



Implications of salinity pollution hotspots on agricultural production

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Salinity pollution can have many negative impacts on water resources used for drinking, irrigation, and industrial purposes. Elevated concentrations of salinity in irrigation water can lead to decreased crop production or crop death and, thus, causing an economic problem. Overall, salinity pollution is a global problem but tends to be more severe in arid and semi-arid regions where the dilution capacity of rivers and lakes is lower and the use of irrigation higher. Particularly in these regions agricultural production is exposed to high salinity of irrigation water as insufficient water quality further reduces the available freshwater resources. According to the FAO, irrigated agriculture contributes about 40 percent of the total food production globally, and therefore, high salinity pollution poses a major concern for food production and food security.

We use the WaterGAP3 modeling framework to simulate hydrological, water use, and water quality conditions on a global scale for the time period 1990 to 2010. The modeling framework is applied to simulate total dissolved solids (TDS) loadings and in-stream concentrations from different point and diffuse sources to get an insight on potential environmental impacts as well as risks to agricultural food production. The model was tested and calibrated against observed data from GEMStat and literature sources. Although global in scope, the focus of this study is on developing countries, i.e. in Africa, Asia, and Latin America, as these are most threatened by salinity pollution. Furthermore, insufficient water quality for irrigation and therefore restrictions in irrigation water use are examined, indicating limitations to crop production.

Our results show that elevated salinity concentrations in surface waters mainly occur in peak irrigation regions as irrigated agriculture is not only the most relevant water use sector contributing to water abstractions, but also the dominant source of salinity pollution. Additionally, large metropolitan regions are initially loading hotspots and pollution, too, and prevention becomes important as point sources are dependent on sewer connection rates and treatment levels. In conclusion, this study provides a detailed picture of the spatial and temporal distribution of salinity pollution and identifies hotspot areas as well as the dominant sources. Furthermore, impacts of water quality degradation on agricultural production and food security are quantified, which aim for a better understanding of the risks for food security caused by water quality impairment.