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Quantifying groundwater recharge under projected climatic changes in an urban area

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Changing climatic conditions highly impact the hydrological cycle and thus the quantity and quality of regional water resources. Those changes interfere with cultivation and forest management, with water supply and with waste water disposal. Here we present the results of a study within the BMBF-supported REGKLAM project (Development and Testing of an Integrated Regional Climate Change Adaptation Program for the Model Region of Dresden). The temporal and spatial variability of groundwater recharge is evaluated for the city of Dresden (Saxony, Germany) with an area of 330 km^2, located in the river Elbe valley.

Groundwater recharge was quantified for present and future conditions of climate change using the water balance model BOWAM. The simulations were done for annual and monthly time steps and a grid resolution of 100 m. Groundwater recharge was modeled for the reference period 1961–1990 and for current climatic conditions (1991–2010) using daily observed weather data. The impact of projected climatic change impacts on the hydrological cycle were simulated under constant land use and vegetation cover conditions using a regional climate model with a statistical downscaling approach (WETTREG 2010).

A strong decrease in groundwater recharge is simulated for the 21st Century, based on the chosen climate projections. The simulated annual long-term groundwater recharge average for the period 2021–2050 is already approx. 40 % lower than in the reference period and the decrease reaches more than 70 % for 2071–2100. This enormous reduction in groundwater recharge is due to high evapotranspiration rates in combination with decreasing annual precipitation totals, particularly at the end of the 21st Century. The results represent a worst case scenario, as most other climate models simulate more or less unchanged annual precipitation totals for the study area, but similar temperature increases. The simulated strong decrease in groundwater recharge would have severe consequences for the general groundwater availability. Several communal and federal fields of action would be affected, as groundwater is currently used for manifold activities. These include the use of groundwater as drinking water, industrial process water, cooling water and for air-conditioning of (communal) buildings. The groundwater levels furthermore influence the structural stability of building. Therefore, the simulation results are important elements for the regional decision makers in planning and implementing climate change adaptation options.