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A climate robust integrated modelling framework for regional impact assessment of climate change

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Decision making towards climate proofing the water management of regional catchments can benefit greatly from the availability of a climate robust integrated modelling framework, capable of a consistent assessment of climate change impacts on the various interests present in the catchments.

In the Netherlands, much effort has been devoted to developing state-of-the-art regional dynamic groundwater models with a very high spatial resolution (25x25 m^2). Still, these models are not completely satisfactory to decision makers because the modelling concepts do not take into account feedbacks between meteorology, vegetation/crop growth, and hydrology. This introduces uncertainties in forecasting the effects of climate change on groundwater, surface water, agricultural yields, and development of groundwater dependent terrestrial ecosystems. These uncertainties add to the uncertainties about the predictions on climate change itself.

In order to create an integrated, climate robust modelling framework, we coupled existing model codes on hydrology, agriculture and nature that are currently in use at the different research institutes in the Netherlands. The modelling framework consists of the model codes MODFLOW (groundwater flow), MetaSWAP (vadose zone), WOFOST (crop growth), SMART2-SUMO2 (soil-vegetation) and NTM3 (nature valuation). MODFLOW, MetaSWAP and WOFOST are coupled online (i.e. exchange information on time step basis). Thus, changes in meteorology and CO_2-concentrations affect crop growth and feedbacks between crop growth, vadose zone water movement and groundwater recharge are accounted for. The model chain WOFOST-MetaSWAP-MODFLOW generates hydrological input for the ecological prediction model combination SMART2-SUMO2-NTM3.

The modelling framework was used to support the regional water management decision making process in the 267 km^2 Baakse Beek-Veengoot catchment in the east of the Netherlands. Computations were performed for regionalized 30-year climate change scenarios developed by KNMI for precipitation and reference evapotranspiration according to Penman-Monteith. Special focus in the project was on the role of uncertainty. How valid is the information that is generated by this modelling framework? What are the most important uncertainties of the input data, how do they affect the results of the model chain and how can the uncertainties of the data, results, and model concepts be quantified and communicated? Besides these technical issues, an important part of the study was devoted to the perception of stakeholders. Stakeholder analysis and additional working sessions yielded insight into how the models, their results and the uncertainties are perceived, how the modelling framework and results connect to the stakeholders' information demands and what kind of additional information is needed for adequate support on decision making.