Spatially distributed investigations on potential consequences of climate change for groundwater recharge in Hesse

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Within the scope of the integrated climate protection programme INKLIM 2012 the Hessian Agency for Environment and Geology has investigated the effects of climate change on groundwater recharge in Hesse. Regional climate projections based on the general circulation model ECHAM4 and the IPCC emission scenario B2 have been used for spatially distributed water balance modelling until the year 2050.

Groundwater accounts for 95 % of public drinking water supply in Hesse. The projected changes in climate have a significant impact on the groundwater resources in Hesse. The modelling results reveal that groundwater recharge increases by about 25 % until 2050, compared to the reference period 1971-2000. This remarkable increase is due to the seasonal shift of rainfall occurrences from the summer to the winter season. In future, the mean groundwater recharge rates will correspond to high recharge rates which have occurred during wet periods in the past. However, low groundwater recharge rates may be still possible during longer periods of drought.

Hesse is unlikely to face any fundamental problems with regard to water supplies, even under changed climatic conditions. However, the possibility of regional shortfalls cannot be excluded, particularly during longer periods of drought. The projected alterations in the groundwater balance do not only affect the water supply sector. High or low groundwater levels cause problems in residential areas, agriculture, forestry and biotopes.

Due to rising groundwater levels roads may be flooded and cellars of buildings in urban areas may be damaged by flooding or moisture. Extremely high groundwater levels cause water-logging in agricultural and forested areas. As a consequence agriculturally used areas can not be cultivated and forests are damaged. Higher groundwater recharge rates may affect the quality of groundwater due to intensified nitrate leaching in agricultural areas.

The extreme weather conditions (dry, hot summers and rainy winters) cause stress on plants. In the Hessian Reed, where agriculture plays a dominant role, the demand for irrigation water will significantly rise.

Low groundwater levels during periods of drought may be harmful to groundwater-dependent biotopes and forests. Buildings and traffic infrastructure can be damaged by settlement cracks as a consequence of falling groundwater levels during periods of drought. Decentralised water supply in the mountainous regions may be threatened by running dry of springs during the summer season.

In order to cope with the described impacts of climate change on the groundwater balance it is necessary to develop adaptation measures and strategies for a sustainable groundwater management. However, the modelling results are based on only one single emission scenario (B2) so that they cannot be regarded as forecasts. Therefore, further investigations are needed considering other climate projections in order to better reflect the entire bandwidth of possible future climate scenarios.