Estimating Wastewater Quantity and Characteristics at the Village-level

The SECO-funded ESRISS project worked on the development of small-scale sanitation in Egypt's Nile Delta. It developed a tool package to estimate wastewater quantity and characteristics on a village-specific basis that does not require wastewater sampling. Ph. Reymond[1], C. Demars[2], A. Papangelou[2], M. H. Tawfik[3], K. Hassan[3], R. A. Wahaab[3], M. Moussa[4]

Introduction

Many investments in the wastewater sector are literally wasted because of the under- or over-design of treatment plants, resulting in underperformance or costly idle capacity. A major reason for this is because often design parameters are used that do not reflect the real conditions, i.e., using Code of Practices based on urban, not rural data. In the Nile Delta, the Egyptian-Swiss Research on Innovations in Sustainable Sanitation (ESRISS) Project's fieldwork showed that the wastewater in small settlements is very different than that in urban areas, and that these settlements (hamlets and villages up to 5 000 inhabitants) are very heterogeneous (which results, for example, in COD concentrations averaging from 400 to 2 500 mg/L) [1]. As a consequence, there are no one-size-fits-all options and design parameters. Instead, there is the need for a case-by-case approach and, thus, for a simple tool that allows practitioners to estimate design parameters on a site-specific basis, based on the collection of a minimal amount of first-hand data [2].

To address this need, ESRISS developed a tool package that allows practitioners to do relevant assessments of the wastewater situation and to be able to estimate the quantity and characteristics of the wastewater to be treated on a village-specific basis within three days and without wastewater sampling. This latter advantage is crucial as taking representative samples in such villages is very difficult and sometimes even impossible because they often lack accessible outlets or sewer networks. This tool package is a result of the collaboration with the Egyptian Holding Company of Water and Wastewater (HCWW) and its Affiliated Company in Beheira Governorate, taking place under the auspices of SECO's institutional support and in parallel to the World Bank-funded ISSIP project.

A tool combining MFA and field experience

The tool package consists of a user-friendly Excel-based model, and a semi-structured interview guideline for village authorities and a simplified household survey questionnaire (in English and Arabic) for the site-specific baseline data collection (Figure 1). It helps the user focus on collecting the key data in a very systematic and structured way. The tool translates the data into an estimation of future wastewater quantity and characteristics. As a result, data analysis is greatly facilitated and the user saves a lot of time, both in data collection and analysis.

The tool package was developed as follows: the material flow analysis (MFA) method was used to systematically estimate the value of the different sanitation-related flows inside small rural settlements. This led to a MFA model that was validated through its application in villages where sewage sampling was possible (i.e., villages where characteristics of both inflows and outflows were known).

Based on both the MFA model and the baseline data, the tool focuses on the key parameters which vary on a site-specific basis, in this case, the number of inhabitants, the water consumption, the type of sanitation system(s), the interaction with groundwater, the liquid manure production and discharge locations, and the greywater management practices. In a context where it is difficult to get accurate data, the tool supports the user to collect information from different sources and then to crosscheck the results. The user has to select a value for each of the six key parameters. This way, the tool pushes the user to critically assess his data and the creation of a blackbox is avoided.

The daily average and peak value for the following design parameters are computed based on the selected values: the flow volume, BOD, COD, total solids (TS), total suspended solid (TSS), total nitrogen (TN) and total phosphorus (TP). The MFA model is used to estimate the wastewater volumes, nitrogen or phosphorus, whereas BOD, COD, TS and TSS, which are much more difficult to assess within the system, are estimated based on field experience. A village factsheet is automatically produced to synthesise all key data. ESRISS has produced a

Philippe Reymond

Photo 1: Village of Kawm Abu Khalifa, Beheira Governorate.

user manual that includes a step-by-step procedure, and has made this available. [3]

Applications

This is a planning support tool for villages where a sewer network and a treatment plant are being built. Besides permitting sound estimates of the characteristics and quantities of the wastewater to be treated once a proper sewer network is built, the tool assists in comparisons of sanitation system scenarios and estimates of the nutrient contents (nitrogen and phosphorus – in the perspective of optimal wastewater and nutrient reuse). The user can, thus, estimate the impact of different measures.

The tool was first validated in four villages where sewage sampling was possible, allowing for the results of the model to be compared with real sewage characteristics. It was then applied in several settlements in collaboration with different rural sanitation programmes in Egypt.

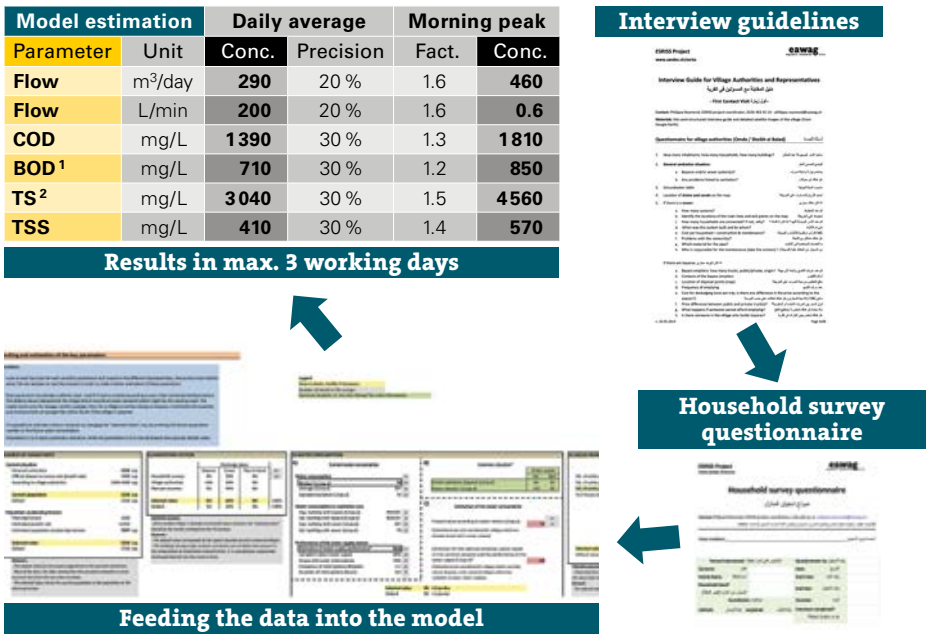

Figure 1: Synthesis of the tool package.

Several research questions could be answered with the MFA model [4]:

a. What are the flow volume and nutrient loads in sewage, respectively, septage? To what extent does the wastewater production increase when a sewer network is built?
b. What influence does liquid manure have on the loads and concentrations of nutrients and organic matter in sewage?
c. Which flow volume and nutrient loads can be isolated through the centralised management of liquid animal manure? What impact does it have on the nutrient loads in sewage, respectively, septage?
d. What are, in terms of reuse potentials and volumes to be treated, the benefits of storing blackwater and animal manure in onsite sanitation systems (e.g., biogas digesters) and of separating greywater?

For example, the study showed that the wastewater volume would increase 67 % when a sewer network is built and that the implementation of a liquid manure management unit permits an average reduction of about 20 % of COD and nitrogen loads in the sewage. The material flow analysis model and results were graphically represented with STAN software.

Adapting the tool to other contexts

The tool is open-source and available at <www.sandec.ch/esriss>. Because it can be applied to any small rural village or settlement, it opens up a large application potential worldwide. Applying the procedure in contexts outside of the Nile Delta requires first, reviewing each baseline parameter and assumption and, if necessary, to replace them with context-specific ones. For example, it cannot be assumed that water consumption patterns or the manure management practices would be identical in every context. The adapted model should then be validated in several villages where the inflows and outflows are known. The user manual describes how the model was developed and how the hypotheses were done. The Excel-based model includes computation sheets which show the model parameters and equations, thus, facilitating any adaptation.

Conclusion

The tool developed by ESRISS constitutes one small step towards an enabling environment for rural sanitation and cost-effective sanitation systems. Its use should support a sound Code of Practice, which should be part of a clear national rural sanitation strategy. In Egypt, a paradigm shift is needed to take up the sanitation challenge of the 85 % unserved rural areas, which includes about 4700 villages and 30000 scattered settlements. This will require constructive coordination among the concerned ministries. As a last outcome, ESRISS intends to translate its extensive experience into a policy paper, and into clear inputs to assist in the development of Egypt's new national rural sanitation strategy.

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[1] Eawag/Sandec, Switzerland
[2] EPFL/ETHZ
[3] Holding Company for Water and Wastewater, Egypt
[4] Helwan University, Egypt

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For more information and to download the documents & tools: <www.sandec.ch/esriss>.

Contact: philippe.reymond@eawag.ch