Coupling models of the same type with OpenMI

an OpenMI news item by
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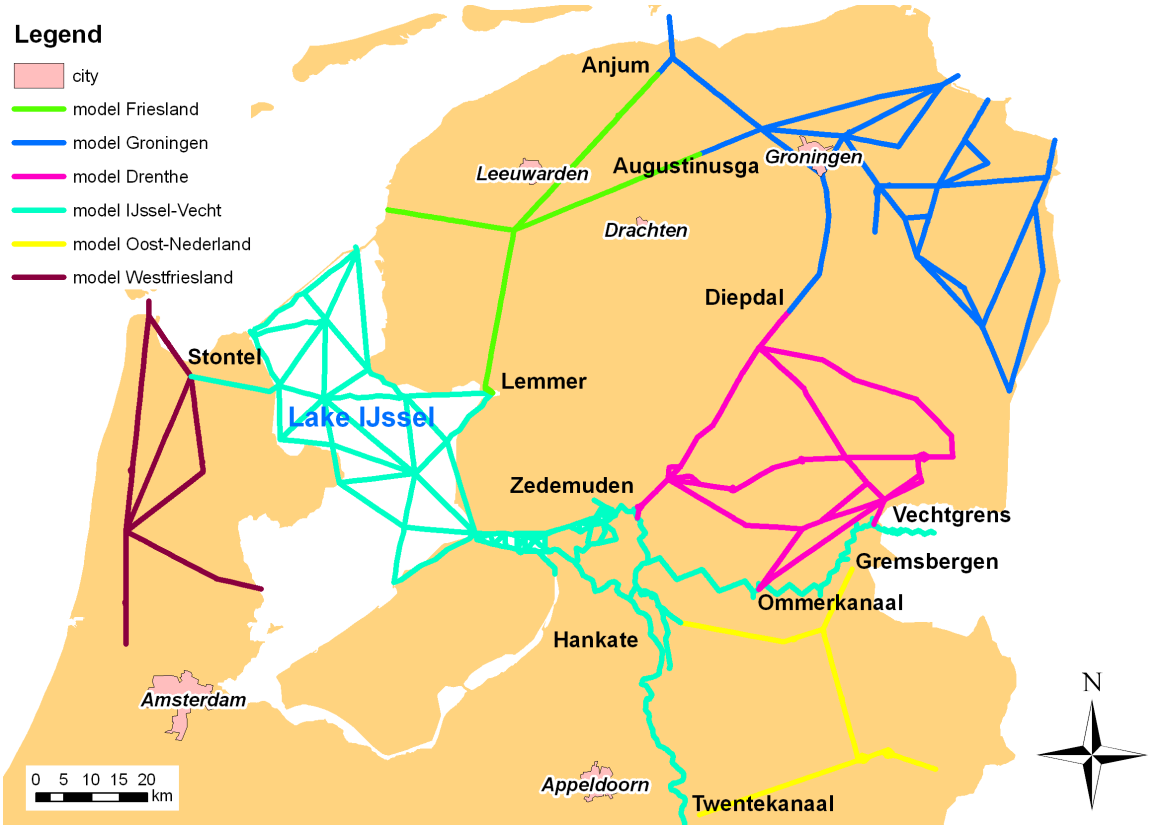
In the Netherlands, neighboring Water Authorities have developed 1D channel flow models for their operational area, which need to be run separately for local issues, but have to be integrated when decisions are taken on a higher scale and the interaction of the neighboring water systems can not be neglected. So there is need for coupling models of the same type (i. e. models that are based on the same software and model the same processes). The Deltamodel project aims to develop a channel flow model for the water distribution network of the whole country. The question is whether to merge the datasets of the existing models (in the following: sub-models) to a new model by merging the datasets (implicit coupling), or to use iterative or external coupling techniques. In the latter case the sub-models remain unchanged and data is exchanged between the models during runtime on a time-step basis.



As a pilot study, two, three, four, five and six sub-models that represent the water system of the operational area of Dutch waterboards (see figure above) have been coupled externally with OpenMI. An implicit coupling, where the datasets of the sub-models are merged to one new model, gives the reference case. For the merging of the datasets the flow simulation programme Sobek provides appropriate functions, while for external coupling the OpenMI standard (OpenMI 1.4) is applied. The performance of the two coupling techniques is assessed in terms of computing time and accuracy of modeled water levels and discharges.

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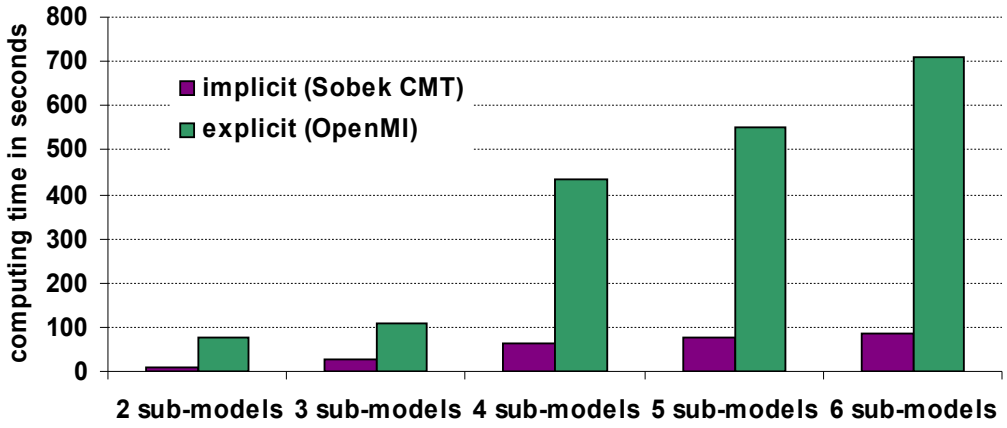
The study proves that multiple Sobek-models can be coupled with OpenMI, but shows that no advantages in terms of computational costs are to be expected with OpenMI-coupling. The figure below shows the computing times for the implicit and external coupling simulations.



The “one-mesh”-approach, i.e. the unification of sub-models to one big model within the Sobek-Netter feature and the subsequent simulation run in the case management tool (implicit coupling) is significantly faster. The higher the number of sub-models, the larger is the advantage in terms of computational costs with respect to the correspondent OpenMI-coupling, whose computing time increases disproportionally with the number of models. The OpenMI request-reply-mechanism is made responsible for high computational costs: the sub-models do not run parallel, in case of a composition of six sub-models only one model computes at a time while the other five models remain in a waiting mode.

However, the one-mesh-approach is basically irreversible. So, a decision between implicit coupling (unification of meshes in Sobek) and external coupling (multiple sub-models coupled via OpenMI) is basically a matter of preference: if computing time and accuracy are more important, models should be unified to one large model. If priority is given to administration and maintenance issues and computational time is not a limiting factor, model coupling with OpenMI-coupling should be chosen. For a small number of sub-models computing times differ not that much. Higher computational costs can easily be accepted in return for the advantage of not having two sets of models to be maintained.

For the Dutch Deltamodel which contains model components from different institutions usually more working hours are spent in model maintenance, model updates, adjustments, and administration than in simulations. Administration issues are thus considered to be more important than computational costs. Thus, coupling multiple models with OpenMI is recommended for the Deltamodel, in particular if the number of models to be coupled is small. For further developments of the OpenMI standard a coupling mechanism where models can run parallel should be considered in order to reduce computational costs for compositions with multiple model components.