Resource-efficient City: Precious Wastewater

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Wood model of the Jenfelder Au new housing estate area, Hamburg. (Photo: H. Lehn)

Since 2007, the number of people living in cities worldwide has exceeded that of people living in rural areas. The billions of urban inhabitants are largely dependent on the surrounding regions. Energy, construction materials, food, water: Nearly everything that is of vital importance is supplied by the countryside. If cities grow – and this is what they are doing to a considerable extent – the countryside has to increase supplies. To prevent this development from resulting in strong conflicts between city and country, we have to make the cities resource-efficient. The principle of "avoiding, reducing, recycling" that is known from waste management should not only apply to household waste, but also to construction materials and reusable civil engineering or operating materials of the city, and above all to water.

Saving drinking water is an important topic. So far, however, discussion has ignored the fact that cities are flow-through systems. They discharge a certain percentage of only partly cleaned wastewater into creeks and rivers. Together with the sewage, also reusable materials are discharged unused. Sewage is no waste, but an important resource! Apart from heat, i.e. thermal energy, and chemical energy in the form of carbon compounds, it contains nutrients urgently required by agriculture, such as potassium, nitrogen, and phosphorus. To better use sewage as a resource, new urban water and sewage management schemes have been developed since the 1980s. Now, consistent further development work is required.

Work should focus on the separate treatment and use of different partial sewage flows. The complete sewage volume is no longer mixed with rainwater from roofs and roads in one sewer system. Instead, various types of sewage are treated and used separately. In a newly developed area in Lübeck, rainwater is separated from toilet sewage (so-called blackwater) and the remaining sewage from showers, bathtubs or washing machines (so-called greywater) and treated separately. Rainwater is subjected to percolation. Greywater is cleaned by vegetated soil filters (so-called constructed wetlands). Toilet sewage is transferred to a biogas facility together with organic waste.

To produce biogas, the sewage must not be diluted too much. The citizens of the Lübeck area therefore use vacuum toilets similar to the toilets of airplanes. Every flush needs less than one liter of water (other toilets require six to ten liters). As a result, drinking water consumption is reduced considerably. A similar approach is pursued by the city of Hamburg in its new settlement project "Jenfelder Au", where about 200,000 people will live from 2016 (Figure 1).

The housing estate project of Arnimplatz, Berlin, has another focus. There, blackwater and greywater of about 40 new apartments are collected separately. A simple heat exchanger transfers the thermal energy of the greywater from the bathtub, shower, or washing machine to the fresh warm water. The cooled-down greywater then is subjected to microbiological cleaning in the basement. After UV disinfection, it is used as water for flushing the toilet again.

Other projects – mainly in Scandinavia and Switzerland – focus on the recovery of plant nutrients. As their concentration is highest in urine, separating toilets are used. Their user friendliness, however, still needs to be optimized.

Concepts for resource-optimized use of partial sewage flows depend on local conditions. All of them require several lines for the supply and removal of various types of water. Although use of partial flows seems to be a far way off, buildings have to be prepared for it now. Architects and engineers are to develop proposals as to what has to be done today when constructing new buildings or reconstructing old buildings. Construction regulations should be adapted accordingly. Also KIT's inventory of buildings is not yet prepared for using partial sewage flows. We, scientists and facility managers, should develop a plan for the adequate reconstruction of buildings and implement it. The users of the buildings should participate in this process. If this process would be included into the education program, this would really be excellent!