Development of a Tool to Analyze Wastewater Treatment Sustainability: Indicators to Assess Technologies for Rural Areas in Developing Countries

Extended Abstract

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Background

Around 37 % of the developing world's population – 2.5 billion people – lack of improved sanitation facilities (UNICEF, 2012). Many constraints, such as country's development priorities, financial restrictions, specific geographical conditions, society's particular mindset or setting priority on energy supply issues place sanitation development in lower priority. Therefore, implementing the most appropriate and sustainable wastewater technology and management, which considers these constraints as well as local potentials, can help to solve the problem. Sustainable technology is, amongst others, defined as technology that does not threaten the quantity and quality (including diversity) of resources. As the quantity and quality of the resources and the resilience of the environment to emissions change over time and space, the most sustainable technological solution will change accordingly (Balkema *et al.,* 2002). Sustainability of a technology depends strongly on its relation with local conditions (idea of appropriate, socially embedded technologies). To analyse the sustainability of technological solutions, analysis on the interaction of technologies with several dimensions (environment, society, economic) is required. This paper presents a methodology and results concerning wastewater treatment sustainability assessment indicators, which allow for taking into account particular local conditions. The indicators serve as a decision support tool to select the most appropriate wastewater technology for particular case studies in developing countries.

Methodology

In order to develop relevant wastewater treatment sustainability indicators in developing countries, two main steps are conducted:

- intensive literature and practical study on wastewater sustainability assessment indicators and particular problems in developing countries,
- utilization of structured interviews to obtain context-specific information from experts, practitioners and government officials, who are working in the field of wastewater treatment and management in Indonesia and other developing countries.

Results

As the first step of the methodology, one set of wastewater sustainability assessment indicators is designed based on the Integrative Sustainability Concept developed by the Helmholtz Association of German Research Centres (Kopfmüller *et al.*, 2001). This concept is translated into general goals for sustainable development, which are further concretized by a set of sustainability rules. Two examples of rules and their relation to sanitation are:

- "satisfaction of basic needs": access to proper sanitation is considered as a basic need,
- "sustainable use of renewable and non-renewable resources": this relates to operation and maintenance of wastewater treatment technologies, which should be considered in decision process.

The rules derived from the Helmholtz concept serve as basic orientation for wastewater treatment sustainability assessment, which is concretized by criteria and indicators. The criteria and indicators are discussed with experts and designed to be applicable for developing countries' context. In proposed sustainability assessment matrix, variables are organized into four hierarchical elements, namely: goals, rules, criteria, and indicators.

Sustainability assessment should be provided in a transparent way, leaving room for adaptation and interpretation suitably considering local conditions (Balkema *et al*., 2001). Therefore the second step is to integrate the local context into the adaptation and selection process of indicators for particular case sudy. In order to select relevant indicators, knowledge on the water-related conditions in the intended area is required. A questionnaire is designed as guideline to obtain information from members of communities and local authorities concerning water-related conditions. It is structured in five parts: (i) social and economic conditions, (ii) water supply condition- including water related infrastructures, (iii) current sanitation practice and solid waste management, (iv) agriculture and farming, and (v) health problems and environmental awareness issues. Finally, discussions with involved stakeholders (community, local authority and institutional) concerning elimination, selection, and ranking (high-low priority) of indicators are conducted. This is also an approach to involve stakeholders in the analysis. Following, exemplary indicators are presented in Table 1:

Table 1. Wastewater treatment sustainability indicators based on Helmholtz concept

Nr.	Rule	Data required	Assessment criteria	Indicators
2.1	Sustainable use of local resources	– Water availability and reliability in service area (lpcd, hours/day) – Identification on local resources (energy sources, local construction material, availability of spareparts within tolerable time of repairement) – Identification of demand on resources recovery	Optimum resources management within the system	Low resources consumption Usable by -product Independency from external sources

lpcd: litre per capita and day

Outlook

As next step, several technology options are analyzed using the selected indicators. In this step technology are analyzed taking into account different aspects of wastewater flow in a system, based on DWA (2008) and Tilley *et al.* (2008). Technologies are analized regarding their input product (type of influent), place of utilization, material flow/transport, treatment process and final products. The result of technologies comparison is presented in a matrix. The results of assessments are presented by a five-level-systematic using (+ +), (+) , (-) , (--) as indications for the degree of sustainability fullfillment of the technology , with reference to the current technology (indicated with 0, for example: simple pit latrine in rural area). A (+) represents higher performance and a (-) represents lower performance compared to the (0) alternative. Additionally, in order to clearly differentiate and prioritize indicators for each criterion, ranking of sustainability indicators which previously has been determined by stakeholders is presented. This ranking is preferred compared to an aggregation of scores into an index, in order to avoid the loss of detailed information.

References:

Balkema, A. J., Preisig, H. A., Otterpohl, R., Lambert, F. J. D. and Weijers, S. R. (2001). Developing a model based decision support tool for the identification of sustainable treatment options for domestic wastewater. *Water Sci. Technol. 43(7), 265–269.*

Balkema, A. J., Preisig, H. A., Otterpohl, R., Lambert, F. J. D. (2002). Indicators for the sustainability assessment of wastewater treatment systems. *Urban Water 4 (2002) 153–161*

DWA (2008). *Neuartige Sanitärsysteme*. DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. Hennef, Germany. ISBN: 978-3-941089-37-2

Kopfmüller, J., Brandl, V., Jörissen, J., Paetau, M., Banse, G., Coenen, R., Grunwald, A. (2001). *Nachhaltige Entwicklung integrativ betrachtet. Konstitutive elemente, regeln, indikatoren.* Sigma. Berlin, Germany

Tilley, Elizabeth *et al*. (2008). *Compendium of Sanitation Systems and Technologies*. Swiss Federal Institute of Aquatic Science and Technology (Eawag). Dübendorf, Switzerland. ISBN: 978-3-906484-44-0

UNICEF. (2012). *Water, Sanitation and Hygiene*. Available at: http://www.unicef.org/wash/ (last access: March 26, 2012)