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Matching agricultural freshwater supply and demand: using industrial and domestic treated wastewater for sub-irrigation purposes

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Agricultural crop yields depend largely on soil moisture conditions in the root zone. Climate change leads to more prolonged drought periods that alternate with more intensive rainfall events. With unaltered water management practices, reduced crop yield due to drought stress will increase. Therefore, both farmers and water management authorities search for opportunities to manage risks of decreasing crop yields. Available groundwater sources for irrigation purposes are increasingly under pressure due to the regional coexistence of land use functions that are critical to groundwater levels or compete for available water. At the same time, treated wastewater from industries and domestic wastewater treatment plants are quickly discharged via surface waters towards sea. Exploitation of these freshwater sources may be an effective strategy to balance regional water supply and agricultural water demand. We present results of two pilot studies in drought sensitive regions in the Netherlands, concerning agricultural water supply through reuse of industrial and domestic treated wastewater. In these pilots, excess wastewater is delivered to the plant root zone through sub-irrigation by drainage systems. Sub-irrigation is a subsurface irrigation method that can be more efficient than classical, aboveground irrigation methods using sprinkler installations.

Domestic wastewater treatment plants in the Netherlands produce annually 40-50mm freshwater. A pilot project has been setup in the eastern part of the Netherlands, in which treated wastewater is applied to a corn field by sub-irrigation during the growing seasons of 2015 and 2016, using a climate adaptive drainage system. The chemical composition of treated domestic wastewater is different from infiltrating excess rainfall water and natural groundwater. In the pilot project, the bromide-chloride ratio and traces of pharmaceuticals in the treated wastewater are used as a tracer to describe water and solute transport in the soil system. Focus of this pilot study is on quantifying potential contamination of both the root zone and the deeper groundwater with pharmaceutical residues. We have installed a field monitoring network at several locations in the vadose zone and the local groundwater system, which enables us to measure vertical solute profiles in the soil water by taking samples. Based on field data obtained during the experiments, combined with SWAP (1D) and Hydrus (2D) model simulations, flow and transport of the sub-irrigated treated wastewater are quantified.

In the south of The Netherlands, the Bavaria Beer Brewery abstracts a large volume of groundwater and discharges treated wastewater to local surface water which transports the water rapidly out of the region. At the same time, neighboring farmers invest in sprinkler irrigation systems to maintain their crop production during drought periods. In this region, increasing pressure is put on the regional groundwater and surface water availability. Within a pilot study, a sub-irrigation system has been installed, by using subsurface drains, interconnected through a collector drain, and connected to an inlet control basin for the treated wastewater to enter the drainage system. We combine both process-based modeling of the soil-plant-atmosphere system and field experiments to i) investigate the amount of water that needs to be and that can be sub-irrigated, and ii) quantify the effect on soil moisture availability and herewith reduced needs for aboveground irrigation.