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Global-scale modeling of groundwater recharge

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Long-term average groundwater recharge, which is equivalent to renewable groundwater resources, is the major limiting factor for the sustainable use of groundwater. Compared to surface water resources, groundwater resources are more protected from pollution and their use is less restricted by seasonal and inter-annual flow variations. Therefore, it is useful to estimate groundwater recharge at the global scale to support water resources management in a globalized world.

A best estimate of global-scale long-term average diffuse groundwater recharge has been calculated using the WaterGAP Global Hydrology Model (WGHM) with a spatial resolution of 0.5° and an internal time step of one day. Groundwater recharge is currently represented in WGHM using a heuristic approach taking into account relief, soil texture, hydrogeology and the occurrence of permafrost and glaciers. Two different data sets of gridded observed precipitation were used as model input which allowed to quantify the uncertainty of model results due to these equally uncertain data sets. The standard WGHM groundwater recharge algorithm was modified for semi-arid and arid regions, based on independent estimates of diffuse groundwater recharge, which lead to improved and unbiased model results in those areas.

We estimated a value of about 12,700 km^3/yr for global groundwater recharge (1961-90), i.e. one third of total renewable water resources. In (semi-) arid, mountainous and permafrost regions and in the Asian Monsoon region, groundwater recharge accounts for a lower fraction of total runoff, which makes these regions particularly vulnerable to seasonal and inter-annual precipitation variability and water pollution. Values of groundwater recharge for single countries vary widely. For example, long-term average renewable groundwater resources in France were estimated at 1825 m^3/(capita·yr)

and at 90 m^3/(capita·yr) in Saudi Arabia.