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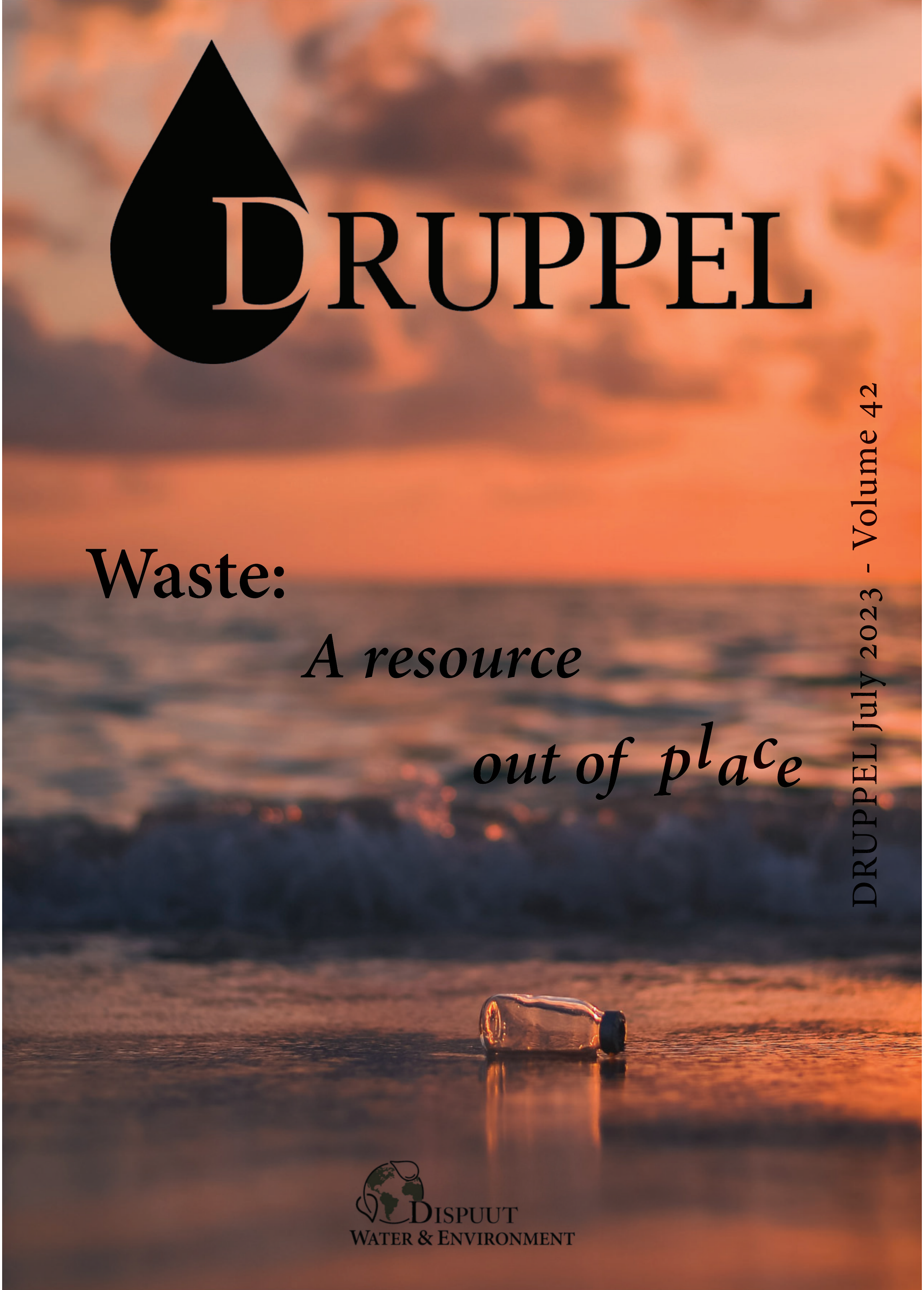

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Waste:

A resource out of place

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Resource and Waste Engineering at water utility Waternet

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Introduction

Waternet is the water utility of Amsterdam and surroundings. It is responsible for all water related activities: drinking water supply, sewerage, wastewater treatment, surface water management, groundwater management, and control of shipping and inland waterways, including the control of the water quality in the canals of Amsterdam. Topics as Circular Economy and Energy Transition are high on the agenda of Waternet, also on the Research & Innovation agenda. The combination of drinking water treatment and wastewater treatment offers challenging opportunities for Resource and Waste Engineering.

Waternet operates two drinking water production plants and eleven wastewater treatment plants, and serves about 1.3 million customers. In total about 95 million m3/year drinking water is produced and 125 million m3/year wastewater is treated. Drinking water production and wastewater treatment result in specific residues. While they were considered as wastes in the past, nowadays they are considered as valuable residues. Smart engineering solutions give value to these residues and help Waternet to realize the ambitions related to the Circular Economy and Energy Transition.

Known examples, already applied in practice, are struvite recovery from wastewater and calcite recovery from drinking water. Both have ben implemented full-scale in the treatment plants of Waternet. In the WWTP Amsterdam-West about 1000 tons/year struvite is recovered from the sludge by dosing magnesium chloride to the sludge, resulting in the controlled precipitation of struvite, $NH_4MgPO_4.6(H_2O)$. The investment costs were € 4 million, while the savings are € 400,000/year as no clogging in the sludge line takes place due to the controlled precipitation. In both drinking water treatment plants pellet softening is applied: a process to reduce the hardness of the water. By using ground calcite as seeding material, pellets are produced which can be reused in the softening process and also be applied in the industry. The principle of this process is shown in Figure 1.

As mentioned above, the combination of drinking water treatment and wastewater treatment in one water utility offers additional opportunities. Three examples will be discussed to show these opportunities.

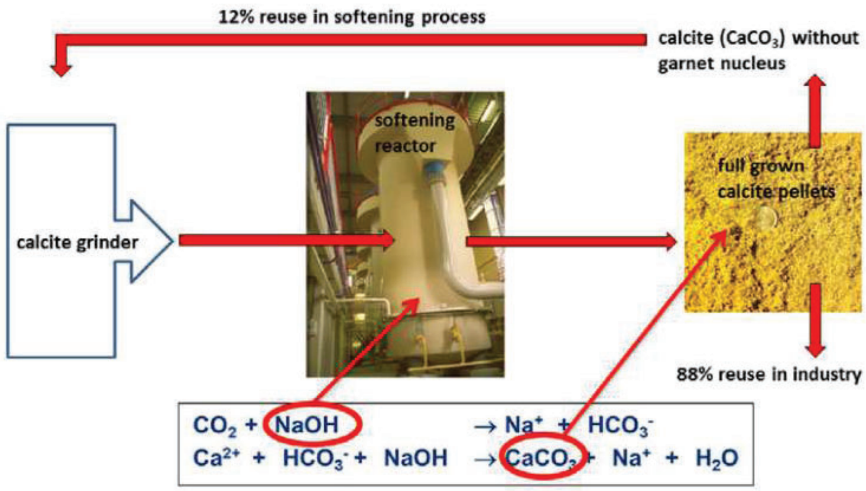

Figure 1: The principle of calcite recovery in drinking water production.

Magnesium from drinking water production used in wastewater treatment for struvite production

Waternet has to increase the drinking water production capacity in the near future due to a growing drinking water demand. One of the possibilities is the use of brackish seepage water in the Horstermeer, a polder near Hilversum. Brackish water results in a low water quality in the polder. One of the options is to "catch" this water (6-8 million m3/year) by interception wells before it reaches the surface water. This brackish water can be used as a source for drinking water production. However, to desalinate this water reverse osmosis (RO) is required. That is where Resource and Waste Engineering comes in. Reverse osmosis results in a concentrate with a relatively high salt content, including magnesium salts. At the same time a magnesium salt, $MgCl_2$, is dosed at WWTP Amsterdam-West in the sludge line for struvite recovery. It may be attractive to recover magnesium salts from the concentrate in the drinking water production process and use it for struvite recovery in the wastewater treatment. Figure 2 shows the principle of this approach. A first study has been done by a MSc student, Divvay Mehta, and he has proven that it is technically feasible by using an ion exchange process to remove magnesium from the RO concentrate. In a next study the financial feasibility and the sustainability will be assessed.

Bio-composite material production from calcite and cellulose

Bio-composite materials are becoming a sustainable alternative on the global market. Bio-composite material can be made from natural ingredients collected from sustainable resources like natural fibres from cellulose from crops or waste paper and glued together with a resin. The use of bio-composite materials will reduce the negative environmental impact compared to the use of composite materials made from polymeric resin and synthetic fibres. Waternet, Delft University of Technology and the Dutch company NPSP work together in the European project Wider Uptake to produce a bio-composite material made from cellulose fibres recovered from wastewater, natural fibres recovered from grass, reeds and aquatic plants collected during surface water management, and calcite (as filler) recovered from drinking water. Once recovered, these raw materials are glued together with different types of resins. The mixed product is moulded using high pressure and temperature into a bio-composite material. A new material like the one described here can have

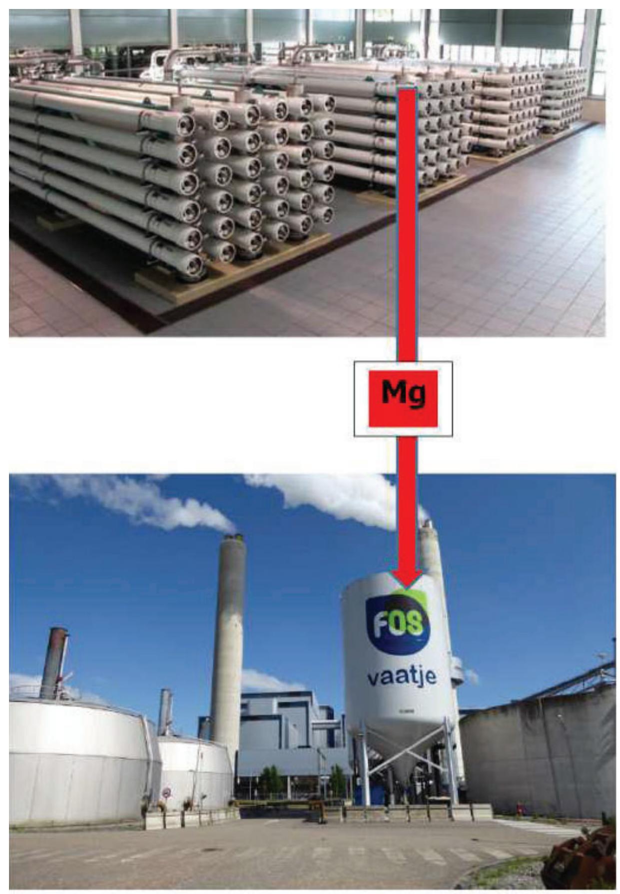

Figure 2: Magnesium recovery from a drinking water production reverse osmosis plant for struvite recovery from wastewater.

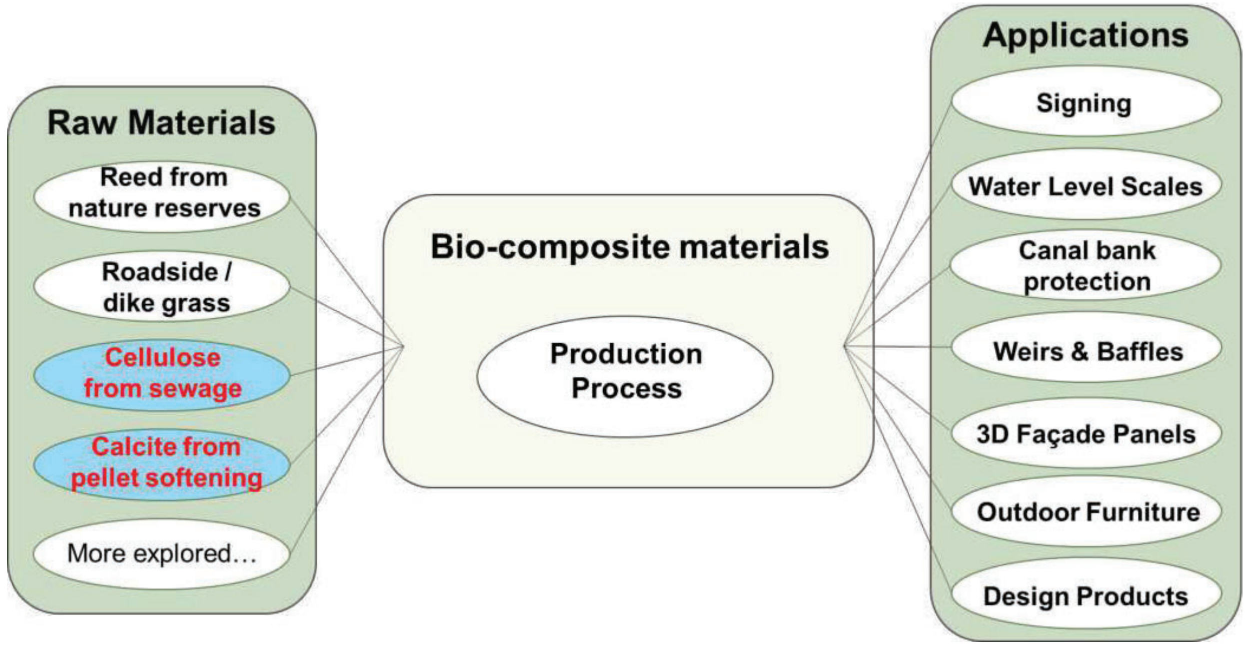

Figure 3: From water treatment and water management residuals to bio-composite material application.

multiple applications such as building construction elements for riverbank protection, creating nautical signs or elements for building facades. Figure 3 shows the process scheme from raw materials to applications. Two PhD students of Delft University of Technology, Anurag Bhambhani and Arianna Nativo, and a postdoc student, Oriana Jovanovic, are involved in this project. They focus on chemical and microbial risk assessment, and circularity and sustainability assessment of bio-composite material production. It is a nice example of combining residues from drinking water treatment, wastewater treatment and surface water management into a high value product.

Using WWTP effluent as source for drinking water production: the Ultimate Water Factory

Recently the RIVM (National Institute for Public Health and the Environment) published the report "Water availability for drinking water production up to 20230: difficulties and solutions". Dutch demand for drinking water is expected to be substantially higher in 2030 than in 2020. Reasons for this include a growing economy and expanding population. Climate change (with warm summers) will push demand for drinking water up even as availability goes down. It is estimated that 100 million m³ more drinking water will be needed in 2030 relative to 2020.

At the same time a new European Urban Wastewater Treatment Directive will come into force. According to that directive the standards for nitrogen and phosphorous in the wastewater effluent will be tightened, while new standards will be introduced for pharmaceuticals and organic micropollutants in the treated wastewater.

That is where Resource and Waste Engineering comes in. On the one hand we need new sources for drinking water production, and on the other hand we have to treat wastewater to a higher effluent quality. Is it possible to use the high quality WWTP effluent as (additional) source for drinking water production? In March this year a consortium of regional water authorities, drinking water utilities and research institutes (KWR Water Research Institute and STOWA) has been established to assess and evaluate this new possibility: "The Ultimate Water Factory". Waternet is a partner in this consortium. We know that technically it is feasible: in Windhoek, Namibia, wastewater has already been used as source for drinking water production since 1968, and in Singapore the NEWater process was launched in 2003. It recycles the treated used water into ultra-clean, high-grade reclaimed water, cushioning the water supply against dry weather and moving Singapore towards sustainability. But what about the acceptance by the customers in the Netherlands? And does it comply with the Dutch drinking water regulations? And does it have effects on the water system as the effluent is not discharged to the surface water but directly reclaimed for drinking water? And what about the economic feasibility? Challenging questions that have to be answered the coming years!

Conclusions

Resource and Waste Engineering is vital for water utilities to contribute to Circular Economy and Energy Transition ambitions. Water management and water technology offer a lot of possibilities. Waternet already implemented some possibilities, and carries out research, in collaboration with Delft University of Technology, to find new and innovative solutions.