 1D models were developed into 2D and 3D models), modeling means to simplify and, hence, a model clearly is not reality. We always need to keep this fact in mind when considering our faith and expectations in models.

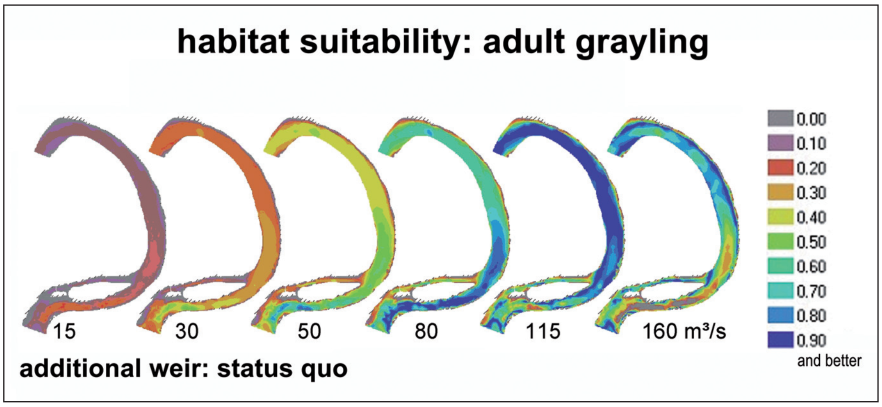

Figure 1. An example of ecohydraulic modeling, River Rhine, showing spatial distribution of habitat suitability for adult grayling (Thymallus thymallus) in relation to various discharge scenarios (15–160 m³/s) and additional weir operation (status quo). The applied model CASiMiR with its "fuzzy logic" approach is a typical example of how to link river hydrology and morphology with fish requirements. By using realistic scenarios, predictions of ecological quality can be made. (Reference: Bloesch J, Schneider M & Ortlepp J (2005): An application of physical habitat modelling to quantify ecological flow for the Rheinau hydropower plant, River Rhine. Arch. Hydrobiol. Suppl. 158/1–2 – Large Rivers 16/1–2, 305–328)

Accuracy and uncertainty matters when we cope with models. This is evident when dealing with weather forecast (short-term prediction), climate change and global warming (long-term prediction), or flood risk assessment (alarm system). Any model must be calibrated against measured data to prove its usefulness. This process is not easy since measured data have a various degree of precision. Therefore, any model needs to consider the accuracy and range of error. Further, the scale in space and time is of crucial importance. The larger and complex the system, the longer the time period, the less accurate is the model output. An inherent problem of modeling is the many parameters changing by time and complex parameter interference. If the calibrated model can well describe the reality, then it has the strength to make predictions into future developments. Hence, a future status of an ecosystem may be predicted under given scenarios or under estimated trends that are extrapolated under certain assumptions of parameter change from historical or present developments.

This issue of Danube News provides a selection of models dealing with basic processes in the Danube River Basin. Hydrology is the driving force of floods, bed-load transport and river morphology, and ultimately the conditioner of biota and their habitats. However, there is also a feedback of the biota by influencing hydrological processes. The articles stress that not only scaling is of utmost importance, but also the quality of input data and monitoring of the model output. The predictive potential of these models can help water managers and decision makers to seek for truly "sustainable" measures in using and protecting the Danube River. IAD can make an important contribution to such applied research.

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Hydrological catchment of the River Danube

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