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Calculating recharge of groundwater more precisely

Researchers demonstrate that current models underestimate role of subsurface heterogeneity

A team of international researchers led by University of Freiburg hydrologist Dr. **Andreas Hartmann** suggests that inclusion of currently missing key hydrological processes in large-scale climate change impact models can significantly improve our estimates of water availability. The study shows that groundwater recharge estimates for 560 million people in karst regions in Europe, the Middle East and Northern Africa, are much higher than previously estimated from current large-scale models. The scientists have shown that model estimates based on entire continents up to now have greatly underestimated in places the amount of groundwater that is recharged from fractions of surface runoff. This finding suggests that more work is needed to ensure sufficient realism in large-scale hydrologic models before they can be reliably used for local water management. The team has published their research findings in the scientific journal “Proceedings of the National Academy of Sciences (PNAS).“

Groundwater is a vital resource in many regions around the globe. For managing drinking water, the recharge rate is an important quantity for securing sustainable supplies. The researchers have compared two hydrological models that simulate groundwater recharge. One is a long-established global model with limited accounting for subsurface heterogeneity. The other is a continental model the researchers have developed themselves that includes, for example, variability in the thickness of soils and different subsurface permeabilities. They have carried out the

comparison for all of the karst regions in Europe, North Africa and the Middle East. Karst regions are known for their great degree of subsurface heterogeneity, because carbonate rock shows greater susceptibility to chemical weathering – a process that is known as karstification. Karstification leads to varying soil depths and permeabilities. A comparison of the models' calculations with independent observations of groundwater recharge at 38 sites in the regions has shown that the model that accounts for heterogeneity produces more realistic estimates.

The researchers explain the reason for the difference between the two models as follows: In simulation, their newly developed model shows reduced fractions of surface According to the new model, a farmer in the Mediterranean region would potentially have up to a million liters more groundwater for extraction available in a year than the established model estimates, dependent on actual subsurface composition and the water demands of the local ecosystems.

When applied to the example of karst regions, the researchers' approach shows how it is possible to adapt global models used to predict water shortages, drought or floods to account more realistically for regional conditions. Scientists from the University of Freiburg, Canada's Victoria University, the University of Bristol in England and International Institute for Applied Systems Analysis in Austria took part in the study.

Original publication

Hartmann, A., Gleeson, T., Wada, Y., Wagener, T., 2017. Enhanced groundwater recharge rates and altered recharge sensitivity to climate variability through subsurface heterogeneity. In: “Proceedings of the National Academy of Sciences”; doi:10.1073/pnas.1614941114.

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