INTERACTIVE DECISION SUPPORT SYSTEM FOR THE VISUALIZATION OF LONG TERM TRANSITION AND TRANSFORMATIONS OF THE URBAN WATER SYSTEMS

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At present, urban water management in the international context is facing big future challenges and the alteration of objectives and concepts as well. Traditional urban water systems generally depend on centralized collection, distribution and treatment operations. In this conventional system, water is obtained by users through large scale piping network. In industrialized countries, the predominance of centralized water and wastewater systems has led to high-level water consumption, large-scale water distribution systems in combination with the transfer of water over long distances. Main consideration in this system has been based on public health and sufficient supply (Moglia et al. 2010). This often requires the application of chlorine to provide for drinking water quality for the consumers. Conventional wastewater disposal, based on underground sewer pipes and end-of-pipe treatment neglects the potential resource of nutrients (organic carbon, nitrogen, phosphorus) and energy (organics, wastewater temperature) – and water. Such current municipal water and wastewater systems would not meet the criteria of sustainability. However, there has been growing concern on ecosystem and sustainability thinking and many researchers have agreed on a need of shift towards new paradigm for future urban water management system (Sophocleous 2000, Carmon and Shamir 2009, Sanguanduan and Nititvattananon 2011, Alves 2008).

While economic and social elements of the urban environment have changed by modern technology, the need for innovative urban water management approaches will emerge (Daigger, 2007). Fast population and economic growth in some areas, decline in others, and possible effects of climate change on the amount, the spatial and temporal distribution of rainfall will affect the availability of water and the demand for it. Planning will face high uncertainties, as these changes can hardly be predicted over the life-cycle of water infrastructure. Thus, new concepts of urban water management will need to show high flexibility and allow continuous adaptation to future developments and needs. The transition and transformation of existing centralized urban water systems to sustainable water systems is a highly complex and long-term process. During this process, it is fundamental that the system provides a reliable performance as well as sufficient supply, disposal and environmental protection. At the same time, sustainability criteria evaluating the extent of water reuse, nutrient recovery and energy gain from the wastewater need to be observed. Only a computer-based decision support that visualizes the options and possible consequences of any action taken in the future will allow planners, engineers and operators to come to near optimal solutions.

The transition and transformation of existing centralized urban water systems to sustainable water systems is a highly complex and long-term process. During this process, it is fundamental that the system provides a reliable performance as well as sufficient supply, disposal and environmental protection. At the same time, sustainability criteria evaluating the extent of water reuse, nutrient recovery and energy gain from the wastewater need to be observed. Only a computer-based decision support that visualizes the options and possible consequences of any action taken in the future will allow planners, engineers and operators to come to near optimal solutions. Quite a number of approaches exist to find sustainable future system solutions using decision support systems – also in combination with visualization (GIS). However, there is a clear lack of methods that actually include the processes and distinct decisions and actions within the period of system transformation.

In this research, a decision support system methodology for transformation of existing centralized urban water system to de-centralized water management is proposed. A study area composed of

Otterbach, Winnweiler, Weilerbach, Rockenhausen, Meisenheim, Wolfstein, Altenglan, Alsenz, and Lauterecken is selected and current performance of the study area is analyzed by using EPANET software. Sustainability objectives are identified in accordance with the current literature review and the interviews with the Technische Werke Kaiserslautern (TWK). Each of these objectives represented as penalty curves and Multi-Criteria Decision Analysis (MCDA) is performed in order to calculate sustainability performance of the study area. After unfeasible locations are identified, future scenarios which represent system transformation and future actions with respect to changing constraints (e.g. climate change, population decrease, and change in water consumption patterns) are proposed. The overall objective of this research is the development of an interactive system for the modeling, simulation and visualization of the long-term transformation of urban water systems.

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