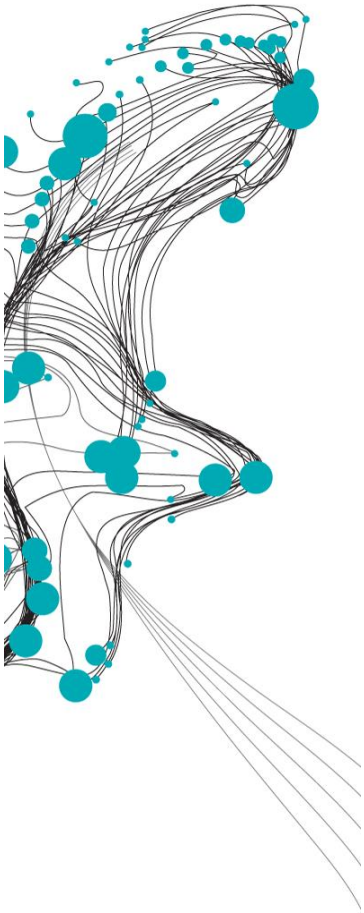
QUANTIFYING THE SHARE OF NON-SUSTAINABLE GROUNDWATER IN THE BLUE WATER FOOTPRINT OF GLOBAL CROP PRODUCTION



The agricultural sector is responsible for the largest share in global freshwater consumption, as well as the largest share in non-sustainable groundwater consumption. The consumption of non-sustainable groundwater has adverse affects for the environment, as well as for food security. Detailed information on which crop uses how much non-sustainable groundwater can be used to guide decision making on the sustainable allocation of groundwater. This study concerns the spatial distribution of, and trends in the contribution of groundwater, surface water and desalinated water to the blue water footprint of crops, globally at a high spatial resolution (5x5 arcmin), with a focus on the role of non-sustainable groundwater consumption for crop production. This is done by coupling crop water consumption from the Aqua21 water footprint modelling framework with consumption from non-sustainable groundwater, sustainable groundwater, surface water and desalination derived from the global hydrological model PCR-GLOBWB. Irrigated area and climate forcing are harmonized to combine output data from both models.

First, the agreement of irrigation withdrawal and consumption from irrigation between Aqua21 and PCR-GLOBWB is assessed. It was found that both models show the same hotspot areas, but differences in withdrawal and consumption from irrigation are large. Compared to literature, a low consumption from irrigation was found in the used PCR-GLOBWB model run, which is expected to cause an underestimation of the non-sustainable groundwater contribution to the blue water footprint of crops.

The global total blue water consumption over 1981-2010 for crops was 816 km^3/yr. The global non-sustainable groundwater consumption equaled 49 km^3/yr (6%). Wheat, rice, maize and cotton have the largest global non-sustainable groundwater consumption. Date palm and cotton have the largest total blue and non-sustainable groundwater footprints (m^3/ton). India, the USA and Pakistan account for the largest share of worldwide non-sustainable groundwater consumption. Countries in North Africa and the Middle East have the largest share of non-sustainable groundwater in their water footprint for agriculture.

The global non-sustainable groundwater consumption by crops showed a slight increase over the period between 1981-2010 of 1.0 km^3/yr. Non-sustainable groundwater footprints decreased for most crops. Trends in both non-sustainable groundwater and total blue water consumption and footprints were mainly driven by changes in irrigated area and crop yields. Interannual variability was largely caused by variability in precipitation and evapotranspiration. Non-sustainable groundwater consumption can be reduced by different measures, such as choosing to consume less crops and crop-derived products from areas with non-sustainable groundwater footprints.

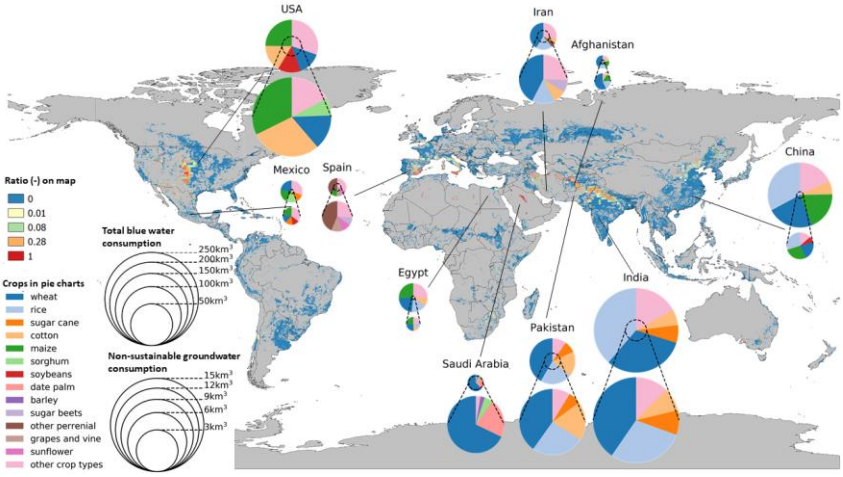


Figure 1: Global map of ratio of non-sustainable groundwater consumption to total blue water consumption in grid cells. For top 10 non-sustainable groundwater consuming countries, pie charts show the share of the four most consuming crops for total blue water consumption (upper pie chart) and non-sustainable groundwater consumption (lower pie chart). The dotted circle in the upper pie chart represents the total non-sustainable groundwater consumption for a country on the same scale as total blue water consumption.

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