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Global Groundwater related Risk Indicators: quantifying groundwater stress and groundwater table decline (1990-2010) at global scale

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Groundwater is an invisible but indispensable resource for the economic development of many countries. Due to the need for this resource, in many cases it is exploited under severe pressure and the exploitation can become not sustainable. The non-sustainable exploitation of water is a well-known problem on both regional and global scales. However, most currently-available assessments on water stress still mostly focus on surface water and on water balances. In this work, we presented two global maps of groundwater risk indicators: an updated version of the groundwater stress (Gleeson et al., 2011, DOI: 10.1038/nature11295) and an indicator on groundwater table decline for the period 1990-2010.

To calculate both indicators, we used the updated PCR-GLOBWB model output at 5 arcmin resolution (about 10 km at the equator), that is extended with an offline coupling to a global groundwater MODFLOW model. PCR-GLOBWB simulates daily river discharge and groundwater recharge, as well as surface water and groundwater abstraction rates. The latter are estimated internally within the model based on the simulation of their availabilities and water demands for irrigation and other sectors. The daily output of PCR-GLOBWB would then be aggregated to the monthly resolution and used to force the MODFLOW groundwater model resolving spatio-temporal groundwater table dynamics, incorporating the simulated groundwater abstraction of PCR-GLOBWB.

Using the PCR-GLOBWB and MODFLOW simulation results from the period 1990-2010, we then quantified groundwater stress and assessed the groundwater table decline. Results are presented on four different spatial scales: 5 arcmin pixel, drainage/sub-catchment unit, state level, and major aquifer unit. The maps clearly show where groundwater is under stress, where there is a trend in the drop of the groundwater table, the slope of the drop and the significance of it.