From conventional to advanced environmental sanitation

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Abstract The basic concept of collecting domestic liquid waste in water-borne sewer systems goes back more than 100 years and became in the last century the conventional approach to sanitation in urban areas. Over the years, these sewage disposal systems had to be successively upgraded by additional sewage treatment plants increasing investment, operating and maintenance costs. Although these conventional sanitation systems could improve significantly the public health situation in those countries who could afford to install and operate them, it is highly questionable, if they are economically and ecologically sustainable. The large number of people in the developing world who still do not have access to adequate sanitation is a clear indication that the conventional approach to sanitation is not adapted to the socio-economic condition prevailing in most countries of Africa, Asia and Latin America. Advanced environmental sanitation is aiming not only to protect public health and the integrity of aquatic ecosystems but also to conserve precious freshwater and non-renewable resources. The Bellagio Principles and the Household Centred Environmental Sanitation Approach (HCES) are suggested as guiding principles and a new approach for planning and designing advanced (sustainable) environmental sanitation systems.

Keywords Bellagio principles; developing world; HCES; millennium goals; sanitation

The conventional sanitation system

Among many other things, the last century was characterised by a big improvement in the public health situation in most industrialised countries. Especially the prevalence of water and waste related infectious and parasitic diseases decreased dramatically. (As we will see later, this was very much in contrast with the situation in most countries in Africa, Asia and Latin America). The development in the industrialised countries went hand in hand with the general improvement of the hygienic and sanitary situation, especially in the urban areas. In fact, as a result of the industrial revolution, many people had moved over the 19th century to urban areas in search of work, both in Europe and in North America. This dramatic increase in population density was coupled with a deterioration in public hygiene (Schertenleib and Gujer, 2000). Apart from aesthetic problems, hygienic problems increased and with them the contamination of drinking water resources, ultimately resulting in widespread epidemics such as the London cholera epidemic of 1854.

As urban areas developed at that time primarily in climatic zones with ample precipitation distributed evenly throughout the year, canals were constructed in order to divert the rainwater and prevent floods. When the hygiene problems increased due to faeces and refuse lying around in streets and backyards, it was obvious that the existing drainage canals would be used for removing these waste materials from the developed areas as well. In this way, the water-borne sewage systems was born. Consequently, water-flush toilets connected to a water-borne sewer system became the norm to solve the sanitation problems in the urban areas of the North and in several regions of the South. What was called in the beginning of the last century the “modern” sanitation system is considered today as the conventional solution to the urban sanitation problems. For many professionals it is even considered to be the only feasible solution to Urban Environmental Sanitation.
Deficiency of the conventional sanitation system with regard to sustainability

There is no question that the introduction of water flush toilets together with water-borne collection systems and the disinfection of drinking water in water supply systems have markedly improved the hygienic situation in urban areas. However, as a consequence of the discharge of pollutants into receiving waters new problems arose. The rapid growth of urban areas led to a pollution load which increasingly exceeded the assimilation and self-purifying capacity of natural waters. Consequently, sewage treatment plants had to be installed, first existing only of simple sedimentation. Soon biological treatment steps had to be introduced to reduce the steadily increasing pollutants to a degree that would not damage the ecosystem of the receiving waters. Economic development and increased production of chemicals after the Second World War has been causing both a quantitative increase and qualitative change in the urban wastewater. Therefore, in order to protect public health and the natural environment, existing wastewater treatment plants must be continually upgraded and expanded with additional and more sophisticated and expensive treatment steps. The latest challenge is the recent discovery that various chemicals and pharmaceuticals in daily use have in receiving waters an endocrine or hormone-like effect on fish, water snails, etc. even at very low concentrations (Zehnder et al., 2003).

The need for continuously upgrading the sewage treatment systems and the increasing amount of wastewater to be transported (pumped) and treated has not only financial consequences with regard to large investment and ever increasing maintenance and operation costs; these systems consume also large amounts of chemicals and energy which is mostly produced using non-renewable resources and contributing to the global greenhouse effect. Furthermore, in the conventional sanitation system, nutrients such as phosphorus and nitrogen are mostly regarded as waste and not as resources. This practice is basically understandable given today’s market prices for energy, nitrogen and phosphorus fertilizers, but does obviously not correspond to the basic criteria of sustainability. It is for instance estimated that the global phosphorus reserves will last only another 50–100 years if they continue to be depleted at the present rate.

Despite these facts, most research being conducted and funded in the field of urban sanitation is still related to the conventional approach of collecting the wastewater (either separate or combined) in large sewer systems and then treating it in centralised treatment plants. There is relatively little research done in looking at alternative sanitation systems and approaches which are more advanced by not only protecting public health and the integrity of aquatic ecosystems but also by conserving precious freshwater and non-renewable energy and natural resources. If we go on trying to improve and optimize the conventional sanitation system we really should ask ourselves: are we not optimising the wrong system?

The current state of urban sanitation in developing countries

This question gets even more serious and almost cynical if we look at the environmental sanitation situation in urban areas of developing countries. According to the latest official statistics, at least 2.4 billion people do not have access to adequate sanitation (WHO/UNICEF/WSSCC, 2000). Less than 50% of municipal solid wastes are collected (World Resources Institute et al., 1996) and nobody knows how many people are flooded out each year due to lack of proper storm water drainage. The statistics stipulate that the proportion of the world’s population with access to excreta disposal facilities increased from 55% in 1990 to 60% in 2000 and that rural services lag far behind urban services in term of percentage coverage. In fact, the statistics even suggest that in contrast to the rural population, only a relatively small minority of urban dwellers (14%) are lacking access to improved sanitation (see Table 1).
Even if the number of 14% (over 400 million people) living in urban areas without improved sanitation would be correct, it would deserve our full attention. Unfortunately, we have to assume that the real situation is much worse. The numbers in the statistics are misleading in the sense that, due to the lack of better data, the definition of sanitation coverage was based purely on technology type.

The following technologies were considered “improved”: (a) connection to a public sewer; (b) connection to septic system; (c) pour-flush latrine; (d) simple pit latrine; and (e) ventilated improved pit latrine;

whereas the following technologies were considered “not improved”: (f) service or bucket latrines (where excreta are manually removed); (g) public latrines; and (h) open latrine.

However, this categorisation is not satisfactory to determine how many people actually have access to adequate and sustainable sanitation. First of all, the issue is not whether urban dwellers have provision for sanitation at all, but whether they have a quality of provision for all members of the household which is affordable and which eliminates their contact with human excreta and other wastewater within the home and the neighbourhood. Therefore, in one of their recent reports, UN-Habitat took a different approach and tried to estimate the number of people without “adequate” provision based on the following criteria (UN-HABITAT, 2003):

1. Adequate sanitation needs good quality provision in the home (e.g. toilets), the immediate surrounding (e.g. connection to a sewer or to a pit or septic tank that doesn’t contaminate the groundwater or other people’s water) and the neighbourhood (provision to ensure no human contact with excreta and to make sure that wastewater is removed safely).

2. Adequate sanitation must be accessible for all (close enough for children to use; accessible at night with public lighting in the roads, not dangerous for woman/girls).

3. Adequate sanitation needs good provision of anal cleaning, hand-washing and maintenance.

4. Adequate sanitation must function properly even during periods of high rainfall.

Using these criteria, the numbers look quite different (see Table 2). Although it is not entirely clear how the numbers have been determined in the UN-Habitat study, the big differences between the two statistics show the limitations if the access to sanitation is based on a purely technological point of view.

The picture would change even more if the criteria to which extent the sanitation systems are polluting freshwater resources in rivers and lakes would also be included in the statistics. It is well known that even in those cities in developing countries which are partly or fully sewered, only a very small fraction of the collected wastewater is treated at all. For instance in Latin America, where a relatively large proportion of the population has access to a sewer system, it is estimated that only about 10% of the collected sewage is treated at all and the quality of treatment is generally low (UNEP-IETC, 2002). In Asia, the government of Thailand invested over the last ten years about 1.5 billion USD for the construction of centralized wastewater collection and treatment systems in 85 municipalities, but less than 40% of these systems are functioning property.

### Table 1 Sanitation coverage in urban and rural areas (WHO/UNICEF/WSSCC, 2000)

<table>
<thead>
<tr>
<th></th>
<th>Urban population with improved sanitation</th>
<th>Rural population with improved sanitation</th>
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<tr>
<td></td>
<td>1990</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>82%</td>
<td>86%</td>
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<td></td>
<td></td>
<td>38%</td>
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Even if the number of 14% (over 400 million people) living in urban areas without improved sanitation would be correct, it would deserve our full attention. Unfortunately, we have to assume that the real situation is much worse. The numbers in the statistics are misleading in the sense that, due to the lack of better data, the definition of sanitation coverage was based purely on technology type.
Taking all this into account, the present and even more the future challenge in urban environmental sanitation is certainly as big as in rural areas. Even more important, while a lot has been learned over the last years about alternative approaches and solutions for sustainable sanitation in rural areas, relatively little is known about suitable alternatives to the conventional, centralised wastewater management approach and there is still a common misconception among professionals and public officials that this is the only valuable solution to urban sanitation.

Guiding principles for advanced environmental sanitation

In the light of the large number of people in the developing world who still do not have access to adequate sanitation, drainage and waste disposal services, it is obvious that the approaches used in the past to address the environmental sanitation problems in developing countries have been failing a large proportion of humanity despite considerable efforts and investments made over the last years. If there is no dramatic change in the way we have been approaching the sanitation problems in the past, it will not be possible to achieve the Millenium Development Goal 7, specifically addressing two targets: to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation, and to achieve significant improvement in the lives of 100 million slum dwellers by 2020 (www.developmentgoals.org/Environment.htm). The widespread lack of access to adequate sanitation services does not only affect directly hundreds of millions of people depriving them from living in a healthy environment, it also leads to a further contamination of the world’s freshwater sources.

Many different reasons have been identified why the sanitation situation in many countries has not improved over the last ten years and why we are facing today a global sanitation crisis (WSSCC/WHO, 1998). One of the most important is the general assumption that the conventional (centralised) waterborne sewer system can be the universal solution to all sanitation problems in urban and peri-urban areas irrespective of the big differences in the physical and socio-economic conditions. Serious attempts to develop alternative approaches and solutions to urban environmental sanitation started only quite recently when more and more sector professionals had to realise that “business as usual” cannot provide services for the poor and that “business as usual” is not sustainable even in the industrialised world.

In an effort to provide guidance to those planning and implementing sanitation programs, the Water Supply and Sanitation Collaborative Council (WSSCC) created an Environmental Sanitation Working Group (ESWG). The ESWG developed the Household Centred Environmental Sanitation Approach (HCES) (SANDEC/WSSCC, 1999) which recommends that:

- people and their quality of life should be at the centre of any advanced Urban Environmental Sanitation System (UESS);
- all UESS systems must be designed in such a way to balance economic and environmental goods;
- solutions of UESS problems should take place as close as possible to the place where they occur;

### Table 2 Urban population with “improved” compared to “adequate” sanitation

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<th>Region</th>
<th>Urban population with “improved” sanitation</th>
<th>People with “adequate” sanitation</th>
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<tr>
<td>Africa</td>
<td>84%</td>
<td>40–50%</td>
</tr>
<tr>
<td>Asia</td>
<td>78%</td>
<td>40–55%</td>
</tr>
<tr>
<td>LA &amp; Caribbean</td>
<td>87%</td>
<td>60–75%</td>
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“wastes”, whether solid or liquid, should be regarded as resources; UESS systems should be “circular” – designed in such a way as to minimize inputs and reduce outputs;

problems relating to UESS should be handled within an integrated framework, and this framework should itself be part of a wider system of integrated water resources, waste management and food production.

Subsequently, the HCES approach was adopted by a representative expert group that synthesized the approach in the Bellagio Principles (SANDEC/WSSCC, 2000).

<table>
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<th>The Bellagio Principles (2000)</th>
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<td>(1) Human dignity, quality of life and environmental security at household level should be at the centre of the new approach, which should be responsive and accountable to needs and demands in the local and national setting.</td>
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<td>(2) In line with good governance principles, decision making should involve participation of all stakeholders, especially the consumers and providers of services.</td>
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<td>(3) Waste should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flow and waste management.</td>
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<td>(4) The domain in which environmental sanitation problems are resolved should be kept to the minimum practical size (household, community, town, district, catchment, city) and wastes diluted as little as possible.</td>
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These principles were endorsed by the members of the WSSCC during its 5th Global Forum in November 2000 in Iguacu, Brazil.

Special characteristics of the household centred environmental sanitation approach

The HCES model consists of two main components: (a) the household centred planning approach and (b) the circular system of resource management.

(a) The household centred planning approach is a radical departure from past central planning approaches. As shown in Figure 1, it places the household at the core of the planning process. Therefore, the approach responds directly to the needs and demands of the user, rather than central planner’s often ill-informed opinions about them.

- Stakeholders are members of a “zone”, and act as members of that zone (“zones” range from households to the nation). Participation is in accordance with the manner in which those zones are organized (for example, communities and neighbourhoods consist of households, towns consist of communities, etc.)

- Zones may be defined by political boundaries (for example, city wards and towns) or reflect common interests (for example, watersheds or river basins).

- Decisions are reached through consultation with all stakeholders affected by the decision, in accordance with the methods selected by the zone in question (for example, votes at national level in a democratic system, town hall meetings at local level, or informal discussions at neighbourhood level).

- Problems are solved as close to their source as possible. Only if the affected zone is unable to solve the problem it is “exported” to the zone at the next level.

- The needs of the users are determined in a bottom-up process where decisions, and the responsibility for implementing them, flow from the household to the community to the city and finally to the central government. Support is ensured and policies and
regulations are determined by central government, with implementation delegated to the appropriate levels flowing towards the household (top-down part of the HCES approach).

(b) The circular system of resource management: an important principle of the HCES approach is to minimize waste transfer across circle boundaries by minimizing waste-generating inputs and maximum recycling/reuse activities in each circle. In contrast to the current linear system, the Circular System of Resource Management (CSRM) emphasizes conservation (reducing imports) of resources, and the recycling and reuse of resources used (minimizing exports, Figure 2). Resources in the case of environmental sanitation are water and goods consumed by households, commerce and industry. The application of this concept will lead to an increased closure of the nutrient loop between sanitation and agriculture, conserving not only natural resources such as phosphorus but at the same time reducing systematically “downstream” pollution. As it was discussed earlier, these are important criteria for an advanced sanitation system.

Guideline for implementing the HCES approach

The implementation of the HCES approach is by far not trivial. As a first step preliminary guidelines were prepared which are mainly targeted at municipal planners (especially those responsible for planning urban environmental services) and civic officials, such as mayors and city managers (Schertenleib et al. 2003). The provisional guidelines provides specific guidance for

(a) Creating an Enabling Environment for the use of the HCES approach; and
(b) Undertaking a 10-STEP Process for developing and implementing the HCES approach.
An “enabling environment” is important for the success of any investment program, but it is especially vital when applying an innovative approach, such as HCES. Most of the critical elements (see Figure 3) should be identified or become evident during the programme development process. Ideally, they should be identified, at least in broad terms, prior to the programme launch, so that the entire process does not start off with misunderstandings. It is essential that they are recognized before or during the identification and evaluation of options at the latest, since if these critical elements cannot be assured, then some of the options may not be feasible.

The second section of the guideline describes ten typical steps involved in developing and implementing an HCES program. These steps are presented in sequence, but in practice they will usually overlap. Some steps may need to be repeated more than once in an iteration to find acceptable solutions, and they will always need to be undertaken bearing in mind the concerns of the municipality as a whole.

Figure 2 The Circular System of Resource Management (CSRM): minimising imports and maximising recycling and reuse within boundaries

Figure 3 The two main components of the preliminary guideline for the Implementation of the HCES approach: The enabling environment and the 10-step process
Conclusions and recommendations

Using the HCES approach to plan and design an advanced environmental sanitation system which not only protects public health and the integrity of aquatic ecosystems but also conserves precious freshwater and non-renewable resources does not mean that a solution at the household or even neighbourhood level is considered always to be the most appropriate solution. It will hopefully lead to different types of technical solutions, even within the same urban area, but always adapted to the local socio-economic and physical conditions. An important characteristic especially of the fast growing urban agglomerations in developing countries is the high heterogeneity within the same city and it is wrong to assume that there should be a “one-for-all” solution. Therefore, it is very important to know the potential and limitations of a wide range of technical solutions from the household to the community level. We have to know not only their treatment performances and costs but also the institutional and human resources requirements as well as their reuse potential.

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References


