



A hotspot analysis of the water footprint and groundwater depletion in the High Plains Aquifer

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The water footprint (WF) of irrigation agriculture sums up to $45.72 \text{ km}^3 \text{ yr}^{-1}$ (46% blue, 54% green) across the High Plains Aquifer (HPA) in the USA. Green WFs are dominating the north-east. Blue WFs are related to regions with intensive depletion of groundwater in the center and southern HPA, a situation further exacerbated by an increase of the blue water fraction of crop WF over the past (by 50% for 1990-1999; by 57% for 2000-2012). By means of a cluster analysis with the three parameter groundwater decline, blue and green WF, hotspots have been delineated spatially. Two sub-regions in the southern and central covering merely 20% of the HPA area have a share of one-third ($7.92 \text{ km}^3 \text{ yr}^{-1}$) of the total WF. This clearly shows that local strategies for sustainable allocation and use of freshwater resources are required. A likely impact of the sowing date (earliest vs. latest) on the WF has been studied, showing that blue WF increases by about 4% on average for all crops for the late sowing date, whereby the green and blue WF of cotton decreases totally about $0.9 \text{ km}^3 \text{ yr}^{-1}$. Further evaluation criteria apart from water conservation considered are economic water productivity and nutritional value per volume of water consumed in agricultural production. Corn leads to the highest economic water productivity of 0.34 USD m^{-3} , which in addition provides the highest nutritional value of 4362 kcal m^{-3} . Favoring sorghum over corn was found advantageous in years with water shortage, because irrigation requirements and crop evapotranspiration of sorghum are lower by 20% and 25%, respectively, yet accompanied with nutritional losses of 28% compared to corn production. Such a trade-off is to be evaluated by farmers and policy makers, whereby the green and blue WFs, the impact of the sowing date as well as the economic and nutritional productivity presented here supports decision making.