MATCHING AGRICULTURAL FRESHWATER SUPPLY AND DEMAND: USING RECYCLED WATER FOR SUBIRRIGATION PURPOSES

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Problem definition: We are increasingly confronted with drought damage in agriculture and nature as well as an increasing pressure on the availability of water for high-grade applications such as the production of drinking water. Strategies are being developed to control these risks and to secure long-term supplies of freshwater. These include increasing regional self-sufficiency in meeting the demand for freshwater and improving the utilization of the available water sources. We provide results of a pilot study in which industrial treated wastewater (TWW) is used for subirrigation in an agricultural field. In this study, we use TWW as external freshwater source for subirrigation purposes. Such direct use of TWW for irrigation provides better control over soil moisture, hence better growing conditions for crops, and a reduced need for groundwater or surface water extraction. Additionally, subsurface irrigation has the advantage over surface irrigation that direct contact of the TWW with the plant is minimized.

Methodology: A pilot study to examine the effects of the use of TWW in a subirrigation system has taken place at the Bavaria Beer Brewery in the south of the Netherlands. The Bavaria Beer Brewery extracts a large amount of groundwater and discharges TWW to the surface water. At the same time, neighbouring farmers invest in sprinkler irrigation to maintain their crop production during drought periods. This leads to increasing pressure on the regional groundwater availability. To reduce the water footprint of the brewery and the abstractions of farmers, excess TWW is delivered to a nearby field by subirrigation. Within the pilot study, a subirrigation system has been installed and tested. 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 subirrigated, and ii) quantify the effect on soil moisture availability and herewith reduced needs for aboveground irrigation.

Results: In 2015, the year without subirrigation, groundwater levels in summer dropped to about 250 cm-s.s. 2016 was not representative for a drought study, due to excessive rainfall in June/July. In 2017 a total of 430 mm of excess TWW was delivered to the field and groundwater levels were raised to 50-100 cm-s.s. The effect was limited to the field; groundwater levels in neighbouring fields were not affected. Subirrigation raised the

groundwater level by 100–150 cm compared with the reference without subirrigation. According to SWAP simulations, this shallow groundwater level optimized the soil moisture conditions for crop growth, i.e. transpiration reduction due to drought equaled zero for the situation with subirrigation and thus no drought stress occurred. The Bavaria-case indicates that subirrigation with treated wastewater can i) increase groundwater levels, even at sites with normally relatively deep groundwater levels ii) optimize soil moisture conditions for crop growth. It should be noted however, that the local soil conditions are important to prevent quick losses due to deep percolation and that clogging may be a serious risk.

Conclusions and discussion: Subirrigation with TWW may be an effective method to optimize soil moisture conditions for crop growth and prevent drought stress. Utilizing available alternative water flows for water supplies to agriculture can reduce the demand for shallow and deep groundwater for sprinkling purposes, which spares the groundwater for more high-grade applications. Besides industrial wastewater treatment plants, domestic wastewater treatment plants in the Netherlands produce annually 40-50 mm freshwater which is discharged on surface water. Unlike most industrial effluent, domestic wastewater contains a variety of micro pollutants. Additionally, the EU regulation on water reuse applies to direct reuse of domestic TWW for agriculture. A similar pilot project as for Bavaria has been setup in the eastern part of the Netherlands, in which domestic TWW is applied to a corn field by subirrigation during the growing season from 2015 onwards, using a climate adaptive drainage system.