EGU2020-8623
https://doi.org/10.5194/egusphere-egu2020-8623
EGU General Assembly 2020

Spatial and temporal patterns of freshwater salinity and impacts on irrigation water use constraints globally

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Salinization of freshwater resources is a growing water quality issue, which poses challenges for different sectoral water uses. While it is generally recognized that salinity may constrain irrigation water use, our ability to evaluate the severity and extent of the problem has been hampered by a lack of assessments at the global scale. The aim of this study is to (i) quantify spatial and temporal trends in salinization of surface- and groundwaters in irrigated regions globally, and (ii) evaluate its implications for irrigation water use, by considering global salinity guidelines.

To address these aims, we collected and harmonized electrical conductivity (EC) monitoring data between 1980-2018 at both ground- and surface water locations in irrigated areas around the world. We used a suit of data sources including local, regional and global online water quality databases, and data provided by governmental organizations, river basin management commissions and scientific literature. Estimates of irrigated regions and associated groundwater and surface water withdrawal rates for irrigation water use was estimated using global grid-based hydrological outputs of the PCR-GLOBWB model.

Our results show that 23 % and 73 % of all surface water and groundwater stations, respectively, have long-term annual average EC values that exceed FAO guidelines of irrigation water use restrictions (700 µS/cm). Regionally, dryland areas, such as central and western parts of the US, eastern parts of Australia, South Africa and Southern Europe are particularly affected, but also coastal areas of Bangladesh, Florida and Vietnam show elevated EC levels. Regarding temporal variability, groundwater stations generally have low absolute EC variability, but with a majority of stations exceeding irrigation water use guidelines at more than 50 % of their total measurements for all continents except Europe and South America. For surface waters stations, more variability in terms of both exceedance levels and absolute EC was observed across continents, but with increasing EC during low flow periods, suggesting discharge (and seasonality) to be a strong control on surface water salinity. These results are a first step in assessing global impacts of salinity on irrigation water use constraints. Further assessments on salinity trends and its large-scale drivers will be provide necessary information for sustainable irrigation water use and management today and in the future.