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Integrated, exploratory catchment modelling: coupling PCRaster and MODFLOW

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The aim of this presentation is to show a recently developed toolbox for integrated, exploratory catchment modelling using PCRaster (pcraster.geo.uu.nl) and MODFLOW (water.usgs.gov/nrp/gwsoftware/modflow.html). Just like laboratory experimentation, numerical modelling has brought many advances in the understanding of catchment hydrology. The use of a proper modelling tool is nowadays essential for doing state of the art hydrological research. Such a tool needs to support integrated and exploratory modelling. Integrated modelling is referred to here as simulation of individual system components and their interactions. Exploratory modelling is the research activity whereby the scientist explores different process representations, aiming at the optimal model given the research goals and the field data. Exploratory modelling may also result in new theories about hydrological systems, whereby the modelling toolbox acts as a virtual laboratory.

In this presentation, we report on research aiming at a model construction toolbox for integrated and exploratory modelling. Integrated modelling requires coupling of processes between different hydrological subsystems. To make use of existing modelling engines linkage between different existing tools is required. A recent approach for linking different model engines in the hydrological domain is the Open Modelling Interface and Environment software (OpenMI, www.openmi.org). This framework provides a protocol to declare the spatial and temporal data and its transfer between different modelling tools. The framework is used by our team to couple existing model construction tools with an environmental modelling language.

The environmental modelling language used is PCRaster, which is a set of applications

for the development of spatial-temporal environmental models. It includes a raster-based temporal Geographical Information System, managing data storage, manipulation and visualisation. The embedded dynamic modelling language abstracts from common programming languages and therefor allows the development or modification of environmental models without specialised programming knowledge: exploratory modelling. A large set of operations, such as surface water routing, is available on temporal data in two and three spatial dimensions.

We illustrate how this toolbox is used for a transient simulation of the hydrology in the 2.7 km^2 Huewelerbach catchment in Luxembourg. In addition, it is shown how different model representations can be programmed in relatively short time.