CMD: a semi-automatic model structure identification and calibration tool for river water quantity modelling

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CMD: a semi-automatic model structure identification and calibration tool for river water quantity modelling

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Detailed hydrodynamic models that solve the full de Saint-Venant equations play a crucial role in support of river engineering, management and integrated catchment modelling. They explain the current state of a river system, and are useful for various types of scenario investigations. However, detailed physically-based models show two major disadvantages. Due to the long calculation times, simulations have to be limited both in time and space. Applications involving numerous simulations, such as global optimization problems at catchment level, real time control applications and uncertainty analyses, cannot be performed. Secondly, the coupling of models created in different software environments can be cumbersome.

To obviate these disadvantages, so called conceptual models can be used that emulate the results of the detailed river models. These models are characterized by a much simpler model structure and have therefore a short calculation time, making them highly suitable for applications that require long-term or large number of model simulations. Recently, such conceptual model of the Demer River in Flanders was employed in a real-time control application to control flooding (Van den Zegel and Vermuyten, 2013). Optimal gate openings of the hydraulic structures were determined using predicted rainfall series. In another application, where the optimal locations of retention basins were determined along the rivers Aa and Visbeek and the sewer system of the city of Turnhout, conceptual models for both the rivers and the sewer system were applied (De Vleeschauwer et al., 2013). A third example is the conceptual model of the River Dender, used for flood probability mapping based on rainfall forecasts (Wolfs et al., 2012).

All these conceptual models were constructed and calibrated based on some simulation results obtained from available detailed full hydrodynamic models. Such conceptual model construction and calibration can, however, be time consuming and requires specific expert skills if done in a manual way. To facilitate the conceptual model build-up, the Conceptual Model Developer (CMD) tool was designed by the authors. Based on simulation results of a detailed hydrodynamic model, the tool guides the user step by step through the conceptual model calibration process, conveying the optimal model structure and parameters. The modeller has the possibility to adopt the proposed model elements, or to select different ones. This way, expert knowledge can still be incorporated. To enhance user friendliness, the
tool is equipped with a graphical user interface. The final conceptual model of the river is built in the Simulink environment. Hence, each important modelling element is represented by a block. This way, the user maintains a clear overview of the entire model structure. The CMD tool is compatible with all different hydrodynamic river software packages (e.g. MIKE11, HEC-RAS, etc.). Very close integration with the InfoWorks RS software was made, in which hydraulic structure parameters and gate level regulations are automatically transferred to the conceptual model.

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References and further reading


