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CMIP6 multi-model estimation of non-renewable groundwater abstractions during the 21st century

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The global water resource is composed of all the exploitable freshwater on Earth and is mainly stored in groundwater, which accounts for approximately one-third of the human freshwater withdrawals. One of the main indicators of groundwater water availability is its recharge (water flux entering groundwater). Indeed, knowledge of groundwater recharge dynamics is crucial to estimate the amount of water that can be withdrawn without depleting its reserves over the long term (renewable abstractions). Whether alone or combined with climate change, groundwater withdrawals can lead to non-renewable abstractions, increasing the risks of water scarcity and food insecurity in some regions.

Here, the current and future non-renewable groundwater abstractions are estimated using climate-driven projections of groundwater recharge from an ensemble of 22 fully coupled global climate models participating in the CMIP6 exercise (without representation of groundwater withdrawals), and projections of irrigation water withdrawals from hydrological models. The projections cover the 1970-2100 period and follow three of the latest IPCC scenarios of greenhouse gas future evolution. Results show non-renewable groundwater abstractions for irrigation in heavily irrigated or arid regions. Despite an increase in global groundwater recharge due to climate change, this evolution is not uniform and presents large regional disparities. In addition, the number and size of the regions with non-renewable groundwater abstractions increase with climate change. These results are put in perspective with current agricultural production maps for the main cereals (data from FAO). This analysis highlights that regions experiencing the strongest non-renewable groundwater abstractions supply a large part of the world agricultural production.