Policy Recommendations for the Scaling-Up of Small-Scale Sanitation in Egypt

The ESRISS Project Final Report

Philippe Reymond, Rifaat Abdel Wahaab, Moustafa Moussa

ESRISS: Egyptian - Swiss Research on Innovations in Sustainable Sanitation

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Nile Delta youth (picture: Lukas Ulrich, Eawag)

Executive summary

Since May 2010, the Egyptian-Swiss Research on Innovations in Sustainable Sanitation (ESRISS), led by the Swiss Federal Institute of Aquatic Science and Technology (Eawag) in partnership with the Egyptian Holding Company for Water and Wastewater (HCWW) and financed by the Swiss State Secretariat for Economic Affairs (Seco), has been working on the topic of small-scale sanitation in the Nile Delta, and more specifically on how it could be replicated on a wide scale. The project was originally designed as a parallel research component of the World-Bank funded Integrated Sanitation and Sewerage Infrastructure Project (ISSIP) and aimed to support the ISSIP's so-called "decentralised component". The ESRISS project produced policy recommendations, a strong data baseline, a planning tool to estimate wastewater quantity and characteristics on a site-specific basis and endorsed an advisory role for the stakeholders of the sector.

To start with, the ESRISS project reviewed previous small-scale sanitation initiatives in the country. The success and failure factors were investigated in an exhaustive and multidisciplinary way. This research led to the definition of the enabling environment necessary for the expansion of such systems in Egypt. Rather than replicating a large number of discrete projects, scaling up requires integrative management and institutional schemes, innovative financing plans and effective inclusion of the private sector. The results of this first analysis can be found in the report entitled "**Small-Scale Sanitation in Egypt: Challenges and Ways Forward**" and in the addendum entitled "**Factsheets on Small-Scale Sanitation Initiatives in Egypt**", which reviews ten such initiatives in detail. The main recommendations of the report were synthesised in the Research-for-Policy Brief entitled "**ESRISS 10 Points to Move Forward**", available in English and Arabic.

The main recommendations are that, for small-scale sanitation systems to succeed, one has to think in terms of economies of scale, both at implementation and management level. Isolated pilots are not sustainable: past initiatives remained prototypes and, as such, are not cost-effective, do not receive the attention required, are considered too expensive and/or prone to failure, and therefore are not replicated. It is necessary to think in terms of numbers from the beginning, i.e. start with a critical mass of projects that can allow economies of scale, involvement of the private sector and a centralised management scheme. Economies of scale at implementation level can be achieved through standardisation of the sanitation systems. A limited number of simple and robust treatment systems should be selected. Different components of the sanitation chain can be prefabricated, which contributes to lower the costs, improve quality control and significantly reduce the implementation time. In order to further increase the cost-effectiveness, a modular and incremental implementation approach is recommended, with a planning horizon that does not go beyond fifteen years for the treatment units.

Economies of scale at the management level imply the centralised management of decentralised systems. A management unit consisting of engineers specialised in small-scale sanitation systems should be created, with the task to monitor the planning, implementation and operation of the systems in the villages. The policy should enable the private sector and communities to take an active role in managing the systems.

To solve the rural sanitation challenge, it is important to engage the demand and the supply side. How to best encourage the private sector? We recommend to investigate adapted business models for rural sanitation. A starting point could be to try to transpose the business model of compact wastewater treatment plants in touristic

resorts, in itself a market niche, to small-scale rural sanitation. The main difference lays in the incentives to properly run the treatment plants. Proper incentives must be developed for rural sanitation as well.

The lack of baseline data characterising wastewater in the rural areas and hence the lack of context-appropriate design parameters was also identified as a major gap for settlements under 5,000 inhabitants and an important cause of low performance of existing treatment units, either because of over- or under-dimensioning. Rural settlements are very heterogeneous, which prevents the definition of one-size-fits-all options and the use of generic design parameters; instead, there is a need for a case-by-case approach, and thus for a simple tool which allows local practitioners to estimate the design parameters on a site-specific basis, based on the collection of a minimal amount of first-hand data, without having to resort to sampling.

The ESRISS project collected a large amount of data in the Nile Delta, mainly in Beheira Governorate in partnership with BWADC, via interviews with the main sanitation stakeholders at village-level, household surveys and sampling campaigns. Among others, a significant amount of sewage samples from ezbas were analysed, leading to a strong data baseline. The baseline data collected can be found in the report entitled "**Small-Scale Sanitation in the Nile Delta: Baseline Data and Current Practices** - 2nd edition".

Based on the field experience and tools developed (survey and interview guidelines, material flow analysis (MFA) model), the ESRISS project developed a **tool package** for the preliminary assessment of the situation in small settlements (cf. report entitled "**Modelling Small-Scale Sanitation in the Nile Delta: A Material Flow Analysis with Nutrient Reuse Perspective**"). The tool package allows, in a maximum of three working days, to **estimate the characteristics and quantities of the wastewater to be treated**, i.e. to determine site-specific design parameters. It also allows to compare sanitation system scenarios, as well as estimate the nutrient contents (nitrogen and phosphorus) in the perspective of an optimal wastewater and nutrient reuse. The user can thus anticipate a future situation and estimate the impact of different measures. The tool is Excel-based and includes a user manual and step-by-step procedure, in English and Arabic.

As final activities, a **project video** is currently under completion, featuring some challenges and ways forward for small-scale sanitation in Egypt. Three dissemination workshops are also planned for HCWW and all the Affiliated Companies.

This report synthesises the main lessons learnt and recommendations of this five-year project and opens the crucial questions which needs to be debated if small-scale sanitation is to move forward in the country. In a first section, enabling standards are discussed. Then, in the second section, different management schemes are proposed, as well as how to involve the private sector and the communities. In the third section, the benefits of working together with the Ministry of Water Resources and Irrigation are discussed. In the fourth section, the important principles for planning and implementation are reviewed. Finally, the last section provides an outlook of what should be done after the ESRISS Project. **The key messages are brought together in a table next page**.

We hope it will provide the foundation for sound policies and strategies for small-scale sanitation in Egypt, and constitute a solid and inspiring basis for the colleagues who will further address this complex and captivating topic.

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LESSONS LEARNT	RECOMMENDATIONS / WAYS FORWARD
Standards:	
"Everything or nothing" philosophy that hinders the development of intermediate solutions. **COD value (80 mg/L) as a main limiting factor**, significantly lower than the standard in the European Union (125 mg/L).	An **incremental implementation of the law 48/1982** should be agreed upon. If all villages would be served by **advanced primary treatment only**, the pollution load would already be cut of at least 60%.
The fear to be blamed as individual institution is totally counter-productive, but unfortunately still prevalent in the country.	A solution is possible with clear responsibilities on each side.
Management schemes:	
The main concerns expressed by HCWW and its Affiliates regarding small-scale sanitation relate mainly to the O&M of the systems, in particular the human resources required.	**Decentralised sanitation systems require a centralised management.** Need for a dedicated structure, with professionals specifically trained, in order to concentrate the skills. Standardise the systems; this will allow **economies of scale**, thus increasing cost-effectiveness.
Isolated technology pilots fail.	Need for the trial of a **large-scale management scheme**. The establishment of an effective management scheme requires a minimum number of villages served from the start ("critical mass").
Involvement of the private sector:	
Currently, the private sector seems to be mainly playing against small-scale sanitation: high resistance to innovation, lack of know-how in that field, huge overheads, poor construction quality and very long implementation time.	Standardise the systems and prefabricate as many components as possible. Will allow reduction of costs and an increase in quality. Encourage **design-build-operate mechanisms**. Investigate potential business models and necessary legal & regulatory framework.Develop a market niche for small-scale sanitation and identify potential private stakeholders. Train local engineers and masons.
Involvement of the communities:	
Experience shows that the communities are mainly interested in getting rid of the wastewater. Sustainable cost recovery requires the people served by small-scale systems to pay more than what is currently paid by those connected to a large centralised WWTP . **People in the unserved villages currently pay significant amounts of money for sanitation, sometimes 20 times more than those served by**	**There is a capacity to pay**: with a small-scale system, paying a fee allowing sustainable cost recovery would always be cheaper than what is currently paid. An incentive for the communities to pay more is to bundle several services together, for example sanitation and solid waste management. **Beneficial enduses should be sought for** in order to incentivise the communities to take care of their

governmental conventional sewer systems. With an average tariff between 0.7 and 1 EGP/m^3, the villagers pay significantly more than the official water tariff, which is of about 0.25 EGP/m^3.	sanitation system and especially the WWTP. **The provision of technical support to the communities willing to pay for a sewer system should be further extended.**
Synergies with the Ministry of Water Resources	**and Irrigation (MWRI):**
The effluent of a functioning WWTP delivers water that is of much better quality than the receiving water of the drains. It is thus spoilt through mixing. A pragmatic solution is currently hindered by the fear of each party to be blamed in case such a solution ends up not complying with the standards.	**The small drains are a key aspect of the solution for small-scale sanitation in Egypt**. The incremental implementation of Law 48/1982 and the use of small drains are possible **if clear responsibilities are defined on each side**. If it is a national priority, an agreement should be fostered at the Prime Minister or Presidential level. Such an agreement is a key for the successful and cost-effective scaling-up of small-scale sanitation.
Planning:	
The main issue is not technical, but managerial, financial and regulatory. A major failure factor is the construction of infrastructure without knowing who will maintain and operate, who will pay, which skills are needed and who will provide training. In the ISSIP Project, the lack of willingness to discuss the management options and to involve the communities led to four years of sterile technology-focused discussions.	**The management scheme, including mechanisms ensuring sustainable cost recovery, must be validated before the final selection of technical options.** It must be discussed and agreed upon with the communities. Any project should be systematically documented and monitored, in order to generate lessons learnt and reliable data, including flow measurements.
Rural sanitation encompasses a wide diversity of settlements, with highly variable wastewater characteristics; **there is no one-size-fits-all solution.** **General lack of flow measurement.** When a sewer network is built in a village equipped with bayaras, an increase in wastewater production of about 67% is expected.	Enforce a thorough case-by-case preliminary assessment. The ESRISS project developed a tool package for the latter and for the determination of site-specific design parameters. Close inflow monitoring, which allows optimisation and increased performance of the WWTPs. Design the polishing step only after monitoring the effluent of the advanced primary treatment stage. **Modular, flexible systems and limited planning horizons** in order to cope with the high uncertainty of future developments.
The study showed that nutrient reuse is something very important for Egyptian farmers. The diversion of greywater into a simplified sewer network drastically reduces the wastewater volume entering the bayaras and leads to a high concentration of nutrients in the latter.	It is clear that in a **nutrient-reuse perspective**, source separation should be the favoured option.
Know-how about small-scale rural sanitation is missing in the country.	**Training about alternative sanitation systems and the specificities of rural sanitation** are needed at all educational levels and as on-the-job training.

Prioritisation of action:

SHORT TERM:

- Agreement on the incremental approach of Law 48, at least for WWTP < 5,000 PE
- Agreement with MWRI on the use of small drains
- Investigation on business models for large-scale implementation
- Provision of technical support to communities willing to build a sewer network

MIDDLE TERM:

- Implementation of a large number of small-scale systems in a region, allowing a large-scale management scheme

(cf. Scenarios in Section 4.1)

- Engagement of the private sector and local industry
- Adapt water tariffs

LONG TERM:

- Replication of large-scale management schemes at national level

Acronyms

ABR	Anaerobic Baffled Reactor
BOT	Build-Operate-Transfer
BWADC	Beheira Water & Drainage Company
CDA	Community Development Association
COD	Chemical Oxygen Demand
DEWATS	Decentralised Water Treatment System (Borda, Bremen)
EAWAG	Swiss Federal Institute of Aquatic Science & Technology
EEAA	Egyptian Environmental Affairs Agency
EGP = LE	Egyptian Pound = "Livre Egyptienne"
ESDF	Egyptian-Swiss Development Fund
ESRISS	Egyptian-Swiss Research on Innovations in Sustainable Sanitation
GIZ	German International Cooperation
HCWW	Holding Company for Water and Wastewater
ISSIP	Integrated Sanitation and Sewerage Project
KES	Kafr El Sheikh
LE = EGP	Egyptian Pound
MFA	Material Flow Analysis
MOHP	Ministry of Health and Population
MWRI	Ministry of Water Resources & Irrigation
NOPWASD	National Organisation for Potable Water and Sanitary Drainage
NRC	National Research Centre (Markaz El Behoos, in Dokki)
O&M	Operation & Maintenance
PE	Population-Equivalent
PIU	Project Implementation Unit (ISSIP)
PM/TA	Project Monitoring / Technical Assistance
PPP	Public-Private Partnership
RSU	Rural Sanitation Unit
SANDEC	Department for Sanitation in Developing Countries (Eawag)
SDC	Swiss Development Cooperation
SECO	Swiss State Secretariat for Economic Affairs
SPO	Swiss Programme Office
WB	World Bank
WSP	Waste Stabilisation Ponds
WWTP	Wastewater Treatment Plant

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Authors: Philippe Reymond, ESRISS Project Manager, Eawag/Sandec
Dr. Rifaat Abdel Wahaab, Sector Head R&D, HCWW
Dr. Moustafa Moussa, Helwan University

Place and date: Cairo, 2015

Contact: philippe.reymond@eawag.ch
www.sandec.ch/esriss

*This report is a result of the **Egyptian-Swiss Research on Innovations in Sustainable Sanitation** (ESRISS - www.sandec.ch/esriss), a parallel research component of the **World-Bank** funded Integrated Sanitation and Sewerage Infrastructure Project (**ISSIP**); this component is run by the Swiss Federal Research Institute on Water and Wastewater (**Eawag**) in partnership with the Egyptian Holding Company for Water and Wastewater (**HCWW**) and financed by the Swiss State Secretariat for Economic Affairs (**Seco**).*

This report is the final report of the 5-year project (2010-2015). It synthesises the main results and recommendations of the project, as well as highlights the open questions.

1 Introduction

Egypt has a long history of implementing large scale centralised wastewater treatment plants (WWTP). At the time of writing, there are more than 300 such WWTPs all over the country. Egypt has the particularity to be a very flat country, with very high population densities in the Nile valley and delta and a very developed network of drains and canals feeding one of the main wealth of the country, its agriculture. The population is growing fast, as well as urban development. The past five years witnessed a blossoming of new small settlements and anarchic urban developments, taking profit of the power gap resulting by the Revolution and following political instability. If the main cities are increasingly being covered with wastewater treatment, rural sanitation coverage is less than 15%, the concept of "rural sanitation" in Egypt encompassing 4700 villages and 30,000 scattered settlements (Abdel Wahaab, 2015). Thus, "rural sanitation" is about everything between the few very large cities, encompassing very densely populated areas, a large population and very heterogeneous settlements, as shown in Figure 1. The high diversity of settlements and densities make it a complex topic, with the need for different solutions. The estimated amount of money required to fill this gap is about 100 billion Egyptian Pounds (EGP). Taking into consideration the expected increase in prices, this amount may rather reach about 180 billion EGP.

Figure 1: The diversity of settlements encompassed within the "Rural Sanitation" in Egypt *(Source: Google Earth)*

If large scale centralised WWTP are certainly the best option for most of the country, there are many small settlements which cannot be connected cost-effectively. Indeed, the high groundwater table, the need for multiple pumping stations, as well as the complicated network of drains and canals, can result in very high costs per capita. Small-scale or decentralised sanitation (here defined for settlements or groups of settlements of up to 5,000 inhabitants) is a necessary alternative – there is no other choice if such settlements are to be served in a near future. Decentralised sanitation allows a significant reduction of implementation and operation and maintenance (O&M) costs, and the reuse of the treated wastewater and nutrients close to its source.

Since May 2010, the Egyptian-Swiss Research on Innovations in Sustainable Sanitation (ESRISS), led by the Swiss Federal Institute of Aquatic Science and Technology (Eawag) in partnership with the Egyptian Holding Company for Water and Wastewater (HCWW) and financed by the Swiss State Secretariat for Economic Affairs (Seco), has been working on the topic of small-scale sanitation in the Nile Delta, and more specifically on how it could be replicated on a wide scale. The project was originally designed as a parallel research component of the World-Bank funded Integrated Sanitation and Sewerage Infrastructure Project (ISSIP) and aimed to support the ISSIP's so-called "decentralised component". The decentralised component of the ISSIP aimed to serve 120 small settlements with individual small-scale wastewater treatment plants (WWTP), thus providing an alternative for the settlements that could not be cost-effectively connected to the large centralised WWTPs; at the time of writing, it is planned to serve about thirty settlements under this component.

The ESRISS project produced policy recommendations, a strong data baseline, a planning tool to estimate wastewater quantity and characteristics on a site-specific basis and endorsed an advisory role for the stakeholders of the sector. This report synthesises the main lessons learnt and recommendations of this five-year project and opens the crucial questions which needs to be debated if small-scale sanitation is to move forward in the country. In a first section, enabling standards are discussed. Then, in the second section, different management schemes are proposed, as well as how to involve the private sector and the communities. In the third section, the benefits of working together with the Ministry of Water Resources and Irrigation are discussed. In the fourth section, the important principles for planning and implementation are reviewed. Finally, the last section provides an outlook of what should be done after the ESRISS Project.

Throughout the five-year project, the ESRISS Project took the "enabling environment framework" as a basis and analysis grid for its research (see Figure 2). It remains the main figure to keep in mind when perusing this policy report.

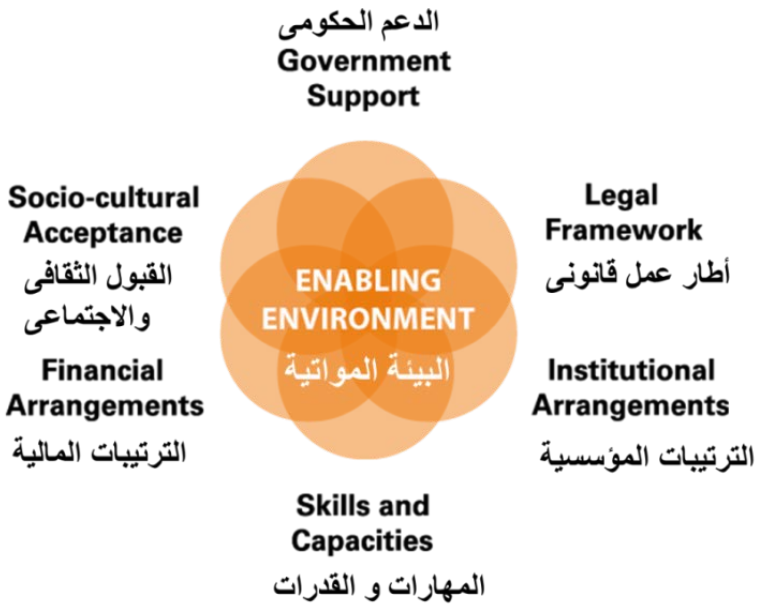

Figure 2: The enabling environment framework (adapted from Luethi et al., 2011)

2 Towards enabling standards

So far, rural sanitation has suffered from an "everything or nothing" philosophy that hinders the development of intermediate solutions

2.1 Effluent quality standards

Currently, the stringent standards of the Water Law 48/1982 "kill" simple but robust solutions and induce complex and costly options that do not work in the long term (O&M, recurrent investment costs, energy, availability of the necessary skills). The main limiting factor in this law is the COD value (80 mg/L), which is even significantly lower than the standard in the European Union (125 mg/L). The dissolved oxygen level (> 4 mg/L) is also a major limiting factor, as it necessitates the implementation of a costly aerobic treatment step.

For small-scale sanitation to reach scale quickly, the effluent standards should be implemented incrementally, or, preferably, differentiated standards should be developed for small communities, e.g. like in the EU (see ESRISS Report "*Challenges and Ways Forward*"). In order to allow cost-effective coverage, it is necessary to have less stringent effluent standards for rural areas.

The Egyptian authorities should take inspiration from countries in the region which have made great advances in terms of water and wastewater management, such as Jordan and Morocco. Both countries have much more pragmatic standards (250 mg/L COD in Morocco; 300 mg/L COD for biological treatment in Jordan). Morocco is implementing an incremental approach for the implementation of the standards. Such an incremental approach is certainly the way to go for the rural areas in Egypt.

Recommendation:

An incremental implementation of the law 48/1982 should be agreed upon as a prerequisite for sound rural wastewater treatment and investment.

In a first stage, the standards should guarantee efficient primary treatment. They could later be increased incrementally when full coverage is reached and funds are available for upgrading. If all villages would be served by advanced primary treatment, the pollution load would already be cut of at least 60%.

In order to practically reach an agreement on an incremental implementation of the effluent standards, there is an urgent need for **constructive institutional arrangements** between the Ministry of Housing, Utilities and Urban Communities (MoHUUC), the Holding Company for Water and Wastewater (HCWW), the National Organisation for Potable Water and Sanitary Drainage (NOPWASD), the Ministry of Water Resources and Irrigation (MWRI) and the Ministry of Health (MoH). There are a lot of common interests and potential synergies as MWRI intends to encourage the reuse of water from small drains and that small drains are the node and the core of the solution, as point of discharge and potential part of the treatment system (see section 0). Small-scale sanitation needs to be a national responsibility and all concerned institutions should together take the responsibility for a common national strategy, under the lead of the President or the Prime Minister.

Way forward:

As a first step, MoHUUC, MWRI and MoH must agree on an incremental implementation of the standards of the Law 48/1982. The interviews showed that a solution is possible with *clear* responsibilities on each side. The fear to be blamed as individual institution is totally counter-productive, but unfortunately still prevalent in the country.

2.2 Planning and design standards

The planning and design standards also hinder the sound development of rural sanitation. In terms of planning, decentralised or small-scale systems should be taken into account from the start for the villages that cannot be cost-effectively connected to the large centralised systems and serious life-cycle cost comparisons should be made. Participatory planning should also be embedded in the planning process. The villagers should be more systematically and transparently involved, in order to avoid conflicts. It would avoid many problems such as experienced in ISSIP, where bad planning and lack of transparency and trust led to many blockages.

Design standards are currently not adapted for the successful implementation of decentralised systems. Alternative sewer and treatment systems need to be included in the standards and Codes of Practice, based on up-to-date knowledge. The simplified sewer system was included recently, but still not systematically considered on the ground. As for technological options adapted to rural areas, they are currently being integrated in the new Code of Practice for Rural Sanitation. These systems should then be promoted among the local consultants.

3 Towards sustainable management schemes

The main concerns expressed by HCWW and its Affiliates regarding small-scale sanitation relate mainly to the O&M of the systems, in particular the human resources required.

In the current circumstances, the main assumptions regarding the management of small-scale sanitation systems are the following:

- The Government cannot manage the expansion of rural sanitation services alone in the short-term; there is a need to involve the private sector and civil society.
- The capacities in HCWW and in the Affiliated Companies are not sufficient; only limited expertise in small-scale sanitation is available and there is little interest for it.
- Small-scale sanitation requires specific skills.
- Some communities are willing to build a sanitation system (at least the sewer network) and to pay part of it.

Our main hypothesis is that a functional management scheme can only be implemented at a large-scale.

Recommendations:

Rather than replicating a large number of discrete projects, scaling up requires integrative management and institutional schemes, innovative financing plans and effective inclusion of the private sector (Eales et al., 2014)**.**

There is a need for a dedicated structure, with professionals specifically trained, in order to concentrate the skills. Decentralised sanitation systems require a centralised management.

It is a necessity to standardise the systems.

The standardisation of small-scale sanitation systems is necessary to allow economies of scale, reduction of costs and an increase in quality.

HCWW and its Affiliates would still be in charge of planning, i.e. determine which settlements should be served through small-scale systems, collecting water and wastewater fees, and then transferring the wastewater percentage of the tariff to the entity in charge of the O&M in the respective villages where it has been collected. Another task of the Affiliated Companies should be to gather the requests from communities and forward them to the centralised management unit.

This chapter looks at how a centralised management unit could look like, at which scale it could be implemented, and how one could start. It also looks in more details at the potential role of the private sector and the communities and how to involve them.

3.1 A centralised management scheme first

What is needed is the trial of a large-scale management scheme.

As demonstrated in the ESRISS Report "*Challenges and Ways Forward*", the isolation of the existing one-off initiatives and the lack of commitment by the government agencies are significant factors preventing the wide-scale replication of small-scale sanitation systems. None of the approaches tested so far has been institutionalised. A clear strategy at a large-scale is needed. It is not a matter of technology selection, and a continuation of yet more pilot schemes should be discouraged. It is only at a larger scale that management schemes enabling the economies of scale necessary for cost-effectiveness and financial sustainability, both in terms of implementation and O&M, can be put in place.

The establishment of an effective management scheme requires a minimum number of villages served from the start ("critical mass").

This critical mass of village should be chosen in the same area, so that it can be centrally managed.

The centralised management unit should provide an **interface** between the institutions, the private sector and the communities. It should enable the private sector to take an active role, for example in the O&M of the small-scale systems or in the prefabrication of modules.

The three main questions to be answered are:

1. How to start?

2. What should be the status of such a unit and where should it be embedded ?
3. What is the setup that would best be able to encourage the private sector ?

3.1.1 How to start ?

Having a "critical mass" of villages is a prerequisite in all cases. Then, there are at least two ways to start:

a. **Incremental approach: start at local level, in a defined area** (in an approach of "strategic niche management", e.g. As Salam or Mahmoudeya Canal area) - such an approach allows to create a centralised management unit for that specific area. This unit would be small, and, as such, could be considered as a pilot. It would be easy to train the staff of the unit and monitor them. Then, in case of success, the unit can be replicated for other areas, or up-scaled to encompass a wider area.

b. **Implement it directly as a national strategy and operate institutional changes** – in that case, a Special Status Unit could be created in order to channel investment, coordinate the initiatives and the centralised management units at a more local level. Such a Special Status Unit could be embedded within MoHUUC for example. In parallel, there should be a structured process of private sector encouragement and niche development for small-scale sanitation systems.

The following sections provide more shape to these two different scenarios. In the current situation, the first scenario seems more realistic.

3.1.2 Incremental approach: a centralised management unit at local level

Starting with a centralised management unit of limited size, dealing with a number of 30-50 villages within one selected area, is the quickest way to get a management scheme validated. It could be tried in the framework of large-scale investment projects targeting catchment areas, such as Mahmoudeya or As Salam area by the World Bank. Such projects offer the critical number of settlements which cannot be connected cost-effectively to the planned centralised WWTPs.

In such scenario, the procedure could be the following:

1. The settlements corresponding to the criteria are identified
2. A joint venture is created for the supply of standardised compact treatment units, which could partly prefabricated.
3. All settlements are served by the same type of treatment system. The private stakeholder is at least responsible of the design, implementation and start-up of the WWTPs.
4. Operation and Maintenance is done ideally by the same stakeholder, which would basically constitute the centralised management unit, but it could be another one. The fees paid by the households must cover the O&M costs and the payment to the centralised management unit must be guaranteed by the Government.

The advantage of this scenario is that the management scheme is tried at a manageable size (in terms of financial and human resources), with limited risk. It does not request major institutional changes and can also fit within programmes of international cooperation agencies, for the joint venture and capacity-building components. It also opens the door to the participation of specialised SMEs.

Table 1 synthesises the potential role of the different stakeholders in this scenario.

Table 1: Potential role regarding small-scale sanitation in the scenario of a centralised management unit at local level

	Current main role	Potential role in this scenario
MoHUUC	Monitoring and validation	Monitoring and validation
HCWW and Affiliates	Planning, supervision of implementation, O&M, fee collection, effluent quality monitoring, lead for the rural sanitation strategy	Planning, fee collection, monitoring (overall and effluent quality) Strengthening the link to the private sector through identifying partners, facilitating joint ventures, providing cost recovery guarantees and, if needed, putting in place licensing and certification mechanisms.
NOPWASD	Not always involved	To be determined
MWRI	Effluent quality monitoring	Effluent quality monitoring; could be a partner for in-drain polishing step
MoH	Effluent quality monitoring; setting up of standards	Effluent quality monitoring; setting up of standards
Private sector	Design, build	Design, build, O&M, manufacturing prefabricated components
Communities	Payment of official tariff	Involvement in the definition of the management scheme; payment of a fee covering O&M cost (i.e. "sustainable cost recovery")

3.1.3 National strategy approach: a Special Status Unit within MoHUUC

This scenario sees big. If a national strategy for rural sanitation is approved by presidential or ministerial decree and enforces a centralised management scheme for small-scale rural sanitation, institutional changes can be operated.

In that case, a Special Status Unit could be created in order to channel investment, coordinate the initiatives and the centralised management units at a more local level. Such a Special Unit could be embedded within the Ministry of Housing, Utilities and Urban Communities (MoHUUC) for example. It could be created either as a new unit, or as an extension of an existing department within MoHUUC's organigram.

Figure 3 features this scenario as a stakeholder relationship diagram.

A "Special Status Unit" functions like a private sector stakeholder, with salaries and working times that are not bound to the government standard practice. Higher salaries and a stimulating working environment are key incentives to attract people with a higher calibre and who will dedicate exclusively to rural sanitation.

The main roles and responsibilities of the unit would be as follows:

1. Be an **interface** between the institutions, the private sector and the communities.
2. **Collect the requests** from the communities
3. **Centralise the funds** for rural sanitation

4. Be a **competence hub** for small-scale sanitation; **manage capacity-building** for the private stakeholders, the local centralised management units and coordinate capacity-building from international partners.
5. **Facilitate the licensing** of private companies engaging in small-scale sanitation
6. **Fostering joint ventures** with international private companies
7. **Monitor the quality** of implementation and O&M

The three main advantages of the scheme presented in Figure 3 are:

- Specialised skills and expertise concentrated in one organisation, working according to a private sector mode.
- Possibility for this unit to channel the funds and have access to a wide variety of donors, on a variety of aspects (technical training, business plan, private sector enhancement, joint ventures, etc.)
- Design-build-operate concept, guaranteeing more sustainability

The foreseen unit would not be a second HCWW in charge of rural sanitation projects, but rather a coordinating agency in this specific field. The potential role of the private sector is discussed in the next section.

Table 2 synthesises the potential role of the different stakeholders in this scenario. Box 1 describes how the procedure could look like for a community interested in a small-scale sanitation system to get it via the Special Status Unit.

Table 2: Potential role regarding small-scale sanitation in the scenario of a Special Status Unit at governmental level

	Current main role	Potential role in this scenario
MoHUUC	Monitoring and validation	Host the Special Status Unit; lead for the rural sanitation strategy, coordination of small-scale sanitation initiatives; manage private sector involvement; monitoring and validation
HCWW and Affiliates	Planning, supervision of implementation, O&M, fee collection, effluent quality monitoring, lead for the rural sanitation strategy	Master planning, fee collection, monitoring (overall and effluent quality) Supporting the private sector through providing cost recovery guarantees and making the bridge with the field.
NOPWASD	Not always involved	To be determined
MWRI	Effluent quality monitoring	Effluent quality monitoring; could be a partner for in-drain polishing step
MoH	Effluent quality monitoring; setting up of standards	Effluent quality monitoring; setting up of standards
Private sector	Design, build	Design, build, O&M, manufacturing prefabricated components
Communities	Payment of official tariff	Involvement in the definition of the management scheme; payment of a fee covering O&M cost (i.e. “sustainable cost recovery”)

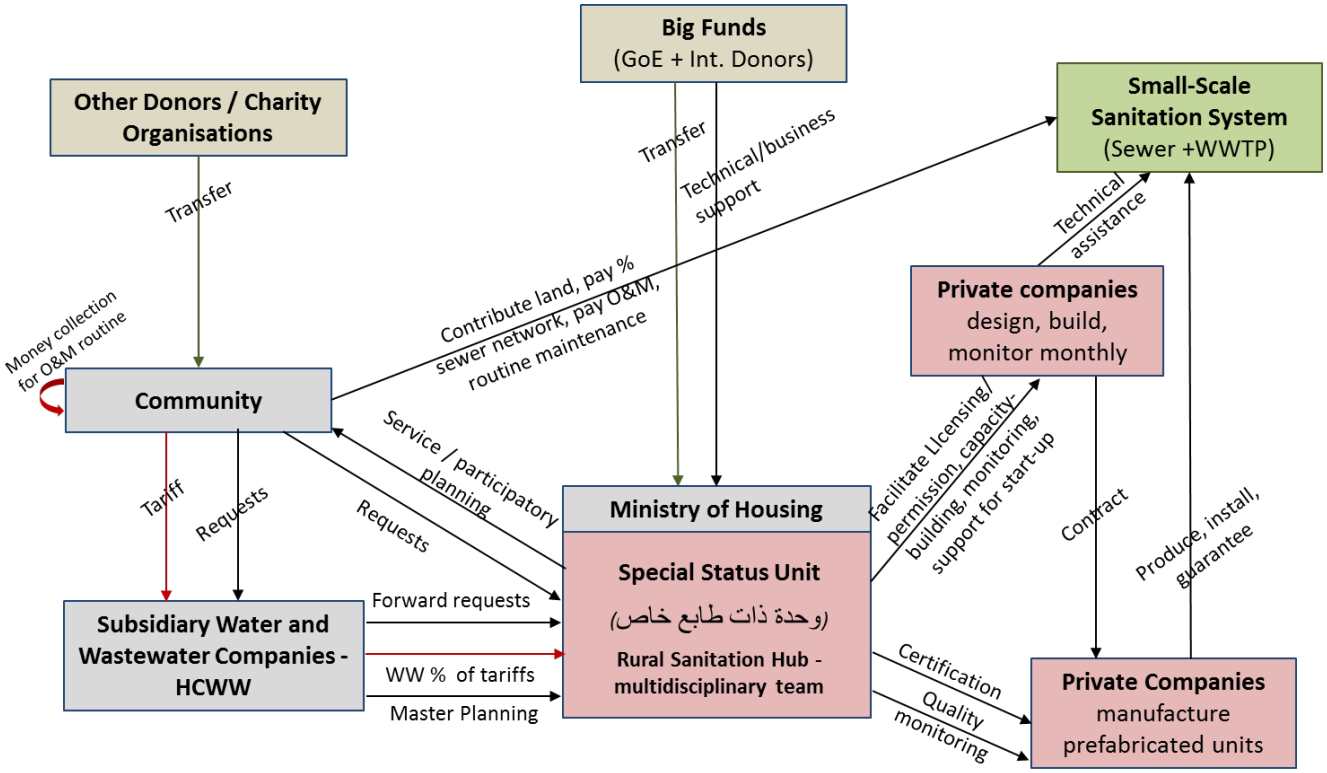

Figure 3: Management scheme with a Special Status Unit within the Ministry of Housing and private companies

3.1.4 Funding potentials

Recommendation:

The proposed management scheme should allow to use different source of funding and generate trust towards the investors.

The money from international banks can only go to governmental institutions, after transiting through the Ministry of Finance. This is one of the major arguments advocating for having the centralised management unit embedded within a governmental institution. The latter setup also makes it easier to channel the money from smaller international donors, as it is becoming more and more difficult to finance NGOs in the country.

The biggest challenge is to attract the private money, from individuals and charities. There is definitely a big potential, as shown at village-level with the willingness of many communities to contribute to part of their sanitation system.

In order to attract private money, there is a need for trust. As an interface between the communities, the institutions and the private sector, the centralised management unit should have a transparent functioning and really be oriented towards public good. If this trust can be established, a quicker coverage will be achieved through an increased proportion of private funds.

Box 1: Synthesis: procedure for the implementation of a small-scale treatment plant

The procedure of how a community interested in a small-scale sanitation system could get it in the second scenario (Special Unit), exemplified through the example of the case of the management setup featured in Figure 2, could be the following:

1. **Process ignition:** A community wants to build a sanitation system. It is ready to pay for part of the sewer network and to donate the land for the pumping stations and treatment plant. It makes a request for support to the Special Status Unit, directly or through the Affiliated Company.
2. **Feasibility study:** The Special Status Unit funds the feasibility study, which leads to a budget for implementation and tendering.
3. **Design-build-operate contracting:** If the project is accepted, the Special Status Unit funds the whole project and assign it to one of the licensed private companies through a bidding process.
4. **Implementation:** the company which won the bidding process gets in contact with the certified companies for the prefabricated units and goes for implementation. The manufacturers of prefabricated treatment unit provide a guarantee of at least two years.
5. **Start-up period:** The start-up period of the biological treatment units is considered as part of the implementation; the final control by the Special Status Unit is done at least six months after the start of operation.
6. **Monthly O&M:** In case of design-build-operate contract, the private company is responsible for the monthly O&M, i.e. checking the performance, reparation needs and monitoring the effluent quality.
7. **Routine O&M:** done by the community.
8. **O&M financing**: through tariffs, collected by the Affiliated Company for the water/wastewater standard tariff and by the community for the extra charge enabling sustainable cost recovery. The Government should also contribute, based on the equity principle, as large centralised WWTPs are also heavily subsidised.

3.2 Role of the private sector

Currently, the private sector seems to be mainly playing against small-scale sanitation: high resistance to innovation, lack of know-how in that field, huge overheads, poor construction quality and very long implementation time.

A paradigm shift is needed to turn the private sector into an ally. As shown in

Figure 3, the role of the private sector would be two-fold:

- **Designing, build and monitor monthly** the small-scale sanitation systems; the design-build-operate type of contracting is overly important here.
- **Manufacture prefabricated components** of the sanitation systems (treatment modules, manholes, etc.), in a first stage through joint ventures or partnerships with foreign companies specialised in this market.

Recommendations:

Standardise the systems and prefabricate as many components as possible.

Encourage good work through design-build-operate mechanisms.

The private sector can be engaged at different levels along the sanitation supply chain: (a) Construction of the sewer system; (b) Construction of the treatment plant; (c) Manufacturing of components; (d) Operation and maintenance. Figure 4 shows different configurations on how a private sector stakeholder can participate in one or several of these levels, with each colour representing a different company. **The question is which configuration could lead to the best service, but also what should be the scale of the companies, i.e. at a local, regional or national level.**

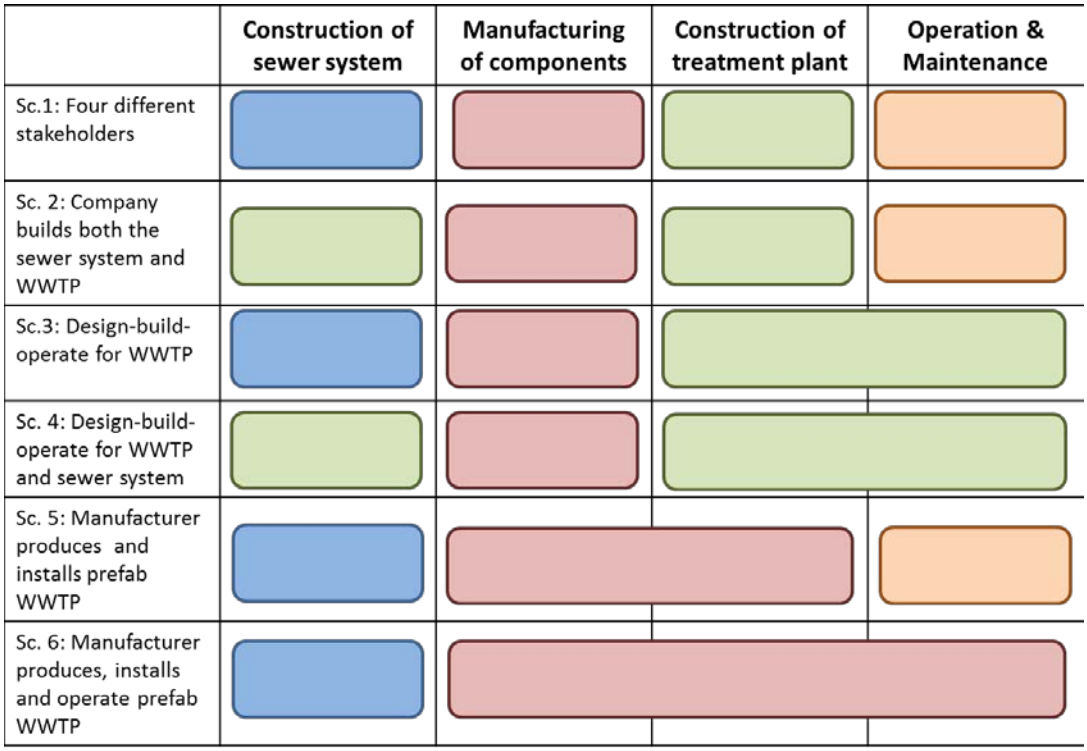

Figure 4: Private sector involvement scenarios along the sanitation supply chain; each colour represents a different private company

Way forward:

There is a need to study the feasibility of each configuration and what are the enabling conditions for each of them. Questions such as at which level/scale they can be viable, potential business models and necessary legal & regulatory framework should be answered.

The challenge is to create this **specific market niche** and build the capacity of the private sector to meet the specific requirements of small-scale/rural sanitation. Only companies that answer given requirements should be allowed to get in. What is proposed instead is the use of carefully selected and trained private sector stakeholders; this selection could materialise through licensing and/or certification.

Small-scale sanitation is a new market in Egypt, and, as such, it has a huge potential in terms of private sector development and job creation.

For the creation of this market niche to succeed, it is critical to develop a solid business model. A feasibility study should be made to convincingly demonstrate that small-scale sanitation is a good business and that it is bankable.

To have the private sector on board, we need to take a business perspective. It is important to build an "incubator" or a "hub", which can facilitate the private sector to enter this niche. The question is where to embed this incubator. At the government level, the Ministry of Investment seems well placed to take such a role, as it has the power and experience to facilitate the emergence of new markets. The national strategy should enable the creation of market niches and job opportunities.

Small-scale sanitation systems function in the touristic resorts, as the enabling conditions are obviously present for this market to work. As for rural sanitation, the enabling environment and the incentives still need to be defined for the private sector to get in.

Recommendations:

Determine which stakeholders have the ability to encourage the private sector, and which stakeholders have an interest in developing the local industry.

Consider both the demand side and the supply side, and take a business-oriented perspective.

Initiate a dialogue between the different concerned institutions and the private sector

International cooperation offices have a role to play here, as most expertise in small-scale sanitation lays abroad, and job creation and economic development is on the top of the agenda. Among others joint ventures should be encouraged.

Recommendation:

Identify potential local manufacturers which could prefabricate components of the sanitation chain and convince them to enter the market.

Private sector encouragement funds could be used to help them go into this new business; here as well, if needed, joint ventures could be created with international companies specialised in compact prefabricated units.

Recommendation:

Train local engineers and masons at governorate-level.

These engineers and masons could then form specialised micro-enterprises or SMEs. There is already such an example in Egypt, which led to the successful scaling-up of household biogas digesters (cf. *ESRISS Factsheets Report*). Local masons and engineers applied for the training and were then taught how to build the digesters and how to run a small business. After that, they received monitoring and coaching during the implementation and operation phase, in order to ensure the quality of their work.

3.3 Role of the communities

The role of the communities is central, as they are the ones to be served.

There are two ways to approach the communities: either it is demand-driven, i.e. the communities address a request either to an Affiliated Company or to a hypothetical Special Status Unit, or it is supply-driven, i.e. a sanitation programme reaches out to them, as is the case in the ISSIP. In both cases, the communities have to be involved from the start in the definition of the management scheme and should agree with their future role and responsibilities.

Experience shows that the communities are mainly interested in getting rid of the wastewater *(cf. ESRISS Report "Challenges and Ways Forward").*

For this purpose, they are ready to gather significant amounts of money and donate land. Very often, they build basic "informal" sewer systems on their own, which results mostly in dysfunctional systems that cannot be connected to a treatment plant (see also Section 5). The task is thus to harness this willingness to participate in order to plan and implement properly designed sewer systems connected to a WWTP.

The level of participation may vary from one community to the other, but the following should be targeted:

- Donation of the land
- Monetary support for the sewer network, in case of expressed demand
- O&M of the sewer network: villagers are used to carry out this task, either themselves or through a dedicated person paid upon service.
- Payment of an O&M fee allowing **sustainable cost recovery**
- Routine O&M of the small-scale treatment plant, in case of WWTP at village-level

The past initiatives in Egypt show that one cannot rely on fully community-based systems (cf. *ESRISS Challenges and Ways Forward Report*). At least the monthly monitoring of treatment plants should remain under the responsibility of experts.

Recommendation:

Sustainable cost recovery requires the people served by small-scale systems to pay more than what is currently paid by those connected to a large centralised WWTP.

If the Government currently does not have enough funds to properly run the latter, a fortiori, it will have little remaining funds for the small-scale ones. It must be seen as a realistic measure to avoid waste of investment. To those who will mention the equity principle, it has to be argued that to the people served by large-scale systems to pay more, and not the contrary.

There is a capacity to pay: surveys conducted by the project showed that people in the unserved villages currently pay very significant amounts of money for sanitation (see Table 3). With a small-scale system, paying a fee allowing sustainable cost recovery would always be cheaper than what they are currently paying.

Table 3: Comparison of the sanitation costs in sewered and non-sewered villages (Beheira Gov.)

	Unit	Haderi *bayaras*	M. Nassar *sewers*	K.Nuss *sewers*	Ashara *bayaras*
Amount for WW services if equal to 35% of the water bill	*LE/cap/mon*	*0.9*	*1.7*	*0.7*	*0.7*
Amount for WW services if equal to 50% of the water bill	*LE/cap/mon*	*1.3*	*2.5*	*1.1*	*1.1*
Bayara emptying	*LE/cap/mon*	28	-	-	16

As shown in Table 2, the costs currently born by the inhabitants for drinking water and sanitation are highly variable. The amount paid for wastewater services from the water bills is insignificant. However,

the amounts paid by the villagers relying on traditional bayaras are sometimes 20 times more than those served by governmental conventional sewer systems. Regarding sanitation costs, there is a high inequity between served and unserved areas.

Regarding the price of drinking water, the results show that, with an average between 0.7 and 1 EGP/m^3, the villagers pay significantly more than the official tariff, which is about 0.25 EGP/m^3. It also shows that, in general, the water bills are not directly linked to the building consumption. It is recommended to cross-check regularly water readings from a few water meters with the respective water bills and what is finally counted at the level of the Affiliated Company. On the positive side, it shows that people are actually ready to pay more than the official tariff.

Recommendation:

Another incentive for the communities to pay more is to bundle several services together, for example sanitation and solid waste management.

Thus, people do not have the impression to pay twice for the same service (on the water bill and to the company in charge of the O&M). Liquid manure management could also be part of such an environmental service. We could imagine having service providers at village-level in charge of the sewer maintenance, solid waste collection and liquid manure collection.

Recommendation:

In order to incentivise the communities to take care of their sanitation system and especially their treatment plant, beneficial end-uses should be sought for.

For example, in the case of effluent polishing through ponds (see also section 0), the farmers would have access to clean irrigation water and could also do a bit of aquaculture. In some cases, biogas could be produced and could be used to fuel a micro-enterprise which could be run by the community development association.

4 Towards synergies with MWRI

There are a lot of common interests and potential synergies between the "wastewater" sector and the "irrigation sector". The former needs the drains for effluent disposal, and the latter needs good quality irrigation water.

Currently, the effluent of a functioning treatment plant delivers water that is of much better quality than the receiving water of the drains. It is thus spoilt through mixing.

The synergies between the Ministry of Housing, Utilities and Urban Communities (MoHUUC) and the Ministry of Water Resources and Irrigation (MWRI) are at least two-fold:

a. Agreement about an incremental implementation of the standards of the Law 48/1982 (see section 2).

b. Agreement on the possibility to use the beginning of small drains as polishing step for the wastewater treatment system.

The small drains are a key aspect of the solution for small-scale sanitation in Egypt.

On the one side, it is the main discharge point for the effluent of small-scale village-level treatment plants. On the other side, MWRI intends to encourage the reuse of water from the small drains. Thus, the small drains should be used for the benefit of both sides. The starting point of small drains can be converted into waste stabilisation ponds in series, as shown in Figure 5. Such a strategy has the following benefits:

1. The effluent polishing is done within the drain space; it means huge savings of agricultural land, as well as capital investment, considering that buying land is very expensive.
2. The farmers are provided with clean irrigation water from the last pond.
3. Aquaculture can be done in the two last ponds, which may be a further incentive for the proper operation of the treatment system.
4. The effluent quality of the waste stabilisation pond system has a quality that is far sufficient for the receiving water body, even if it may not match the Law 48/1982 all the time. The incremental implementation of the standards of Law 48/1982 would greatly help.

The status of such an "in-drain treatment unit" could be the following: the land remains in the property of MWRI, whereas MoHUUC remains responsible for the treatment plant and its effluent, as for any treatment plant.

It appears that such a pragmatic solution is currently hindered by the fear of each party to be blamed in case such a solution ends up not complying with the standards.

Way forward:

The interviews showed however that with the definition of clear responsibilities on each side, such a solution is <u>possible</u>. If it is a national priority, an agreement between the Ministry of Housing, MWRI and the Ministry of Health should be fostered at the Prime Minister or Presidential level. Such an agreement is a key for the successful and cost-effective scaling-up of small-scale sanitation.

In any case, this solution provides a vast improvement to the current situation.

Figure 5: Example of the beginning of a drain converted into waste stabilisation ponds in series (*Sources: Figures from ISSIP PM/TA, Memorandum, Feb. 2013 – Picture from Ph. Reymond, Beheira*)

5 Towards planning guidelines for small-scale sanitation

Planning of small-scale sanitation systems should be carried out as an integrated approach. It is not only about technology selection. The current lack of workable small-scale sanitation solutions in Egypt is due to the exclusive consideration of hardware aspects.

As demonstrated in the ESRISS Report "*Challenges and Ways Forward*",

the main issue is not technical, but managerial, financial and regulatory.

First of all, the management and financial arrangements have to be investigated and discussed with the different stakeholders, including of course the beneficiaries: the communities. Only once an agreement is reached, which ensures sustainable cost recovery for the operation & maintenance, can the final technology selection take place, as a function of the available skills and capacities and financial resources.

In the ISSIP Project, the lack of willingness to discuss the management options and to involve the communities led to four years of sterile technology-focused discussions.

Recommendation:

First and foremost, the management and financial arrangements have to be discussed and agreed upon with the communities. The technology selection should not be finalised before an agreement ensuring sustainable cost recovery is reached.

Planning necessitates both a large-scale overview and a village-level case-by-case approach.

A large-scale overview, because cost-effectiveness can only be reached with the implementation of a large number of projects together and the centralised management of this "critical mass" of units (more details in section 3); a village-level case-by-case approach, because, small settlements are very heterogeneous and one-size-fits all design parameters cannot be provided at that scale (more details in section 5.3).

The key village sanitation stakeholders should be involved in the process from the start.

A major failure factor is the construction of infrastructure before having secured the main roles and responsibilities with the different stakeholders: who will maintain and operate, who will pay and how much and which skills are needed.

Work with the community and local sanitation stakeholders is overly important for sanitation in small rural settlements.

Our study shows that there are no reliable statistics and no reliable numbers regarding critical factors such as the population number, the water consumption and the number of animals.

Even the population number provided by the census often significantly differ from the reality. A thorough preliminary assessment provides context-specific design parameters, which are a key cost-effectiveness factor as they allow dimensioning as close as possible to the needs. Animal manure and effluent of dairy factories need to be considered as parts of the sanitation system. Wastewater, animal manure and stormwater are closely linked in such settlements and should be dealt with together. In many villages, solid waste should also be managed in parallel.

In the past, faulty dimensioning of infrastructure due to the lack of consideration of the actual situation on the ground cost a significant amount of money, in capital and operational costs, and threatened the replication of small-scale systems.

Treatment facilities that are over-dimensioned risk reaching the full life expectancy far before they reach their design capacity; over-dimensioning may also lead to reduced performance.

Recommendation:

Enforce a thorough case-by-case preliminary assessment.

The selection of appropriate options should be tailor-made and based on:

(i) a good preliminary assessment, including the definition of village-specific design criteria;

(ii) the definition and participatory validation of feasible management schemes; in particular, full-cost recovery should be guaranteed for O&M

(iii) the search for economy of scale;

(iv) comparisons with life-cycle cost analysis.

Flow measurements is observed to be a major shortcoming in Egypt, and any new wastewater infrastructure would greatly benefit from close inflow monitoring; this in turn would help to better design further treatment plants.

Recommendation:

Any project should be systematically documented and monitored, in order to generate lessons learnt and reliable data; this is currently hardly the case.

In what follows, the results regarding the situation and diversity of Nile Delta settlements are synthesised, and recommendations are provided in terms of planning and preliminary assessment at village-level. These results are further developed in the ESRISS Report "*Baseline Data and Current Practices*", and in the user manual of the Excel-based planning tool.

5.1 Different scales, different solutions

Rural sanitation encompasses a wide diversity of settlements, with highly variable wastewater characteristics; there is no one-size-fits-all solution.

The size of a settlement or group of settlements is a key parameter for the selection of an appropriate treatment system. It is however not possible to provide clear categories based on population equivalent. Instead, overlapping population ranges need to be defined, for each of which different technologies may be most cost-effective; technologies should then be compared based on the other selection criteria, as shown in Box 2. As a starting point, we propose the following population ranges for the consideration of the scale implications:

- 1 – 200 inhabitants: from individual building to street, neighbourhood or small isolated satellite
- 100 – 2,000 inhabitants: small ezbas
- 1,000 – 5,000 inhabitants: middle sized ezbas
- 3,000 – 15,000 inhabitants: bigger villages, micro-cluster of villages
- 10,000 – 50,000 inhabitants: big villages – mother villages with satellites

Examples of typical systems corresponding to these categories are given in Box 3.

Box 3: Example of typical systems for different scales

For example, conventional systems with activated sludge may be the most cost-effective for the range between 10,000 to 50,000 inhabitants. For the range between 3,000 and 15,000, an anaerobic step followed by a sequencing batch reactor (SBR), may be an option. Below 3,000 inhabitants, options such as anaerobic baffled reactors, anaerobic filters or waste stabilisation ponds fitted in drains should be preferred. The situation may be different where desert land is available; in that case, for example, waste stabilisation ponds are adequate at all scales.

5.2 Key implementation principles

It must be emphasised that the current lack of workable small-scale sanitation solutions in Egypt is due to the exclusive consideration of hardware aspects only. Besides, a focus on construction only is observed, which do not consider the costs over the entire infrastructure lifetime, such as O&M expenses, and sometimes even not the costs of land, a very significant cost factor in the Nile delta.

Recommendation:

In order to increase cost effectiveness, the national strategy should include the following key implementation principles:

- Think in terms of economies of scale and critical mass, not in terms of isolated pilots.
- Technical options are bound to management schemes: the management and financial arrangements should be defined first in a participatory process, including the communities, before the final technology selection.
- Reduce idle capacity through a modular approach and phased implementation, as shown in Figure 6, and through a limitation of the planning horizon to max. 15 years.
- Enforce life-cycle cost comparison
- Standardisation of treatment units; encourage prefabricated components
- If possible, the systems should be modular and flexible.
- Allow flexibility for the treatment plant location; especially, no minimal distance to the settlements, but rather focus on measures to minimise nuisance.
- Give preference to *design – build – operate* contracts
- Enforce a clear village-specific assessment of the initial situation.
- Define clear criteria for the technology selection, as shown in Box 2.

Recommendation:

The involvement of the communities from the start is very important, in particular to determine the availability of space, the potential management schemes (roles and responsibilities for the community) and the willingness and capacity to pay.

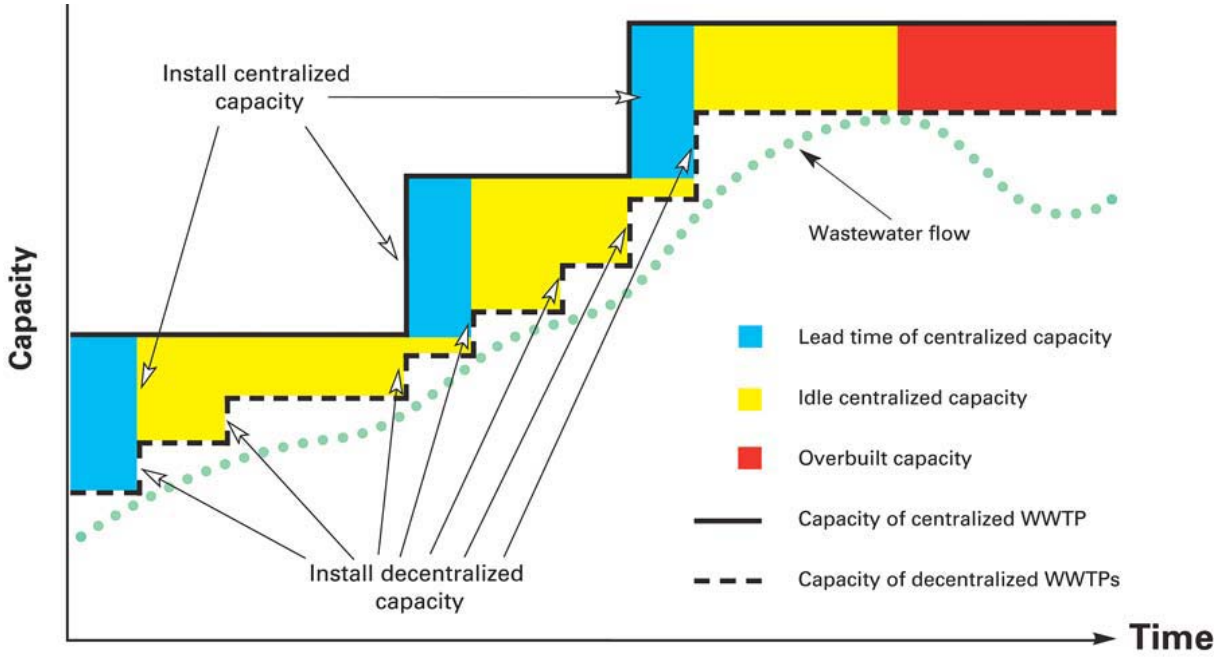

Figure 6: Reducing idle capacity and thus saving money with small-scale modular sanitation systems (© Rocky Mountain Institute, 2004 - *Valuing Decentralized Wastewater Technologies*)

The Code of Practice for Rural Sanitation, under development at the time of writing, is one of the most adapted documents where to materialise these principles. The latter were presented to the Committee in charge of drafting the new Code on 20th October 2014.

Box 2: The main criteria for technology selection

1. Availability of space
2. Quality of electric supply
3. Skills available for O&M
4. Financial resources available for O&M
5. Availability of spare parts (local manufacturing)
6. The number of projects, which influences management possibilities
7. Life-cycle costs

5.3 Conducting the preliminary assessment at village-level

Recommendation:

Small settlements are very heterogeneous and one-size-fits all design parameters cannot be provided at that scale. It is recommended to have a case-by-case approach for planning and selection of appropriate technologies.

Small settlements in the Nile delta are very heterogeneous. These differences in density, shape, proximity to drains or canals, groundwater table, quality of the water supply, number of animals per household have an impact on how the sanitation system should be designed and which options are more cost-effective. In particular, these factors have a strong influence on the quantities and characteristics of the wastewater to be treated and on the cost of the sewer system per capita. For any new project, a site-specific preliminary assessment is necessary (see also the report "*Challenges and Ways Forward*" and the report "*Material Flow Analysis*", which details the parameters to be collected on a site-specific basis).

5.3.1 The high variability of rural wastewater

The sampling campaigns done within the ESRISS Project have shown the high variability of wastewater quantities and characteristics in the small settlements in the Nile Delta.

(see Table 4 and for the full results, see the report "*Baseline Data and Current Practices*" or the webpage). Rural wastewater is clearly more concentrated than urban wastewater, which should be taken into account in the designs. Regarding septage from the bayaras, it is five to ten times more concentrated than the average sewage from such villages.

Table 4: The heterogeneity of wastewater characteristics in Nile Delta settlements

Parameter	Range *(averages)*
COD	400 – 2500
TS	700 – 3000
TSS	150 – 800
TN	100 – 250

The analysis of the current practices highlights the factors causing this high variability.

The villagers who rely on on-site sanitation systems tend to minimise their water consumption in order to reduce the emptying frequency.

The surveys have shown that approximately half of the greywater produced by bayara owners is discharged directly in the environment and thus do not contribute to dilute septage. For this reason, wastewater production increases very significantly when a sewer network is built; this increase may only be restrained in some villages by inadequate water supply (low pressure and interruptions).

5.3.2 A tool package to estimate site-specific design parameters

The ESRISS project developed a tool package for the preliminary assessment of the situation in small settlements and for the determination of site-specific design parameters.

The tool consists of a household survey questionnaire and interview guidelines simplified to the minimum and of an Excel-based model, which builds on the material flow analysis (MFA) model and the ESRISS data baseline (see Figure 7). In a maximum of three working days, it allows to estimate the wastewater quantity and characteristics after the implementation of the sewer network. Besides, it allows to compare sanitation system scenarios, as well as estimate the nutrient contents (nitrogen and phosphorus) in the perspective of an optimal wastewater and nutrient reuse. The user can thus anticipate a future situation and estimate the impact of different measures.

It can also support in estimating the wastewater quantity and characteristics at the planning horizon. This is however much less accurate: the future population growth, the spatial development and the upgrading of the water supply system are very difficult to forecast.

This again advocates for modular, flexible systems and limited planning horizons in order to cope with the high uncertainty of future developments.

The tool calculates the value range for the main design parameters: the flow volume, BOD, COD, total solids (TS), total suspended solid (TSS), total nitrogen (TN) and total phosphorus (TP). We recommend to include such a tool in the new Code of Practice.

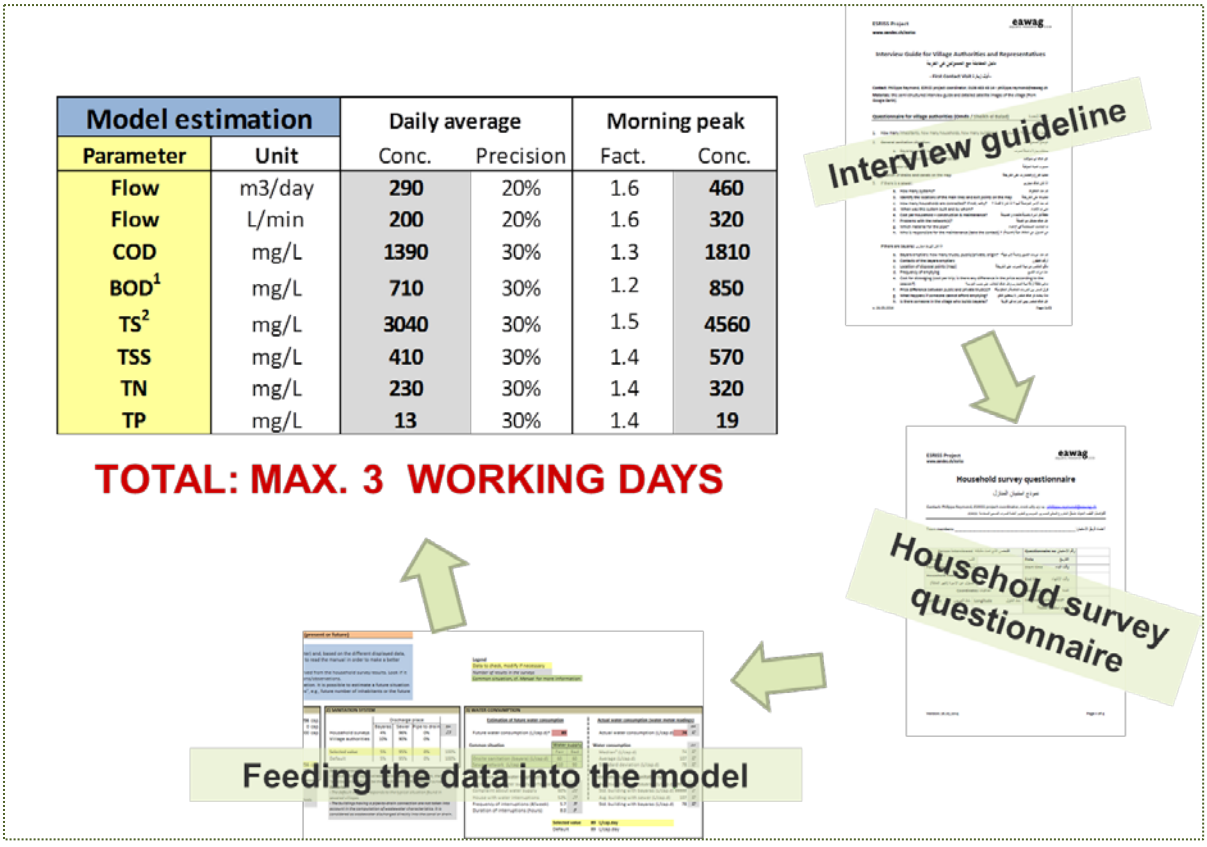

Figure 7: Synthesis scheme of the tool package to estimate wastewater quantity and characteristics at village-level.

5.4 Planning that promotes nutrient reuse

The material flow analysis (MFA) carried out within the ESRISS Project provides a very systematic assessment of the sanitation-related flows and parameters in Nile Delta villages under 5,000 inhabitants (see ESRISS Report "*Modelling Small-Scale Sanitation in the Nile Delta: A Material Flow Analysis with Nutrient Reuse Perspective*"). The *system boundary* is the settlement itself and does not include wastewater treatment nor agriculture, but the quantities and characteristics of the flows leading to them. The model is in the form of an Excel sheet (available on www.sandec.ch/esriss) and can be adapted to reflect the reality of villages in other regions (e.g. Upper Egypt) or countries.

Several questions regarding sanitation planning could be answered through the model:

a. What are the flow volume and nutrient loads in sewage, respectively septage?

b. What influence does liquid manure have on 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 nutrients 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 (bayara or biogas digesters) and separating greywater, either through soak pits or simplified sewer systems?

When a sewer network is built in a village equipped with bayaras, an increase in wastewater production of about 67% is expected.

The implementation of a centralised liquid manure management can be justified by two reasons: (a) attempt to decrease the loads in the wastewater to be treated, thus reducing the size and the costs of the treatment units; (b) direct reuse of liquid animal manure, either by bringing it directly to the fields or by storing it in a centralised liquid manure storage unit. The liquid manure has a very high concentration of nitrogen and high COD loads. Depending on the number of cattle, the implementation of a liquid management unit leads to a reduction of 5% to 40% of the nitrogen and COD concentration and loads in sewage.

In a village relying on bayaras, the diversion of greywater into a simplified sewer network leads to a drastic reduction of wastewater volume entering the bayara and to a high concentration of nutrients.

The study shows that separating the blackwater and liquid manure from the greywater leads to a very nutrient-rich (both in nitrogen and phosphorus) and concentrated product in the onsite systems. These can be either treated offsite or digested onsite in a biogas reactor. In some cases, only a few adjustments to the existing situation are needed.

Recommendation:

It is clear that in a nutrient-reuse perspective, source separation should be the favoured option.

Nutrient reuse does not stop with the flows leaving the village boundary. It is actually where it really starts. The nutrients still have a way to go before reaching the fields and, in-between, many losses are to be expected. Optimising nutrient reuse also means

selecting appropriate treatment options and field application methods, which conserve the nutrients and make them bioavailable to the plants. This part, however, is out of the scope of this report and is well described in the literature.

The study showed that nutrient reuse is something very important for Egyptian farmers (see the ESRISS Report "Baseline Data and Current Practices"), at a time when the price of chemical fertilisers is rising. However, so far, the farmers only use the solid part of animal manure and, sometimes, buy dry sludge from existing WWTPs. There is a big margin for improvement, which a well-designed nutrient management at village-level can highly support.

Each scenario necessitates an integrated planning approach, to ensure that all stakeholders agree and that the system is sustainable on the long run. Each of them implies a certain number of preconditions in order to be successfully implemented. Table 5 synthesises the measures to be taken and the potential impacts of each scenario.

Table 5: Synthesis of the measures to be taken and the potential impacts of the reuse-oriented scenarios

SCENARIOS	MEASURES	POTENTIAL IMPACTS
1. Creation of a liquid manure storage unit	• Involve the community for the development of a centralised liquid manure management scheme • Build on the current practice of liquid manure separation	• Recovery of an average of 2.2 tons of nitrogen per 1,000 inhabitants per year, ready to be reused in agriculture.
2. Separate blackwater and greywater	• Check feasibility at house level • Adapt the piping system and cesspit • Check feasibility for biogas production and end-use interest	• Substantial reduction of the volumes to be emptied from the bayaras and, thus, of the volumes to be treated. • A much more concentrated septage, which is easier to treat and reuse • Biogas production is possible
3. Anaerobic treatment systems	• Select anaerobic systems • Check effluent reuse options	• Most nutrients are conserved in the effluent, which can be used for irrigation or fish farming.
4. Use of the sludge stored in the bayara	• Improve septage management and build septage treatment plants	• A high amount of treated sludge is available for agriculture
5. Reuse of sludge from WWTPs	• Improve sludge treatment in the WWTPs • Systematise the sale of sludge	• Increase of good quality dry sludge available for agriculture

6 ESRISS project: what next ?

The ESRISS project tried to approach rural sanitation in an integrated way and think out of the box. In five years of dynamic changes, it could not answer all the questions, but give a clear direction of the ways forward and the paths to be further investigated. These are a few recommendations how to follow up and build upon the results of the ESRISS project:

- **Define the best institutional arrangement for the centralised management unit and find a way to implement it.** The easiest would be with an incremental approach, starting in a limited area.

- **Define sustainable business models for small-scale sanitation**: in order to convince the institutions and attract the private sector, it is crucial to prove that small-scale replication implemented on a large scale is bankable and is a financially viable market niche.

- **Define the best institutional setup for the involvement, encouragement and licensing of the private sector**

- **Reach an agreement between the Ministry of Housing, Utilities and Urban Communities, the Ministry of Water Resources and Irrigation and the Ministry of Health about the incremental implementation of the effluent standards and the use of small drains**

- **Capacity-building:** Training about alternative sanitation systems and the interdisciplinary skills specific to rural sanitation are needed at all educational levels, in pre-professional colleges, at the university, and as on-the-job training for the employees of HCWW and the Affiliated Companies.

- **Increase the data baseline:** The data baseline would greatly benefit from further sewage and septage sample analyses in ezbas. Further sampling campaigns should be organised, in more villages, but also on a more extensive period of time. The understanding of seasonal variations, as well as daily variations and peaks should be strengthened by more data.

- **Consider improving septage management as an intermediate solution:** Numerous villages in the Nile delta still rely on onsite sanitation and pumping trucks to evacuate septage. Improved septage management could include primary treatment close to the current disposal points. Transport of septage to the nearest WWTP is most of the time not realistic due to the distance and travel time which would raise emptying fees to unaffordable heights.

- **Create an online library:** It is strongly recommended that HCWW create an online library and repository on its website, to collect reports and experiences done in Egypt, and proactively make interested agencies aware of the work already done. There is an urgent need for institutional learning and sharing lessons learnt. Several projects have been implemented by different organisations and Ministries in the past, but lessons learnt are few and far between. It seems that year after year, conference after conference, the sector is constantly reinventing the wheel.

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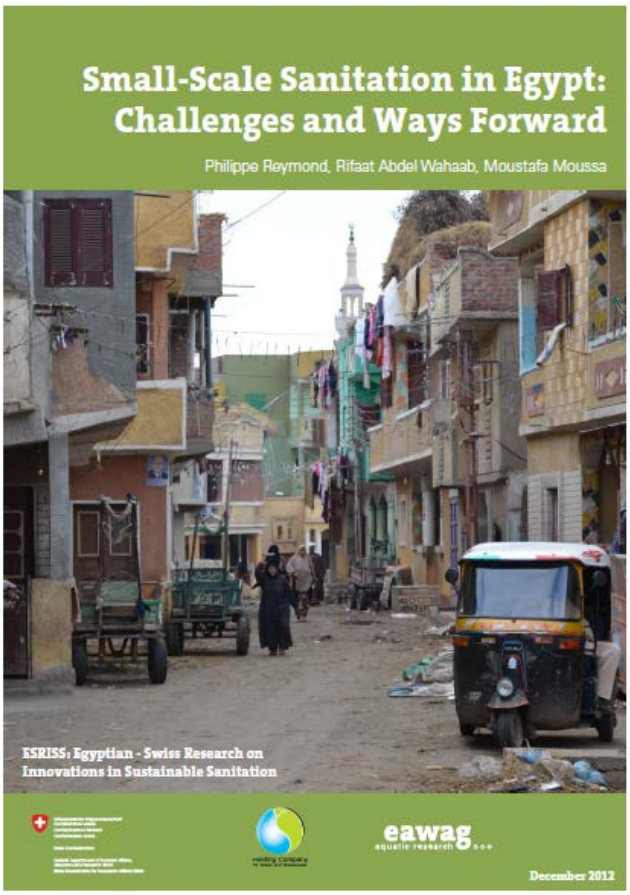
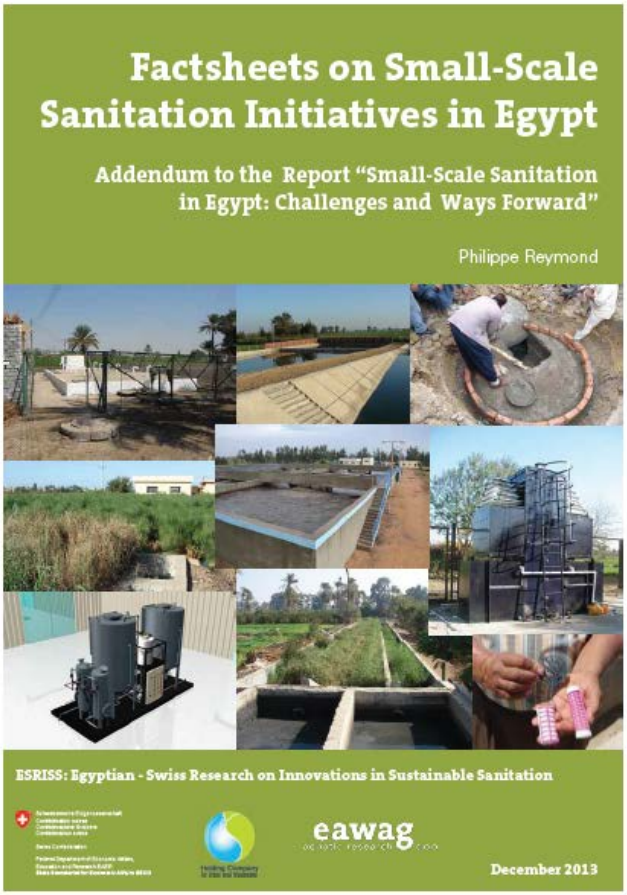
All ESRISS project documents can be downloaded at www.sandec.ch/esriss .

The cover pages of the different ESRISS project reports and briefs are shown in the Appendix.

APPENDIX: Cover pages of the different ESRISS project reports and briefs





"Small-Scale Sanitation in Egypt"

10 POINTS to move forward

Authors

Philippe Reymond, Eawag/Sandec
Dr. Rifaat Abdel Wahaab, HCWW
Dr. Moustafa Moussa

The ultimate goal of the ESRISS Project is the development of a wide-scale replicable model for small-scale sanitation in the Nile Delta. By "small-scale" we refer to "settlements or groups of settlements of up to 5,000 inhabitants". In our approach, the whole sanitation system, including management schemes, is considered. Cost-effectiveness and context-appropriateness are key targets. This document synthesises the main findings detailed in the ESRISS report entitled "Small-scale sanitation in Egypt: challenges and ways forward".

The 10 Points:

1. Development of a clear institutional strategy
2. Standardisation of treatment units
3. Centralised O&M management under the leadership of HCWW
4. Selection of appropriate collection & treatment options
5. Adaptation of laws and regulations
6. Move beyond "business as usual"
7. Development of a data baseline
8. Focus on preliminary assessment
9. Improvement of the project management cycle
10. Transparency and dissemination of lessons learnt

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"الصرف الصحي في المجتمعات الريفية الصغيرة في مصر"

١٠ نقاط للمضي قدما

المؤلفون

م. فيليب ريمون
المعهد السويسري للعلوم والتكنولوجيا المائية
philippe.reymond@eawag.ch (Eawag/Sandec)

أ.د. رفعت عبد الوهاب
الشركة القابضة لمياه الشرب والصرف الصحي
rawahaab@yahoo.com (HCWW)

د. مصطفى موسى
كلية الهندسة - جامعة حلوان
m.moussa@delft-environment.net

وتتلخص العشر نقاط الرئيسة في الآتي:

١. وضع استراتيجية مؤسسية واضحة
٢. التوحيد القياسي لوحدات المعالجة
٣. الإدارة المركزية للتشغيل والصيانة تحت قيادة الشركة القابضة لمياه الشرب والصرف الصحي
٤. اختيار نظم معالجة مناسبة من بين العديد من الخيارات المتاحة
٥. تهيئة القوانين واللوائح المنظمة
٦. تجاوز سيناريو "بقاء الأمور على حالها"
٧. تنمية البيانات الأساسية
٨. التركيز على التقييمات الأولية
٩. تحسين إدارة المشروع
١٠. الشفافية ونشر الدروس المستفادة

إن الهدف الأساسي للمشروع ESRISS هو تطوير نموذج قابل للتكرار على نطاق واسع للصرف الصحي في المجتمعات الريفية الصغيرة في منطقة دلتا النيل. وعندما نقول

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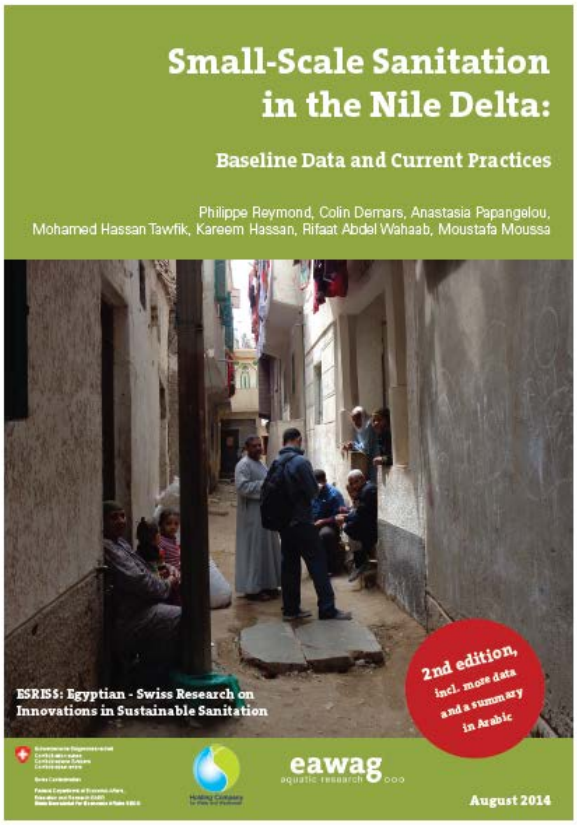
Small-Scale Sanitation in the Nile Delta:
Baseline Data and Current Practices
Philippe Reymond, Colin Demars, Anastasia Papangelou, Mohamed Hassan Tawfik, Kareem Hassan, Rifaat Abdel Wahaab, Moustafa Moussa
2nd edition, incl. more data and a summary in Arabic
ESRISS: Egyptian - Swiss Research on Innovations in Sustainable Sanitation
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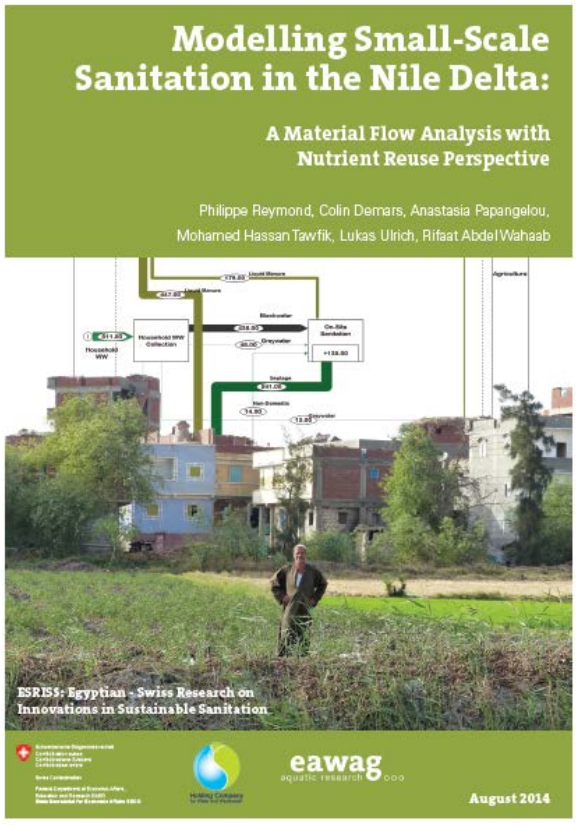
Modelling Small-Scale Sanitation in the Nile Delta:
A Material Flow Analysis with Nutrient Reuse Perspective
Philippe Reymond, Colin Demars, Anastasia Papangelou, Mohamed Hassan Tawfik, Lukas Ulrich, Rifaat Abdel Wahaab
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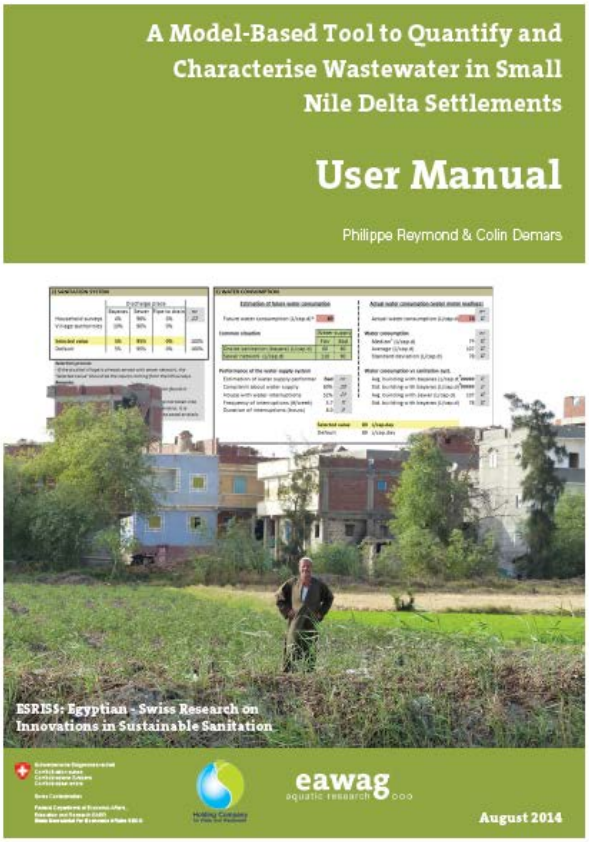
A Model-Based Tool to Quantify and Characterise Wastewater in Small Nile Delta Settlements
User Manual
Philippe Reymond & Colin Demars
ESRISS: Egyptian - Swiss Research on Innovations in Sustainable Sanitation
eawag aquatic research
August 2014

The ESRISS project deals with the sanitation planning gap in Nile Delta villages which cannot be connected to large centralised treatment plants. Led by the Swiss Federal Institute of Aquatic Science and Technology (Eawag-Sandec) in partnership with the Egyptian Holding Company for Water and Wastewater (HCWW) and funded by the Swiss State Secretariat for Economic Affairs (SECO), it aims to provide baseline data, policy recommendations and planning tools for the scaling-up of small-scale sanitation in Egypt.

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