SANIRESCH

Research Project SanitaryRecycling Eschborn (SANIRESCH)
Project component: Economic Feasibility

1. Background

In this project component, the investment and reinvestment costs of the system and the running costs for its operation were determined. Additionally, the system was compared with a conventional system to find out the overall costs for implementing such a system as well as to determine the most vulnerable and sensitive parameters which might result for or against the selection of such an implementation.
Moreover, two ways of urine reuse that have been investigated in the project "application of urine after storage" and "MAP (Magnesium-Ammonium-Phosphate) precipitation and utilisation of the product in agriculture" were analysed and compared with the costs for applying a mineral fertiliser.

2. Material and methods

The dynamic cost comparison of LAWA (2005) identifies the most cost-efficient solution for water and wastewater projects. Based on scenarios the total project costs (TPC), the annual project costs as well as the dynamic project costs of the SANIRESCH scenarios were calculated along the LAWA guidelines. The economic feasibility of the SANIRESCH concept was investigated with two analyses (see Figure 1) which considered the complete office building and not only the middle part within which the alternative concept was implemented.

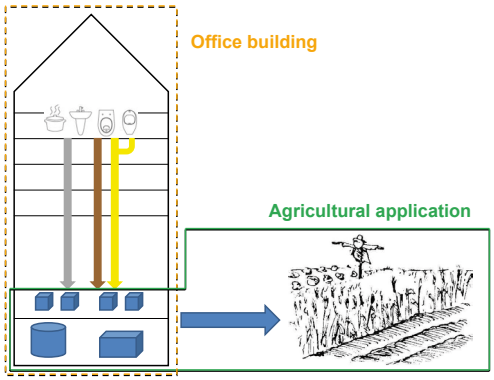

Figure 1: Displays the two systems considered in the economic feasibility analyses, "Office building" and "Agricultural application", with their system boundaries and the areas of overlap.

Economic feasibility analysis „Office building"

Within the analysis "Office building" the following three scenarios were investigated *Scenario A:* SANIRESCH system and the pick-up of the stored urine by the farmer; *Scenario B:* SANIRESCH system with MAP precipitation and direct sale at the building; *Scenario C:* Conventional wastewater system.

Different sensitivity analyses were conducted such as increased automation within the process of MAP precipitation, increased durability of the spare parts of the NoMix toilets and reduced investment costs for sanitary equipment.

Economic feasibility analysis "Agricultural application"

Within the analysis "Agricultural application" three scenarios were investigated combined with different logistic variations *Scenario I:* Urine application after storage within the office building; *Scenario II:* Urine application after storage close to agricultural areas; *Scenario III:* MAP application with storage of MAP within the building; *Scenario IV:* conventional fertiliser application by the mineral fertiliser Calcium-Ammonium-Nitrate (CAN). Different sensitivity analyses were considered such as a decrease of urban land prices in Eschborn, rise of phosphor price and reduction of costs within the MAP production.

3. Results and discussion

The economic feasibility analysis of the office building shows that there is a large difference between the two SANIRESCH scenarios and the conventional one (see Figure 2). The differences come especially through the higher running costs. Their influence is higher than higher investment costs originating from the triple pipe system and higher prices of toilets and urinals.

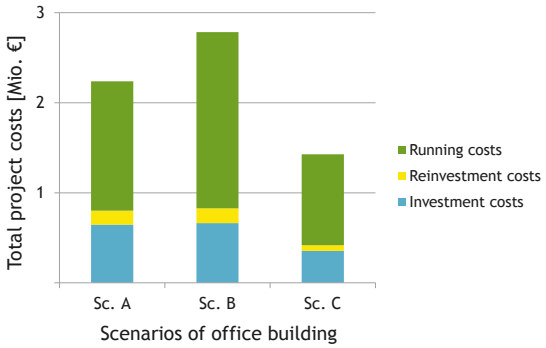

Figure 2: Total project costs of "Office building": A - SANIRESCH with urine application, B - SANIRESCH with MAP precipitation, C - Conventional system.

A high sensitivity is shown within a rising automation of the MAP precipitation process. Currently, 4.35 h/batch of manual labor is required. If the process automation rises up to 75-95%, the TPCs are reduced by 9.8 and 12.4% respectively. However, further aspects have to be adopted before reaching the TPCs of the other two scenarios.

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The rise of durability of the spare parts of the NoMix toilets and a decrease of the investment costs for toilets and urinals result in a clear cost reduction. If spare parts, currently holding an average lifetime of 495 days, last for 30% longer and investment costs are reduced by 25%, the DPCs for scenario A are 6.89 and for scenario B 9.5 €cents/use compared to 6.65 €cents/use of the conventional system. The economic feasibility analysis of the agricultural application showed that due to high land prices within urban settlement areas, storage of urine is much more attractive close to the agricultural areas holding lower land prices (see Figure 3). However, here the transportation costs are much higher. For all scenarios, transport performed by the farmer is always the most economical alternative. Much more expensive than the urine scenarios is MAP production and application. The main cause are the high treatment costs consisting of up to 78% of manual labor costs.

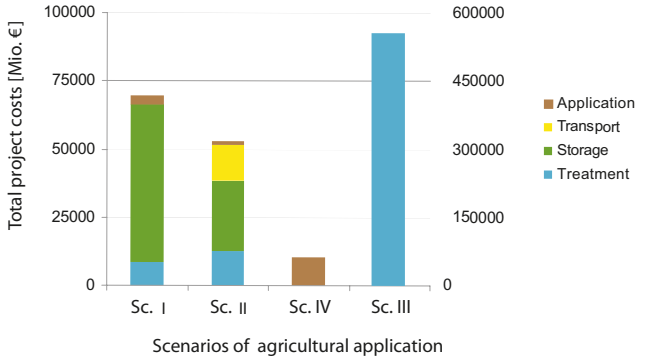

Figure 3: Total project costs for „Agricultural application" of the four scenarios: Direct urine application: I - Storage at GIZ, II - Storage close to fields; III - Production and application of MAP; IV – Application including purchasing of a mineral fertiliser (CAN). The cheapest option of each scenario is shown. Scenario III orients itself at the right y-axis. For further details see Winker et al. (2012).

The fertilising costs per hectare show that comparing the costs for Scenario I-III with Scenario IV, both alternative fertilisers are more expensive. Urine costs result in 748 € ha^{-1}, for MAP 46.800 € ha^{-1} and CAN 124 € ha^{-1} were calculated. While urine still remains in the same range as CAN, MAP is 400 times more expensive, as a result of the high production costs. The sensitivity analyses show clearly that a reduction of the land price in Eschborn from 500 to 100 € m^{-2} would decrease the costs for the urine scenario I to 530 € ha^{-1}. If additionally, a storage without ventilation (leading to less volatilization and thus to higher concentration of nutrients) is considered, the costs for scenario I drop to 228 compared to 296 € ha^{-1} in scenario IV. However, the analysis did not show a severe impact if just the phosphor price increased. When the agricultural scenarios are considered without treatment costs, as already included in the analysis "Office building", the picture changes. TPCs, now including only transport or purchasing and application, for the scenarios with urine application decrease only slightly by 9-24%, where costs of scenario III are reduced by more than 100% showing the potential attractiveness of MAP production.

4. Conclusion and outlook

Comparing the costs for SANIRESCH with today´s costs for conventional wastewater treatment and standard commercial fertiliser, the alternative system is more expensive for both "Office building" and "Agricultural application". However, the sensitivity analyses show that a certain potential exists. With augmented durability of the spare parts of the NoMix toilets in combination with reduced investment costs of sanitary equipment, the alternative scenarios, especially Scenario A can reach the costs of a conventional system. Both changes are reasonable when the development of the toilet and a wider interest in such alternative treatment systems continues. If additionally a higher automation of the MAP precipitation is achieved, Scenario B can become economically feasible as well. Regarding the agricultural application, it is obvious that the urine scenarios can become economically feasible when the conditions of the site are suitable. The use of MAP as a fertiliser is only realisable when the production costs stay below those for commercial phosphorus fertiliser.

5. Major references

LAWA (2005): Guidelines for execution of dynamic cost comparison, Länderabeitsgemeinschaft Wasser (LAWA), Unterausschuss Wirtschaftlichkeitsfragen in der Wasserwirtschaft, Kulturbuchverlag, Berlin, Germany.

Winker, M., Schröder, S., Bischer, L., Arnold, U. (2012): Wirtschaftliche Aspekte des SANIRESCH-Konzepts und relevante Erfolgsfaktoren, in: NASS-Tage, Neue Wasserinfrastrukturkonzepte in der Stadtplanung, DWA, 6.-7.11.2012.

6. Acknowledgements

This research was realised within the research project SanitaryRecycling Eschborn (SANIRESCH) and supported by the BMBF (Federal Ministry for Education and Research), fund No. 02WD0947. The authors thank the BMBF for the financial support and Andrés Lazo Paéz, Christina Braum, Lisa-Marie Bischer and their supervisors for their valuable contributions.

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Publisher: Coordination by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
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October 2012