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Climate and Land Cover Change Impacts on Large-Scale Groundwater Recharge

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The heterogeneity of land-use and subsurface properties, such as the distribution of land use/vegetation types, hydraulic conductivities or porosities, exert important controls on the water cycle. This notably includes groundwater recharge, which is an important variable for efficient and sustainable water resources management. Current large-scale hydrological models do not adequately consider such heterogeneity, especially related to subsurface characteristics. We show that regions with strong subsurface heterogeneity have enhanced present and future recharge rates due to a different sensitivity of recharge to climate variability compared to regions with homogeneous subsurface properties. Our study domain is comprised of the carbonate rock regions of Europe, Northern Africa and the Middle East, which cover $\sim$25% of the total land area. We compare the simulations of two large-scale hydrological models, one of them accounting for subsurface heterogeneity. Carbonate rock regions strongly exhibit "karstification", which is known to produce particularly strong subsurface heterogeneity. Aquifers from these regions contribute up to half of the drinking water supply for some European countries. Our results suggest that water management for these regions cannot rely on most of the presently available projections of groundwater recharge because spatially variable storages and spatial concentration of recharge result in actual recharge rates that are up to 4 times larger for present conditions and changes up to 5 times larger for potential future conditions than previously estimated. We have just added explicit vegetation related processes to the model so that we can assess the relative impacts of climate and land use change for the same study region as well. We will present results from both studies.