UCD Impact Case Study

Constructed wetlands: from waste to oasis

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SCIENTIFIC · SOCIAL · TECHNO-LOGICAL · ACADEMIC · ENVIRON-MENTAL · HEALTH

"The impact will be to make wastewater treatment more integrated into the urban environment, while re-using the water industrial by-product and ensuring that human populations have clean drinking water."

SUMMARY

Wastewater treatment systems are not always pleasant to look at. But what if they could be aesthetically pleasing and offer the public a space for recreation and enjoyment as they carry out the necessary work of removing impurities from the water supply?

Dr Yaqian Zhao is a world leader in constructing artificial wetlands to do just that. His group has not only developed and tested an approach that re-uses waste products to build wetlands that clean water themselves, they have also devised an approach to generate electricity from wetland activity. Dr Zhao has been recognised internationally for his pioneering contributions to the field.

Building wetlands for clean water

Humans around the world need clean drinking water , while producing wastewater at the same time.

There are plenty of technologies to treat wastewater, but wastewater treatment plants tend not to have much aesthetic or recreational value for the societies they serve.

How can we make more of these necessary services? One approach, being pioneered by Dr Yaqian Zhao at University College Dublin School of Civil Engineering, is to construct artificial wetlands. These patches of land that can 'filter' water and remove impurities, and the beauty is that these wetlands can also support the growth of plants and provide space and amenities for people to enjoy.

"In wastewater treatment engineering we have many different kinds of treatment technologies, and we are focused on constructed wetlands," explains Dr Zhao, who is directs the Water and Effluent Laboratory at UCD.

"A constructed wetland looks like a park and has plants growing on it, but on the inside it is a wastewater treatment facility."

Dr Zhao started building his expertise in wastewater treatment as an early-stage researcher in Scotland. He worked on the material that is left over from drinking water treatment, which is aptly named 'sludge'. His goal was to develop ways to make the "waste" more compact and manageable.

"All across the world water treatment plants treat sludge as waste and it goes to landfill, so I was looking at better ways to make it concentrated in a form called 'cake'," he says.

Reducing the volume into this cake is useful, but could the cake itself be reused? Dr Zhao could see the cake material was high in aluminium, which meant it had the potential to chemically remove nitrogen and phosphorous from wastewater.

"Back in 2004, when I moved to UCD, we looked at this," he says. "People were talking about how expensive it is to remove nitrogen and phosphorous from wastewater to meet with directives on water quality, and we showed that this sludge, this waste product that people were throwing away, had a high capacity to remove nitrogen and phosphorous from wastewater."

Zhao and colleagues started to test out the aluminium-rich material as the substrate for a constructed wetland - they used the cake as a base and put different species of plants on the top of it. Soon they had developed a new generation of constructed wetlands, they published many papers about it in the academic literature and they built up their international reputation in the field.

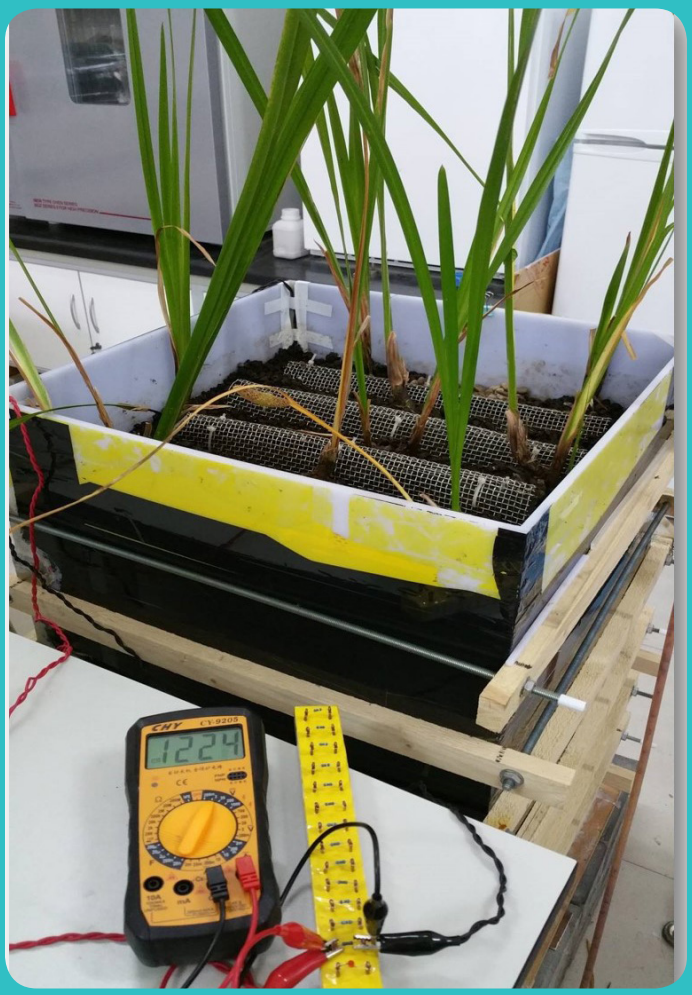
A park with social and environmental impact

"We design the wetland so that it fits in with the local environment and for the general public it appears as a small park, but there is more to it than that," says Dr Zhao. "We build the constructed wetland using the cake, the leftover material from drinking water treatment process, and this continues to treat the water by removing impurities. And at the same time the wetland **supports biodiversity** and can be an **educational site** for the local community. This is very different from the usual wastewater treatment facility, which is often set far away from where people live and spend their leisure time. Instead we want these **constructed wetlands to be part of the community."**

Dr Zhao's group at UCD has shown that the constructed wetland model is an effective and efficient way to purify wastewater. "We have more than 20 systems up and running to test the capacity of constructed wetlands," he says. "And we have demonstrated that the approach works very well for domestic wastewater. We are also finding that it works well with wastewater from the UCD Lyons Research Farm, where we are also testing the constructed wetland system."

Dr Zhao has taken another leap further, too. His group is developing ways of **harnessing energy from the constructed wetlands.** "We have combined our constructed wetland system with bacteria to generate electricity," he explains. "Currently our system for wastewater treatment and electricity generation can **power a small light** like a torch, and we think we can generate electricity during the night for lights. We are leading this innovation in the world, we have published about a quarter of the literature in this field."

As well as **publishing almost 300 academic papers on constructed wetlands**, Dr Zhao has hosted two major international conferences in Ireland and presented in China to explore the technology and **his work has been featured on Chinese CCTV**. He has also been honoured as a Fellow of the International Water Association, recognising his contribution to the wastewater and wetland sector and his contribution to improving the **wellbeing of societies and the environment.**



Dr Zhao now plans to install constructed wetland systems directly in wastewater treatment tanks. "That will mean wastewater treatment tanks will look like a park on the top, they will make ugly tanks beautiful and again support biodiversity as the wastewater is treated," he says. "The impact will be to **make wastewater treatment more integrated into the urban environment**, while re-using the by-products of previous drinking water treatment process and **ensuring that human populations have clean drinking water**."

Research References

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