Environmental impact of source separation systems for blackwater, greywater and food waste in the H+ urban renewal project, Sweden.

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Abstract
The study covers an environmental impact assessment of source separation systems for the H+ urban renewal project in Helsingborg, Sweden. Using LCA methodology the study showed that source separation system have a potential to severely decrease the environmental impact of wastewater management compared to today's conventional system. The difference was specifically pronounced for climate impact, mainly due to emission of nitrous oxide in conventional wastewater management. The results showed that source separation systems could have a great potential to decrease environmental impact of wastewater management.

Keywords
Source separation; LCA; sustainable wastewater management; nutrient recovery.

INTRODUCTION

Conventional wastewater treatment is focused on removal of solids and nutrients. However, future wastewater treatment systems should find wastewater as a resource for increased biogas production and nutrient recycling to farmland in order to increase sustainability. Source separation systems, as initially suggested by Otterpohl et al. (2003), has been shown to have the potential to increase both nutrient recovery as well as biogas production (Kjerstadius et al., 2015); thus reaching a more sustainable wastewater management. Today, only a few pilot areas with source systems exist in Europe. Although, the potential for increased nutrient recovery with source separation systems is known challenges with implementing a change of infrastructure is multifaceted. An initial challenge is to accurately describe the total benefit to politicians and policy makers. Although earlier studies of the environmental impact of source separation systems exist (Remy, 2010) no study has included the entire chain from collection in households, treatment and return to agriculture. This study aimed to mitigate this gap by performing and extensive LCA of source separation systems compared to conventional systems with the aim of find the overall environmental impact.

MATERIAL AND METHODS

The study considers two hypothetical urban areas of 120 000 inhabitants were the infrastructure for food waste and wastewater is to be "built from scratch". One system represents what today is conceived as a conventional system in Sweden while the other is a source separation system as explained in detail by Kjerstadius et al. (2015). Each system includes infrastructure for collection, transport, treatment and nutrient recovery, as well as machinery for nutrient spreading on farmland or disposal of sludge as construction soil.

An attributional LCA was performed comparing the two infrastructure systems. For environmental impact attributional LCI-modelling was used using SimaPro software. All processes were modelled using average European data (RER) if available in the ecoinvent database (ecoinvent, 2013). If not,

global average data (GLO) was used. Adjustments of ecoinvent data were done to Swedish conditions when relevant (mainly for production of chemicals).

RESULTS AND DISCUSSION

The results from the environmental impact (Figure 1) generally show a decreased impact of the source separation system in comparison to the conventional system. Specifically, the impact on climate change and acidification can be drastically reduced with source separation system. In regards to climate change the main contributor for the conventional system is emissions of nitrous oxide from biological denitrification in the treatment plant, a finding that is supported by the results of Gustavsson & Tumlin (2013). This impact is decreased for the source separation system due to nitrogen recovery by ammonia stripping. For acidification the reduced impact of the source separation system is caused by replacing mineral fertilizer (especially nitrogen fixated through the Haber-Bosch process). For marine eutrophication the decreased impact of the source separation system is less pronounced and for freshwater eutrophication the impact of the source separation system is slightly higher than for the conventional system due to the use of NaOH in ammonia stripping. Overall it seems clear that source separation systems generally have a lower environmental impact than today's conventional system and thus would constitute a more holistic and sustainable practice of wastewater management.

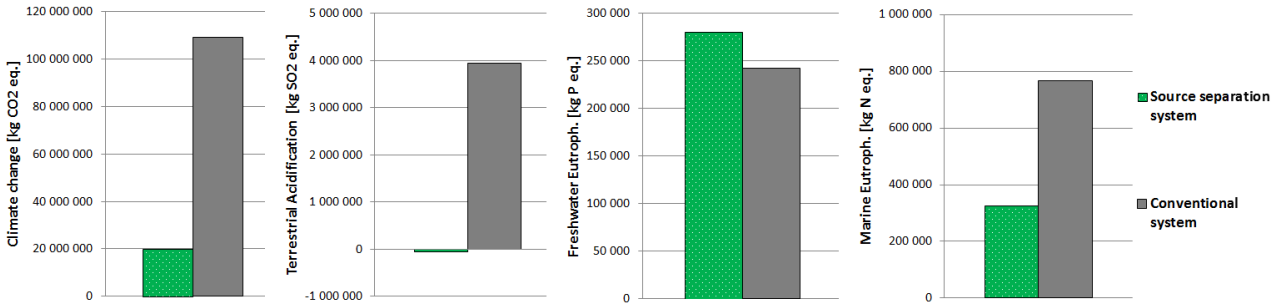

Figure 1. Results of LCA for impact categories climate change, terrestrial acidification, freshwater eutrophication and marine eutrophication.

CONCLUSIONS

The environmental impact, and especially the climate impact, of domestic wastewater management can be severely decreased with source separation systems compared to conventional management. In addition to previous knowledge of increased potential for nutrient recycling with source separation system a shift in urban wastewater management to source separation systems would thus promote a more holistic and sustainable sludge management.

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