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Regional Differences in Climate Change Impacts on Groundwater and Stream Discharge in Denmark

Lieke van Roosmalen,* Britt S. B. Christensen, and Torben O. Sonnenborg

Regional impact studies of the effects of future climate change are necessary because projected changes in meteorological variables vary regionally, and different hydrological systems can react in various ways to the same changes. In this study the effects of climate change on groundwater recharge, storage, and discharge to streams are compared in two geologically and climatologically different regions in Denmark. Outputs are used for the periods 1961 to 1990 and 2071 to 2100 from a regional climate model representing the Intergovernmental Panel on Climate Change (IPCC) scenarios A2 and B2. A physically based, distributed hydrological model simulates changes in groundwater head, recharge, and discharge. Precipitation, temperature, and reference evapotranspiration increased for both the A2 and B2 scenarios. This results in a significant increase in mean annual net precipitation, but with decreased values in the summer months. The magnitude of the hydrological response to the simulated climate change is highly dependent on the geological setting of the model area. In the Jylland area, characterized by sandy top soils and large interconnected aquifers, groundwater recharge increased significantly, resulting in higher groundwater levels and increasing groundwater–river interaction. On Sjælland, where the topsoil is dominated by low-permeability soils and the aquifers are protected by thick clay layers of regional extent, only minor changes in groundwater levels are predicted. The primary effect in this area is the change in stream discharge, caused by changes in drain flow and overland flow, with up to 50% increase in winter and 50% decrease in summer. This study shows the added value of studying different climate scenarios and hydrological systems, so that the simulated effects can be compared both qualitatively and quantitatively.

ABBREVIATIONS: GCM, general circulation model; GEUS, Geological Survey of Denmark and Greenland; IPCC, Intergovernmental Panel on Climate Change; masl, meters above sea level; ME, mean error; RCM, Regional Climate Model; RMS, root mean squared error.
