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Future Global Water Deficit: Allocation mechanisms within the nexus

Stefan Dekker (1,2), David Bijl (1), Hester Biemans (3,4), Patrick Bogaart (1), Jonathan Doelman (3), Elke Stehfest (3), Detlef van Vuuren (1,3)

(1) Utrecht University, Environmental Sciences, Copernicus Institute of Sustainable Development, Utrecht, Netherlands (s.c.dekker@uu.nl), (2) Open University, Faculty of Management, Science and Technology, The Netherlands, (3) PBL Netherlands Environmental Assessment Agency, Den Haag, The Netherlands, (4) Water and Food Research Group, Wageningen University and Research, Wageningen, The Netherlands

To assess the future increase in freshwater scarcity we need to understand how future population growth, agricultural production patterns, energy use, economic development, and climate change may impact the global freshwater cycle. Integrated models provide opportunities for quantitative assessment. In this presentation we integrate models of hydrology and economics, using the models IMAGE (Integrated Model to Assess the Global Environment) and LPJmL. Within this modelling framework we can explicitly account for (1) water use for different sectors: electricity, industry, municipal and irrigation; (2) inter-sectoral water allocation rules at 5 minute resolution; and (3) withdrawal, consumption, and return flows.

The aim is to understand competition dynamics between the different freshwater users at the basin and grid scale for current and future states (2010 vs 2050) by using three Shared Socioeconomic Pathways (SSPs). In addition, to find solutions we explore allocation rules to find sensitivities for the different water use sectors by keeping socioeconomic drivers as in SSP-2. Allocation rules are (i) Irrigation first, (ii) Other sector first, (iii) No expansion of irrigated areas, (iv) Increase water use efficiency for all sectors.

We found that global water withdrawal is projected to increase for all scenarios (from 12% to 29%) during 2010–2050 with a large increase in water deficits for the nonagricultural sectors, also caused by inter-annual variability of precipitation. For the allocation rules, we found that water use efficiency improvements reduce water withdrawal but have little impact on water deficits. On the contrary, the different priority rules at the local level have a large impact on nonagricultural water deficits, while limiting the expansion of irrigated land has almost no effect. Global water deficit in 2050 can be reduced with 45% when nonagricultural sectors are prioritised.