Global Water Resources in a Global World

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Introduction

To achieve a sustainable development of the planet Earth, water resources need to be managed well. This requires an assessment of the current water situation, an understanding of historic developments and the generation of scenarios of the future. A global-scale freshwater assessment helps to understand the global water system and how it is impacted by humans, as in a globalized world, freshwater assessments can no longer be restricted to the river basin scale. To support these tasks, we have developed the global-scale water model WaterGAP that computes both water resources and water use with a spatial resolution of 0.5° x 0.5°(55 km at the equator), and we keep improving the model.

Methods

We have harmonized model versions developed at the University of Kassel and the University of Frankfurt (WaterGAP 2.2) and evaluated the sensitivity of global freshwater fluxes and storages to input data, hydrological model structure, human water use and calibration[1] . In cooperation with geodesist, we evaluate simulated seasonal water storage variations against GRACE gravity field and GPS observations[2]. We participated in the ISI-MIP effort to estimate the impact of climate change on freshwater resources, applying a number of bias-corrected climate model outputs[3]. Using a recent model version that takes into account groundwater recharge from surface water bodies in semi-arid regions of the globe, we estimated global-scale groundwater depletions and its contribution to sea-level rise[4].

Results

We found that groundwater depletion is likely to be lower than formerly estimated due to deficit irrigation in depletion regions. About one-tenth of total sealevel rise around the turn of the century can be attributed to groundwater depletion.

Outlook

We currently participate in another ISI-MIP multi-model experiment regarding historical land and water use effect, and are developing an improved WaterGAP 2.2b model version that will allow easy integration in data assimilation efforts.

Reference

[1] H. Müller Schmied, S. Eisner, D. Franz, M. Wattenbach, F.T. Portmann, M. Flörke, and P. Döll (2014), Sensitivity of simulated global-scale freshwater fluxes and storages to input data, hydrological model structure, human water use and calibration. Hydrol. Earth Syst. Sci. 18: 3511-3538. https://doi.org/10.5194/hess-18-3511-2014

[2] P. Döll, M. Fritsche, A. Eicker, and H. Müller Schmied (2014), Seasonal water storage variations as impacted by water abstractions: Comparing the output of a global hydrological model with GRACE and GPS observations. Survey in Geophysics. 35 (6): 1311-1331. https://doi.org/10.1007/s10712-014-9282-2

[3] F.T. Portmann, P. Döll, S. Eisner, and M. Flörke (2013), Impact of climate change on renewable groundwater resources: assessing the benefits of avoided greenhouse gas emissions using selected CMIP5 climate projections. Environ. Res. Lett. 8 024023. https://doi.org/10.1088/1748-9326/8/2/024023

[4] P. Döll, H. Müller Schmied, C. Schuh, F.T. Portmann, and A. Eicker (2014), Global-scale assessment of groundwater depletion and related groundwater abstractions: Combining hydrological modeling with information from well observations and GRACE satellites, Water Resour. Res., 50 (7): 5698-5720. https://doi.org/10.1002/2014WR015595

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