Geophysical Research Abstracts
Vol. 12, EGU2010-2603-1, 2010
EGU General Assembly 2010

Large scale groundwater modeling using globally available datasets: A test for the Rhine-Meuse basin

Edwin H. Sutanudjaja (1), Steven de Jong (1), Frans C. van Geer (1,3), Marc F.P. Bierkens (1,2)

(1) Department of Physical Geography, Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands (e.sutanudjaja@geo.uu.nl / fax: +31 (0)30 25 31145), (2) Deltares, Utrecht, The Netherlands, (3) TNO Built Environment and Geosciences, Utrecht, The Netherlands

Groundwater resources are vulnerable to global climate change and population growth. Therefore, monitoring and predicting groundwater change over large areas is imperative. However, large-scale groundwater models, especially those involve aquifers and basins of multiple countries, are still rare due to a lack of hydro-geological data. Such data may be widely available in developed countries but are seldom available in other parts of the world. In this study, we propose a novel approach to construct large-scale groundwater models by using global datasets that are readily available. As the test-bed, we choose the combined Rhine-Meuse basin (total area: ± 220000 km^2) that contains ample data (e.g. groundwater head data) that can be used to verify the model output. However, while constructing the model, we use only globally available datasets such as the global GLCC land cover map [http://edc2.usgs.gov/glcc/glcc.php], global FAO soil map [1995], global lithological map of Dürr et al [2005], HydroSHEDS digital elevation map [Lehner et al, 2008], and global climatological datasets (e.g. the global CRU datasets [Mitchell and Jones, 2005 and New et al, 2002], ERA40 re-analysis data [Uppala et al, 2005], and ECMWF operational archive data [http://www.ecmwf.int/products/data/operational_system]).

We started by building a distributed land surface model (1×1 km) to estimate groundwater recharge and river discharge. Then, a MODFLOW transient groundwater model is built and forced by the recharge and surface water levels calculated by the land surface model. We run the models for the period 1970-2008. The current results are promising. The simulated river discharges compare well to the discharge observation as indicated by the Nash–Sutcliffe model efficiency coefficients (68% for Rhine and 50% for Meuse). Moreover, the MODFLOW model can converge with realistic aquifer properties (i.e. transmissivities and storage coefficients) and can produce reasonable groundwater head spatial distribution that reflects the positions of major groundwater bodies and rivers in the basin.

Subsequently, we compare the spatio-temporal pattern of the calculated groundwater head to the soil moisture products from AMSR-E and ERS/METOP. However, the resolution of soil moisture fields (25 km) is too coarse compared to our model resolution (1 km). For this reason, we use several 1 km MODIS products (e.g. land surface temperature, leaf area, and vegetation indices) to downscale the soil moisture fields. From the downscaled soil moisture fields, particularly during the dry summer, we distinguish wet areas that are associated with shallow groundwater table occurrence. These are compared to the groundwater head calculated by the groundwater model. Based on this comparison, model fallacies are identified and turned to improve the model.

We argue that the combination of groundwater modeling and remote sensing may enable groundwater assessment in data-poor environments.