New life despite drought

Water is a scarce commodity, as recent hot summers have made very clear. Specially treated wastewater can serve as a new source – for instance for growing vegetables.

By Christine Broll

The greenhouse is located on the grounds of the wastewater treatment plant in Wolfsburg-Hattdorf, right next to the clarification tank. Inside, the succulent green heads of lettuce grow in neatly ordered rows of long plastic tubes. Their roots extend, not into soil, but into a special nutrient solution – specially treated wastewater.

The Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB teamed up with 11 partners in a recently completed research project, HypoWave, to investigate the reuse of purified wastewater in agriculture. When the project was launched in late 2016, no one had any idea how dry the summers of 2018 and 2019 would be – the research became increasingly relevant from one year to the next.

The location of the HypoWave greenhouse – on the grounds of a Wolfsburg wastewater treatment plant – was chosen, in part, for historical reasons. "Unlike in the rest of Germany, the Braunschweig/Wolfsburg area has a long tradition of irrigating fields with treated wastewater," explains Dr. Marius Mohr, head of the water technologies and resource recovery innovation field at Fraunhofer IGB and one of the initiators of HypoWave.

But the treated wastewater is not used directly in the greenhouse, as it could contain pharmaceutical residues, heavy metals, industrial chemicals or pathogenic bacteria and viruses. The HypoWave partners tested various technologies for treating the wastewater in Wolfsburg-Hattorf. ▶

Lush green even during very dry periods? The HypoWave project is creating new opportunities by using wastewater in smart ways.
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▶ Ozonation and using an activated carbon biofilter proved to be particularly effective. Ozonation eliminates pollutants and pathogens through oxidation with ozone. While ozonation is already used in wastewater treatment plants today, treatment using activated carbon biofilters is new. The advantage of these filters is that they can both adsorb and biologically degrade pollutants.

"We did not detect elevated concentrations of pharmaceutical residues or pathogenic germs in the lettuce we irrigated with water from the activated carbon biofilter," says Marius Mohr, whose team is working to further improve the stages of wastewater treatment.

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Dr. Marius Mohr, Fraunhofer IGB

How well the lettuce plants thrive in the greenhouse was the investigation focus of Dr. Jörn Germer's working group at the University of Hohenheim. The fact that the plants are not grown in soil was nothing new – cultivation in nutrient solution, known as hydroponics, is already used on an industrial scale in fruit and vegetable production. The team of agricultural ecologists focused mainly on nutrient supply. "Wastewater contains relatively high levels of nitrogen and phosphorus, but comparatively little potassium and micronutrients such as zinc and iron," says Germer, so these nutrients had to be supplied.

In the first year of the study, water still flowed through the pipes permanently, but in the following year, the research team experimented with a recirculation system. Nitrate sensors continuously monitored the nitrogen content. If it dropped below ten milligrams per liter, the water was reconditioned. "Not only did this enable us to boost our production level," says Germer enthusiastically, "we were also able to remove nitrogen and phosphorus from the wastewater far more extensively than conventional treatment plants."

Studies test acceptance

To get their new technology into applications as quickly as possible, the researchers investigated the levels of interest and acceptance in various regions by bringing together wastewater associations, farmers and sellers. They analyzed how the concept was implemented in a rural area – the district of Gifhorn, north of Braunschweig – and in another case study they looked at the Rhein-Main metropolitan region. In Raeren, a municipality in Belgium, the concept was applied to the cultivation of cut flowers, and in Portugal's Alentejo region, wastewater was used in hydroponics and, subsequently, to irrigate olives, almonds and wine.

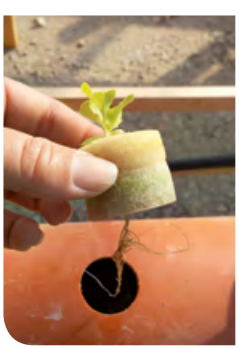
Greenhouses could replace wastewater treatment plants

Interest in Weißenberge, in the district of Gifhorn, was particularly great. Here, one farmer was so convinced of the project that he is prepared to invest in a greenhouse. The Gifhorn wastewater association plans to invest in it too, as they expect the project to yield cost savings. The wastewater from Weißenberge, a town with a population of around 500, is currently fed into a treatment pond where it stays for about 90 days before being discharged into a stream. The long-term plan is to connect the municipality to a wastewater treatment plant, which requires major investments.

"If we succeed in significantly reducing the nutrients in the effluent from the treatment pond in the hydroponic greenhouse, Weißenberge wouldn't need to be connected to a wastewater treatment plant," explains Mohr. He plans to team up with some local partners there in a follow-up project, HypoWave Plus, to explore how that could be done.

"Since the farmers in the Gifhorn district were questioning how they were going to irrigate their fields the last two summers, interest in implementing a project of this kind has risen considerably," says Mohr. The water treatment facility is set to be built and tested next spring, enabling him to run his greenhouse with plenty of water in 2022. He plans to grow cucumbers, tomatoes and bell peppers, and he already knows how he's going to sell them: the local Edeka supermarket is one of the partners in the research proposal and will add his vegetables to its product range.

Marius Mohr is looking to the future. He aims to use the lighthouse project in Weißenberge to make this technology known and get more people interested in it. ■



From seedling to lettuce: the recirculation system is equipped with nitrate sensors to monitor nitrogen levels, and the water is reconditioned as needed. © *ISOE Wikom*