Abstract of poster presentation
IWA World Water Congress and Exhibition.
16-21 September 2018. Tokyo, Japan..
https://worldwatercongress.org

Full scale resource recovery from domestic wastewater in Europe

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Keywords: Nutrient recovery; resource recovery; sustainable cities; water reclamation; wastewater management

Abstract: The past decade has seen a rising interest in resource recovery from domestic wastewater. New urban developments allow innovative approaches to transition to more sustainable future cities by greatly increased nutrient recovery and water reuse. This study investigates four sites located in the Netherlands, Belgium, Spain and Sweden that collaborate in new fertilizer production. The larger size of the sites, covering hundreds of dwellings, and the involvement of water utilities shows that domestic wastewater with source separation is becoming a mature resource management system. The study shows detailed material balances and important findings for planners of urban infrastructure regarding energy, water, waste and resources. Being a comparison of larger real life installations, the study shows a possible transition to more sustainable cities of the future.

Background and relevance

The growing urbanization worldwide increases the demand for energy, water and food in our densely populated cities. This urban energy-water-food nexus is rapidly increasing importance when planning urban infrastructure. Domestic water management is especially important in this regard, since domestic wastewater is an important carrier of nutrients and energy and suitable for water reclamation.

A clear example of this importance is the current emergence of larger urban areas with resource recovery in Europe. As seen in Figure 1, areas with source separated domestic wastewater have grown from smaller areas meant for proof-of-concept, into larger areas with up to 2000 person equivalents. Furthermore, a recent study showed that several of these new areas are being built by public water utilities, which emphasizes that source separation systems have now matured into a technological readiness which allows public utilities to invest in them (Skambraks et al., 2017).

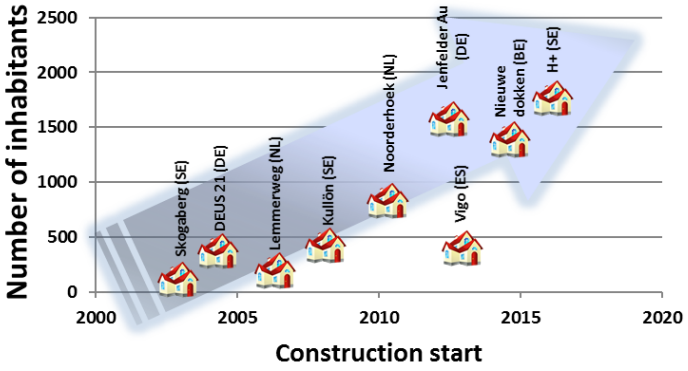

Figure 1. Increased size of urban areas with source separation systems in Europe.

These new pilot areas are focused on blackwater (toilet water) separation from greywater (other domestic wastewater) which greatly facilitates resource recovery since blackwater contains most of the nutrients and organic material in a relatively small flow, whereas greywater represents a large flow containing a low amount of pollutants. In addition, there are synergetic effects by incorporating the organic kitchen waste in the blackwater flow, since it increases biogas production and nutrient recovery, while decreasing the need for waste handling by trucks.

A similarity between the new transition sites with blackwater systems is the use of vacuum technology for transport of the separated blackwater. Some of these transition sites (Figure 2) have heavily emphasized the evaluation of both existing and novel technologies to increase recovery from domestic wastewater. Up to 90-100% nutrient (NPK) recovery is foreseen (several times higher than current P and N recovery rates in Europe, which are usually below 20 % for centralized systems) and obtain >90% water reuse.

As such, these transition sites constitute a path leading to more sustainable cities of the future. This gain can be multiplied by proactive sharing of experiences with government officials and other stakeholders in urban waste and water management. The overall aim of the current study is to compare and quantify the environmental gain of the decentralized nutrient recovery Europe. The results will be presented in comprehensive tables suitable for the target audience; professionals and policy makers working with sustainable future urban water cycles.

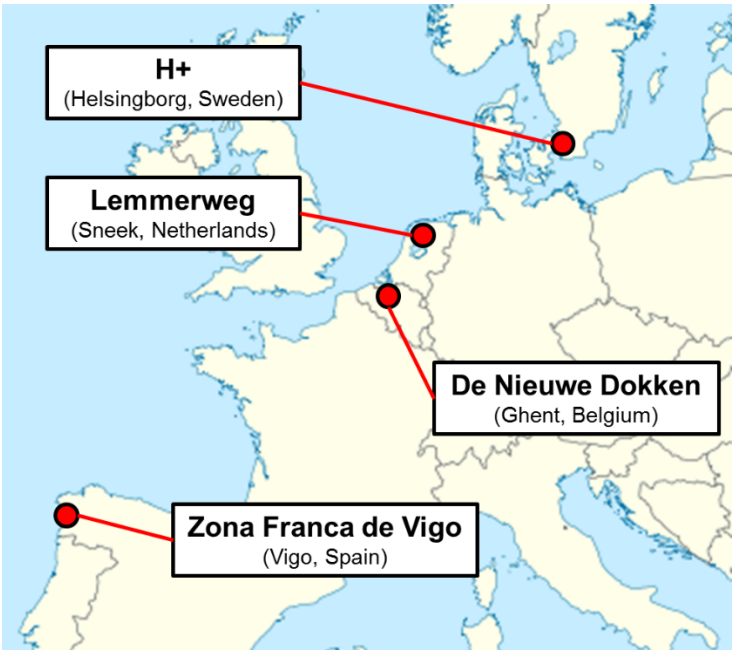

Figure 2. The selected European transition sites that are evaluated in the current study.

Material and Methods

For the study four transition sites with source separation systems were chosen (Figure 2). These sites were selected due their high focus on resource recovery as well as their participation in the Horizon 2020 project Run4Life which facilitates data collection. To get up to date information, technical results were complemented with data collection from interviewing key stakeholders of the different sites. This data, and experiences from sites, will also be updated for the IWA World Water Congress & Exhibition 2018.

Results and Conclusions (to be updated for the presentation)

Although similar in their choice of source separation systems, the respective technologies for resource recovery differ between the sites. The sites with blackwater vacuum system (Ghent, Sneek and Helsingborg) and blackwater gravity system (Vigo) will all have anaerobic digestion as primary treatment of blackwater. This will subsequently be followed by nutrient recovery steps. Additionally, for the sites in Ghent and Vigo, greywater will be processed and reused for toilet refill and irrigation (Vigo) or sold to a local industry for water reuse (Ghent). A joint basic flow scheme of the transition sites is presented in Figure 3.

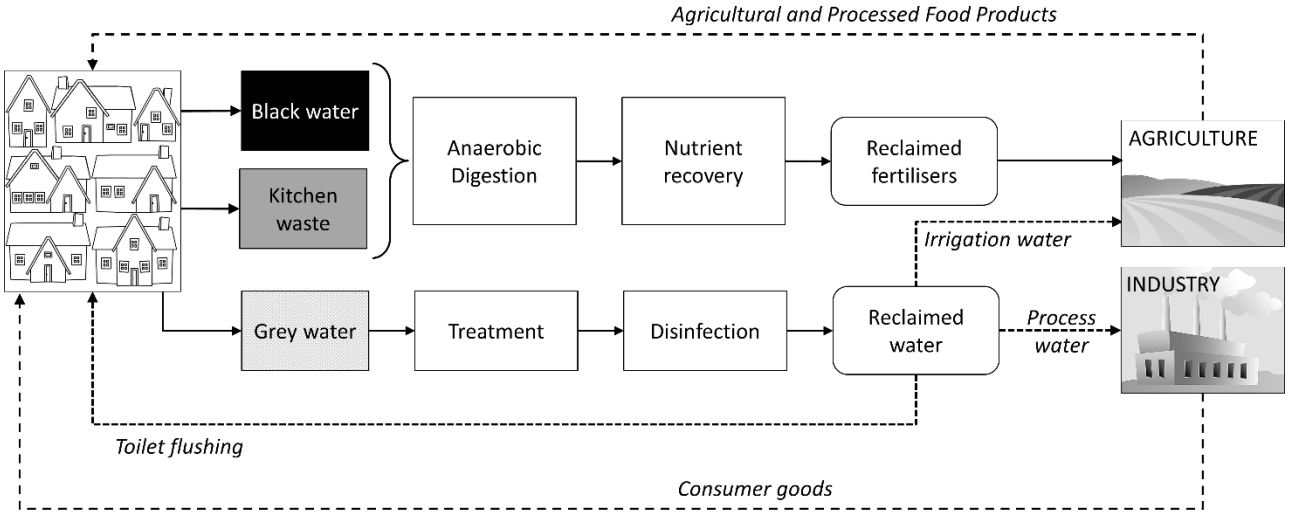

Figure 3. Basic flow-scheme of transition sites with resource recovery from source separated domestic wastewater.

Lemmerweg (Sneek, Netherlands)

The city of Sneek has four areas with source separation systems; Lemmerweg, which has been in operation since 2006; Noorderhoek which has been in operation since 2010 and recently was expanded to ca. 200 households during 2015-2017, the Antonius hospital and the office building of DeSaH / Landustrie. The local treatment plants in the housing estates include phosphorous recovery as struvite and energy efficient wastewater treatment. Main stakeholders are the company DeSaH, the property owners, the municipality, regional water board as well as STOWA (Dutch Foundation for Applied Water Research). Lemmerweg is a proof-of-concept of the Nieuwe Sanitatie (new sanitation) concept, which was developed in the Netherlands during the past 15 years (Swart & Palsma, 2013).

Zona Franca de Vigo (Vigo, Spain)

In the advanced industrial park of Porto do Molle (Nigran, Spain) the main office building is equipped with separated systems for blackwater and greywater. Zona Franca de Vigo is promoting the introduction of innovative water and energy strategies in order to obtain sustainability certificates such as BREEAM and LEED. Greywater is treated in an aerobic MBR and the effluent is reused for toilet refill and garden irrigation. Presently, a new blackwater treatment train with AnMBR + nutrient recovery + disinfection for 150 workers has been started up during of 2017.

De Nieuwe Dokken (Ghent, Belgium)

Located in a former harbour area in northeast Ghent, De Nieuwe Dokken is an urban renewal project with 420 households, offices and a school. The project is operated by a cooperative (DuCoop) who manage wastewater and food waste treatment, the income from heat recovery from greywater and selling treated greywater to a local industry. The economic benefits of the systems will render reduced fees for water and heat for the inhabitants of the area. Construction started in 2017, and inhabitants will move in by the summer of 2019.

H+ (Helsingborg, Sweden)

The urban renewal project of H+ consists of old port and industrial areas. 320 apartments plus offices for 2 000 workers, will have source separation systems. Construction started in 2017 and people will move in during the fall of 2019. To reach its goals, the city of Helsingborg has emphasized co-operation between the municipal waste, energy and water companies (Skambraks et al., 2017). The local treatment plant will be constructed in to a facility for research on source separation systems.

Collection of data and management experiences will continue throughout 2017-2018. Already, some results as well as forecasted results for nutrient recovery and water savings (Table 1). Compared to conventional wastewater treatment (WWT) the transition sites will greatly increase resource efficiency. Nutrient recovery will increase up to 60% for phosphorus (P) or 90% for nitrogen (N) and potassium (K). Importantly, the potential for water saving and reuse will also increase greatly, marking a distinct new regime for water management in urban areas.

Table 1. Results and forecasted impacts of each transition site on key environmental parameters based on previous experience.

	Conventional WWT	Sneek	Vigo	Ghent	Helsingborg
People equivalent	100	70 [a]	150	1280	1650
Greywater flow (m^3/d)	20		7.5	120	
Blackwater flow (m^3/d)		0.50 [a]	7.5	15	20
Kitchen waste flow (m^3/d)					6.5
Water saving (%)	0	>90	50-100 [b]	35	35
Water reuse (%)	0	0	60-80	>80	>80
N recovery (%)	0-20	90	35	>5	35
P recovery (%)	0-20	60 [a]	40	35	60
K recovery (%)	0	90	50	0	0
Biogas (m^3 CH_4/capita/year)	6.0	8.0 [a]	6.7	15.6	13.0

a) Results to date. b) Water saving in toilets.

Conclusions

- Larger transitions sites with resource recovery from domestic wastewater are being built in Europe.
- These sites will greatly increase nutrient recovery and water reuse from domestic wastewater and food waste.
- Up to date experiences and results will be given at the conference.

Acknowledgments

The present work is financed by the EU framework programme for research and innovation, EU Horizon 2020 within the Run4Life project (grant agreement number 730285).

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