An Optimization Tool for the Transformation of Wastewater Systems

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A software-based optimization and decision support system can enable the systematic analysis and multi-criteria evaluation of future scenarios and options for action. A problem-oriented visualisation with intuitive recording of results is particularly important for achieving a high transparency of results and a good understanding among the model application's target groups.

Keywords - Optimization, transformation processes, visualization, decentralized water technologies

I. INTRODUCTION

Future developments like demographic and climate change as well as changes in the energy sector have an impact on the long-established municipal infrastructures of water supply, urban drainage and wastewater disposal systems. Innovative sanitation systems in combination with source-based stormwater management measures enable the transformation of existing systems to new decentralized concepts of wastewater disposal. The challenge is to assess these new solutions and combinations of adaptation measures and to estimate the effects on the existing infrastructure.

II. MATERIAL AND METHODS

In the BMBF (German Federal Ministry of Education and Research) – research project SinOptiKom an innovative software-based optimization and decision support system for long-term transformations of wastewater infrastructure has been developed. The overall structure of the software based optimization system consists of and integrates three components. These components are mainly a pre-processing tool with a database and a scenario manager, a mathematical optimization model and an interpretation tool [1,2]. In order to determine an optimized transformation strategy of urban drainage systems, a mathematical model based on integer linear programming (ILP) is used. Input data and generated results (e.g., geodata, demographic data or adaptation measures) are stored in a knowledge and evaluation data base [3]. The developed scenario-manager enables the generation of comprehensive scenarios by combining different drivers. The system uses user-specific evaluation criteria and visualizes transformation processes including their effects and time-dependent costs.

III. RESULTS AND DISCUSSIONS

The optimization system has been applied to two individual municipalities for a time period of 50 years (Fig. 1). The model application demonstrates that "optimal decisions" are significantly influenced by the level of importance given to the single evaluation criteria. Decentralised measures for the separation of material flow with separated blackwater and grey water treatment and the establishment of decentralised wetlands are selected in cases in which both flexibility and the conservation of resources take on considerable weight. A standard level of importance given to cost, on the other hand, leads to the preservation of centralised systems. Decentralised measures for the separation of material flow with separated blackwater and grey water treatment and the establishment of decentralised wetlands are selected in cases in which both flexibility and the conservation of resources take on considerable weight. A standard level of importance given to cost, on the other hand, leads to the preservation of centralised systems.

Fig. 1. Display in demonstration model: Existing sewers in selected residential areas in the year 2060.

IV. CONCLUSIONS

The presented method and general adaptation strategies can be applied to settlement areas facing the same challenges. The demonstration and visualization of different solutions for an expedient future transformation of wastewater infrastructure is a great benefit for planners, engineers and political decision-makers.

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