DEVELOPMENT OF SOURCE CONTROL SANITATION SYSTEMS IN GERMANY

Li, Zifu; Gajurel, Deepak Raj; Otterpohl, Ralf
Technical University of Hamburg Harburg, Institute of Municipal and Industrial Wastewater Management, D-21073 Hamburg, Germany z.li@tu-harburg.de

System with source control can solve many problems of conventional system. Separate treatment of different domestic wastewater flows makes the recycling of nutrients and water possible. With low- and non-flush water toilets (i.e. composting toilet, separation toilet and vacuum toilet) the volume of wastewater and freshwater consumption can be reduced largely (Table 1). Small volume provides a good condition for wastewater treatment.

Table 1: flush water consumptions daily per capita of different types of toilet

toilet system	conventional without water saving measurement	flush cistern with two different amounts of water	composting toilets	vacuum toilets	separation toilets
water amount per flush	(9 l)	(9 l or 4 l)	(0,2 l)	(1 l)	(9 l or 0,2 l)
water consumption (l/p*d) - daily one faeces flush - daily four urine flush	45	25	1	5	10

In the following some typical projects with source control systems in Germany will be described. Based on the toilet system different domestic wastewater flows are treated in different processes respectively.

In Eco-settlement Braamwisch, Hamburg single chamber composting toilets (biolett-compst toilet or Clivus multrum model) are installed in the households. There are 40 housing units in 5 town house rows and 2 duplex houses in this settlement. The composting chamber is in the cellar and is connected to the toilet seat by a pipe. A ventilator draws air through the composting chamber to eliminate odour in the room and supply the composting process with oxygen. The human excrete is treated together with kitchen waste in the precomposting chamber. For better composting, carboniferous material such as bark mulch or wooden chips must be added regularly and lime to regulate the pH value. After some months the precompost is taken out and composted with bio-waste in the post composting box in the gardens. After more than one year the compost is used as fertilizer in the gardens. The filtrate is used to irrigate the garden or be transported by pump to the settling tank and treated together with greywater in the constructed wetlands. The greywater treatment plant was designed with a size of approx. 2 m^2 per inhabitant. Most of rain water percolates on site. Walks and parking areas are not asphalted but are paved with walking stones, cobble stones or checkered bricks, whereby the rain water can easily percolate in their joints. The remaining rainwater flows through trenching and ditches into a small rainwater retention basin. Almost all inhibitants have a rainwater barrel in their yard to collect rainwater to irrigate their gardens. In figure 1 the schematic of wastewater treatment system is shown.

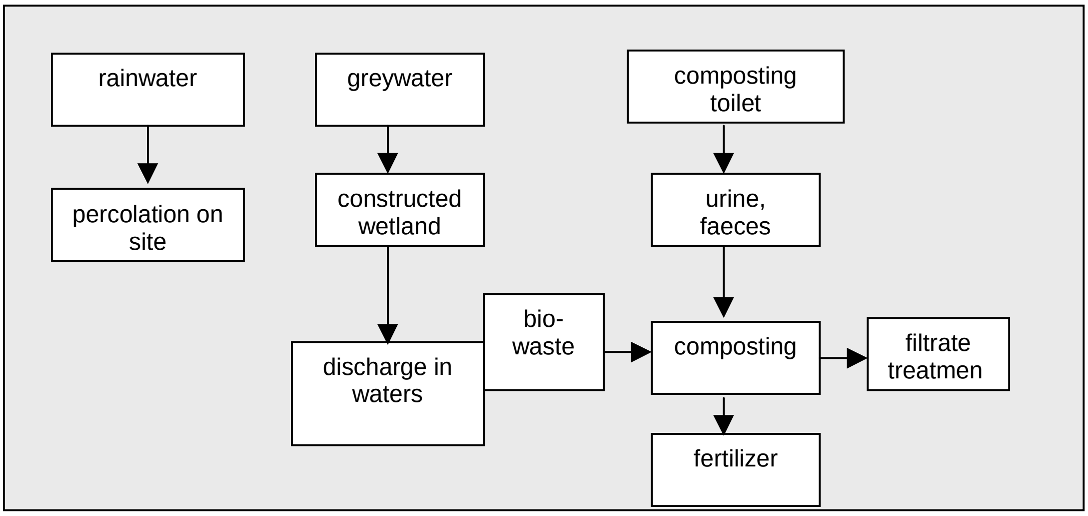

Figure 1: Schmatic of wastewater treatment system with compost toilet in Hamburg

In the historic water mill, Lambertsmuehle in the suburban of Cologne, a newly developed urine-sorting toilet (separation toilet) is installed. Lambertsmühle, which is an old watermill, has been put under preservation order and will be reconstructed to a museum. Separation toilet is similar to conventional toilet, except that it is equipped with a small collection unit for urine and men have to sit during use. Thus the urine is collected separately and led through a pipe to a collection tank for urine. A mechanical device closes the urine pipe when users stand up. It can avoid flush water going into the urine pipe. The urine storage period should be at least half a year, since this is an appropriate time for tank emptying and part of the eventual medicament residues can be destroyed during this time period. An underground dewatering and precomposting tank has been used to intercept the faeces and solids from greywater. No treatment plant is needed for further treatment, local post composting of the tank contents that have already been dewatered and pretreated at least for a year can produce material for soil conditioning. The filtrate is treated together with greywater in a vertical constructed wetland. A schematic of treatment system is shown in figure 2.

In the eco-settlement Flintenbreite, Luebeck vacuum toilets are installed in the households. The area with a total of 3.5 ha will not be connected to the central sewerage system. The settlement will be inhabited by about 300 inhabitants. A schematic of treatment system is shown in figure 3. The sewage is transported by air and pressure differential (vacuum) instead of water and gravity. Water is used only for rinsing the bowl, not for transporting the waste. Limited vertical lifts and long horizontal transportation of the sewage are possible. The little diluted black water is transported to biogas reactor in which black water is treated together with bio-waste from kitchens. After the treatment the hygienic end product is used as fertilizer. At the digestor a vacuum pumping station will be installed. The pumps have an extra unit for the case of failure. Pressure in the system is 0.3 bar operating both the vacuum toilets and the vacuum pipes. Pipes are dimensioned 50 mm to allow good transport by the air. They have to lie deep enough to be protected against freezing and must

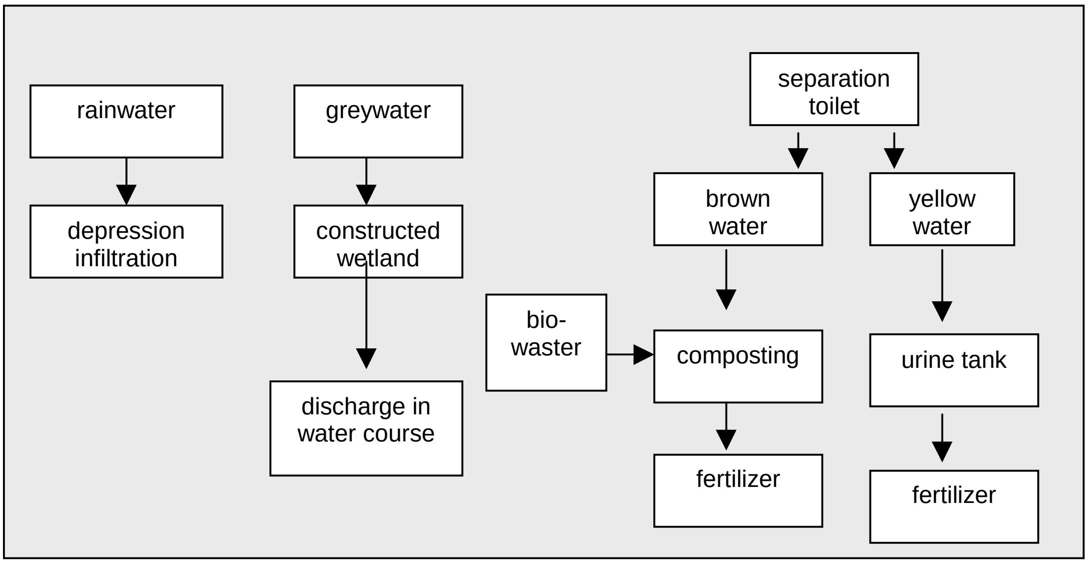

Figure 2: Schmatic of wastewater treatment system with separation toilet in Cologne

have down-bows about every 30 meters to create plugs of the transported matter. Blackwater mixed with the shredded biowaste will be hygienised by heating the feed to 70°C for 30 minutes. The energy is reused by a heat exchanger that preheats the incoming flow. The digestor will be operated thermophilically at around 55°C with a capacity of 35 m^3, which is half of the size compared to mesophilic operation (around 37°C). However, high concentrations of NH_4/NH_3 may occur in operation. In case of difficulties operation will be switched to mesophilic conditions, where the portion of NH_3 is lower at the same pH-value with an additional tank. Another concern is the amount of sulphur in the biogas. This can be minimised by controlled input of oxygen into the digestor or into the gas flow. The biogas is used to operate the heat and power generator.

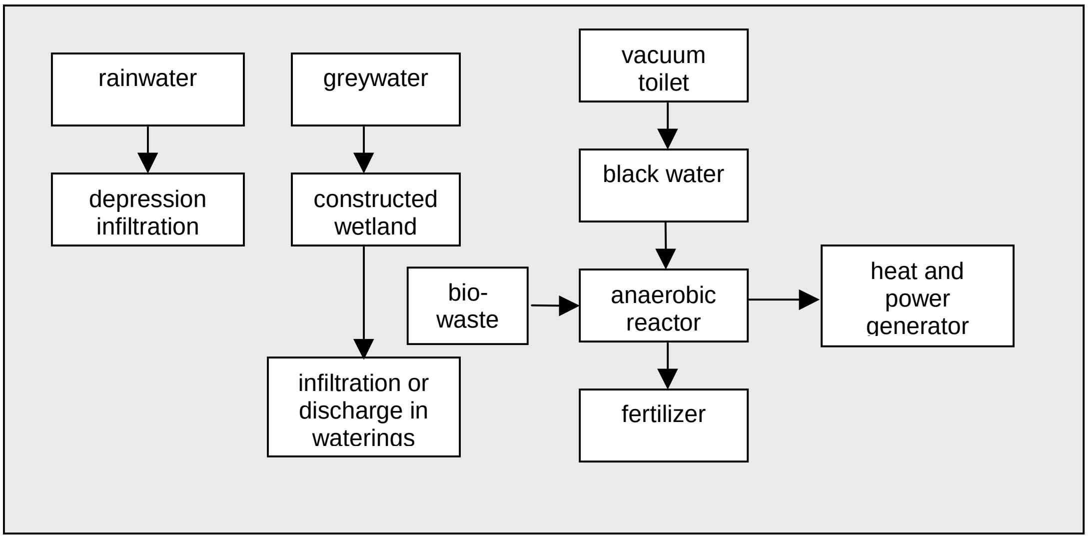

Figure 3: Schmatic of wastewater treatment system with vacuum toilet in Hamburg

The greywater is treated in constructed wetlands with sizes of 2 m^2 per inhabitant. The effluent is preferably infiltrated in the drain trench system for stormwater.

In these three projects constructed wetlands are used to treat greywater because of low maintenance. But other treatment processes like SBR (sequencing batch reactor), biofilm processes etc. can also be used according to local situation. Composting toilet system could only be used in low building, in the rural areas and less densely populated suburban areas. Vacuum toilet system could be used for different settlements, especially urban area with high-rising buildings. Separation toilet may be fit for both rural and urban areas, which can provide a low cost and relatively low maintenance system with a potential of full resource recycling based on the appropriate technical solutions. Perhaps these new systems can be applied in many countries according to local situations and solve the existing problems of sanitation and water management. It is important especially for the developing countries where the agricultural industry plays the main role in the economical development.

Source control system might be a future sustainable sanitation technology helping to save water and to reintegrate the nutrients and treated greywater into the material flows. Since the research about these systems is very limited, there are many questions which should be answered through the investigations. e.g. hygienic investigations of the final product must be done. The final product must be analyzed for nutrients, and nutrient-balances should be made. The content of harmful substances must be analyzed. The appropriate processes to dewater stored urine should also be developed for improvements of the handling of the collected urine.

References

Del Porto, D. and Steinfeld, C. (1999): The Composting System Book. Center for Ecological Pollution Prevention, Massachutts. ISBN 0-9666783-0-3

Esrey, S.A., Gough, J., Rapaport, D., Sawyer, R., Simpson-H?ert, M., Vargas, J., and Winblad, U. (1998) Ecological sanitation. Swedish International Development Cooperation Agency, Stockholm.

Joensson, H; Vinneras, B; Hoeglund, C; Stenstoem: Source Separation of Urine. Wasser & Boden, Nr. 11 (1999)

Otterpohl, R, Albold, A., and Oldenburg, M. (1999) Source control in urban sanitation and waste management: ten systems with reuse of resources. Wat. Sci. Tech. 39(5), 153-160.

Otterpohl, R., Grottker, M., u. Lange, J. (1997) Sustainable water and waste management in urban areas. Wat. Sci. Tech. 35(9), 121-133.

Winblad, U., Kilama, W. (1985): Sanitation without Water. London, Macmillan.