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SANDEC News

Water & Sanitation in Developing Countries
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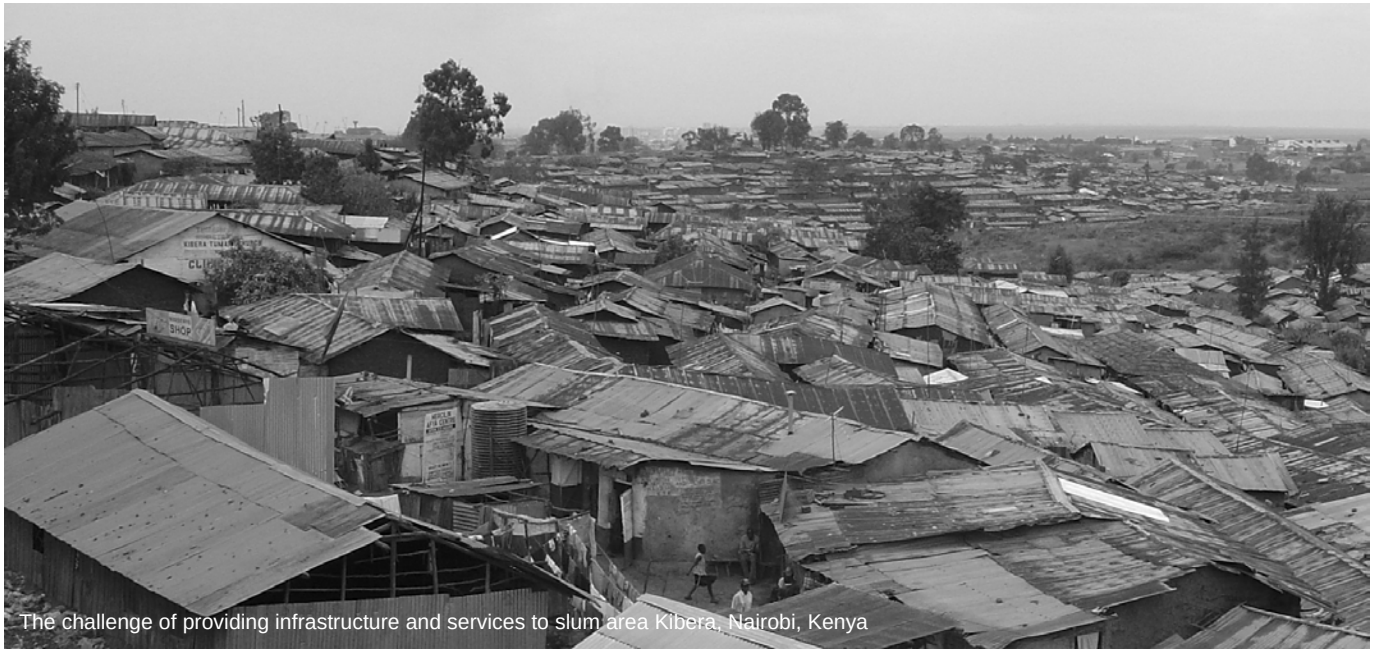

The challenge of providing infrastructure and services to slum area Kibera, Nairobi, Kenya

Dear Reader,

This edition brings you up to date on SANDEC and its partners' research and capacity development activities to reduce by half the number of people without sustainable access to safe drinking water and basic sanitation by 2015 (as set by the "Millennium Development Target 10").

Let me also inform you about changes at SANDEC. Roland Schertenleib is now a member of EAWAG's Directorate, while still heading the NCCR North-South Project at SANDEC and conducting research on strategic environmental sanitation planning issues. I was given the unique opportunity to replace him as Director of SANDEC. Hasan Belevi has been appointed Professor at the University of Innsbruck, Austria. He remains one of our research partners in the field of Material Flux Analysis (MFA). Agnès Montangero is now further developing MFA as part of her PhD thesis. Doulaye Koné has replaced Agnès Montangero in the field of "Faecal Sludge Management". Furthermore, Ives Kengne has started his PhD in Cameroon on faecal sludge treatment with constructed wetlands. Halidou Koanda's PhD on "Stakeholder Analysis and Involvement for an Optimal Faecal Sludge Management in Ouahigouya, Burkina Faso" is supervised by senior researchers at SANDEC.

In Urban Agriculture, Dionys Forster's PhD focuses on "Assessing the Reuse Potential for Organic Waste Products in Urban and Peri-urban Agriculture", and Noah Adamtey's on "Use of Co-compost under Irrigated and Rain-fed (Peri-)urban Agriculture in Ghana".

All our activities remain committed to improving water supply and environmental sanitation in low and middle-income countries, and aim at: 1) developing, providing and facilitating the implementation of new concepts and technologies; 2) increasing research capacity and developing professional expertise in low and middle-income countries in this field, and 3) raising awareness and developing professional expertise in high-income countries for water supply and environmental sanitation in developing countries.

Happy reading and looking forward to your feedback.

Chris Zurbrugg
Director SANDEC

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An Example of Water Quality Improvement through SODIS in Lombok, Indonesia

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The Context

The high diarrhoea incidence in East Lombok is attributed to the fact that the population drinks untreated water from contaminated water sources. Child mortality lies at 86 per 1000 births, and diarrhoea ranks third after respiratory and skin diseases.

Figure 1: The population in East Lombok mainly consumed untreated water from contaminated water sources

A SODIS pilot project therefore raised the interest of local health officials since Indonesian health policy emphasizes preventive action rather than curative measures. Introduction of a new water treatment method for use at household level is, thus, very much in line with national government policy.

The Project

Following the pilot phase, a large-scale dissemination project, funded by Georg Fischer AG, was implemented in East Lombok from April 2003 to June 2004. The local NGOs Yayasan Dian Desa (YDD) and Yayasan Masyarakat Peduli (YMP), in close collaboration with the district health department, were responsible for SODIS dissemination and establishment of a structure for hygiene promotion and SODIS training at village level conducted through local community health centres. The project staff trained health and sanitary officials, teachers and community representatives. They in turn reached 144 villages and 70 elementary schools. About 130,000 people were trained in improved hygiene practices and SODIS application.

The project focused mainly on establishing the structure and capacity within the government system for continuous, long-term support and supervision of the local community in the application of water treatment methods such as SODIS and improved hygiene practices. Creating community awareness and initiating the corresponding behavioural changes were at the core of the training provided to government officials, and the focus at grassroots level.

Factors of Success

The key factors for the success of the project were the interest and involvement of government health institutions and the integration of SODIS as well as hygiene education into existing government structures such as the community health centres. Promotion through these structures is an important precondition for large-scale SODIS dissemination and its sustainable application.

During the 14-month SODIS project in Lombok, the drinking water quality at household level was significantly improved from an average contamination of 174 CFU/ 100 ml to an average of 4 CFU/ 100 ml. The average diarrhoea incidence in the project villages was reduced by no less than 73%! This major health improvement further enhanced SODIS acceptance by government institutes and led to its wider dissemination by the Lombok Health authorities.

The Challenges

The main constraint for the spread of SODIS use and its sustainability in East Lombock was the lack of transparent plastic bottles at village level. However, the availability of resources, such as the SODIS bottles, is crucial for the sustainable SODIS application. To overcome this, bottle supply systems had to be established through the health centres.
The project staff, who initially purchased, supplied and distributed bottles to the health centres, stressed the importance of a bottle supply system at village level. Following the SODIS community trainings, five bottles were distributed free of charge to each family. Additional bottles will have to be bought from the health centres and the income from the sale of these bottles will be used as capital to purchase new bottles.

Figure 4: Staff of the health centres established a bottle supply system.

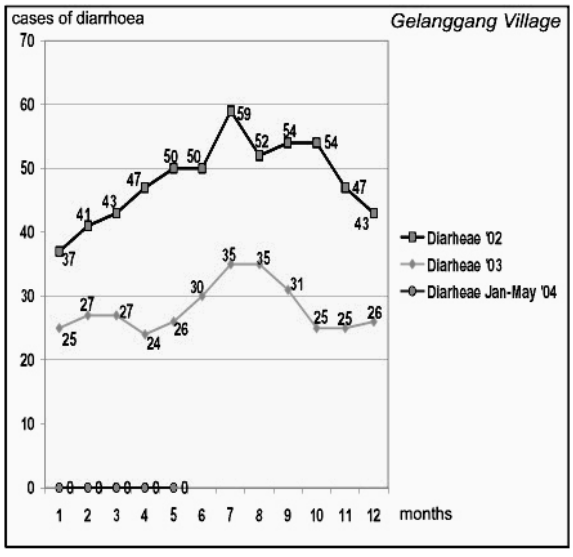

Figure 2: Diarrhoea reduction in Gelanggang village after the introduction of SODIS

Figure 3: SODIS training in schools was an element of the dissemination strategy

Strategic Environmental Sanitation Planning (SESP)

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Rationale of the SESP Programme

The large number of people around the world still without access to adequate water, sanitation, drainage and solid waste disposal services is sufficient evidence that conventional approaches to environmental sanitation are unable to make a significant dent in the existing service backlog. Inadequate environmental sanitation services create a major threat to public health and environmental security. At the same time, the world's natural supply of freshwater is subject to increasing environmental and economic pressure. It has also been widely recognised that the improvement of basic sanitation is a critical factor for meeting the Millennium Development Goals (MDGs).

Challenging Conventional Thinking

In the past, planning of environmental sanitation services consisted of a "top-down" approach neglecting the actual needs and willingness/ability to pay of a large section of the population. As a result, beneficiaries often decline to pay for services or neglect to maintain facilities. Therefore, a new approach to environmental sanitation planning was developed: The Household-Centred Environmental Sanitation Approach (HCES).

Figure 1: Heterogeneous settlement structures require different sanitation alternatives

The Household-Centred Environmental Sanitation Approach

The HCES approach is based on the Bellagio Principles for Sustainable Sanitation and attempts to avoid the problems resulting from either "top-down" or "bottom-up" approaches by using elements of both in an integrated framework. The needs and demands are formulated in a bottom-up approach by placing the household and users at the core of the planning process.
Decisions on determining the type of environmental sanitation services to be implemented is mainly based on the actual needs and means of the users.

Government agencies respond to the needs by creating an environment enabling the successful implementation of these services.

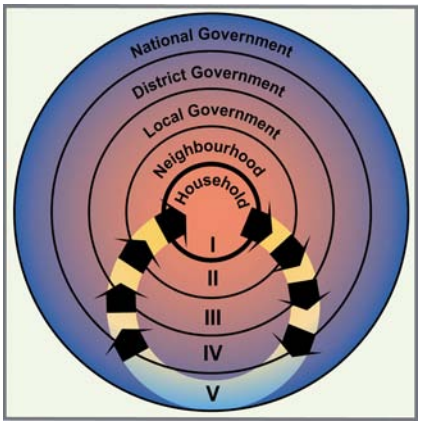

Figure 3: The concept of zones in the HCES approach with top-down and bottom-up components

The Concept of Circular Resource Management

Another important weakness of current environmental sanitation planning is that problems are not addressed close enough to the point where they originate. Problems are "exported" to other levels ("downstream pollution"). The HCES approach attempts to remedy this situation by insisting that problems be solved as near as possible to the point where they occur. This is done by establishing a series of "zones" and by using the concept of circular resource management systems. Problems relating to environmental sanitation can then be addressed at the smallest appropriate zone (initially the household). A problem is "exported" to the next larger zone only if it cannot be solved in the smaller zone (or if it is more cost-effective to deal with it on a larger scale). The Circular Systems of Resource Management (CSRM) proposed by the HCES concept emphasises conservation of resources and reduction of waste exports from one zone to the next higher zone by minimising waste-generating imports and maximising reuse and recycling of adequately treated waste (including liquid and solid human waste).
Waste reuse also provides the opportunity for local food production and horticultural produce by individual homeowners, community cooperatives and commercial ventures in urban agriculture. A particularly attractive feature of the circular system is its potential to make waste reuse and, thus, environmental sanitation, an income-earning activity.

Preliminary HCES Guideline

A preliminary guideline for decision-makers has been produced to provide guidance on the application of the HCES approach in urban environmental sanitation service planning. The guideline provides specific guidance for (a) creating an enabling environment for the application of the HCES approach and (b) undertaking a 10-step process for its development and implementation. Its aim is to support those who will initially have to take the decisions on whether and how to apply the HCES approach. These are mainly municipal planners of urban environmental services and public officials, such as mayors and city managers.
This guideline is neither comprehensive nor final, but will be developed further on the basis of extensive field experience.

Additional Information

Documents produced by SANDEC on strategic sanitation planning may be downloaded from SANDEC's homepage: www.sandec.ch/EnvironmentalSanitation/SESP_Home.html

WSSCC/SANDEC (2004): Implementing the Bellagio Principles in Urban Environmental Sanitation Services: Provisional Guideline for Decision-Makers. WSSCC Geneva. November 2004.

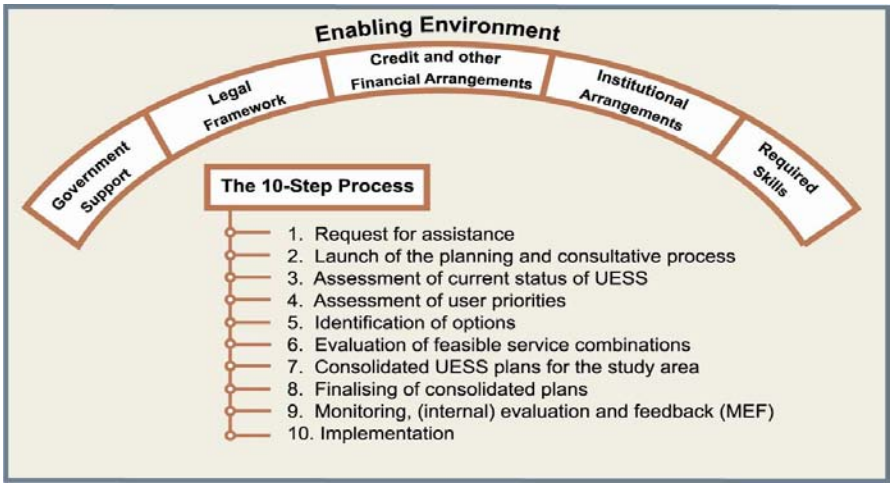

Figure 2: The two main components of the HCES planning guideline: creating an enabling environment and undergoing a 10-step process

Biological Treatment of Municipal Solid Waste

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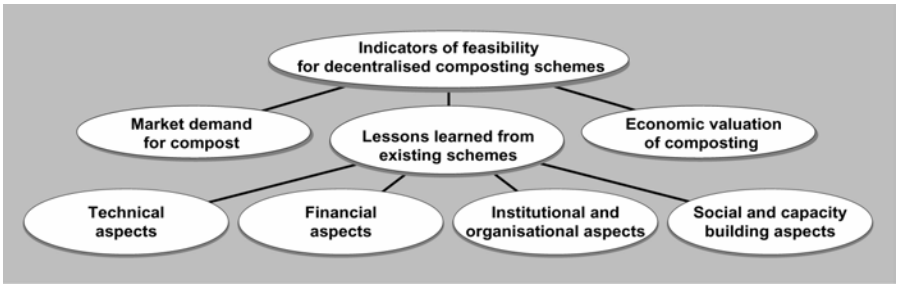
SANDEC News No. 5, 2002 contains an overview of the recent research programme on Decentralised Composting of Municipal Solid Waste. The different aspects of the programme, as shown in the figure, are still relevant to SANDEC's ongoing work.
The overall objective of our research programme is to develop tools to assess the potential of decentralised composting schemes as one treatment option for a city's solid waste management system.



Lessons Learned from Existing Schemes

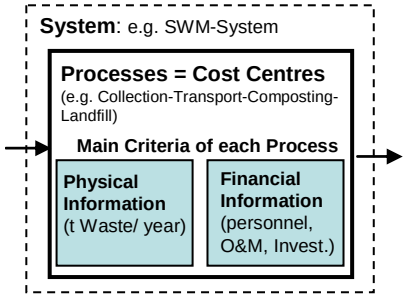
Since 2002, SANDEC has assessed the technical, financial, organisational, and social aspects of approx. 40 different composting schemes in Asia and South America. A collaborative research project with the Universidad Católica de Valparaíso reviewed existing composting schemes in the Latin American region with specific focus on the Chilean experience. Based on this regional overview, recommendations are currently developed for urban municipal solid waste composting activities in poor urban areas.
The case studies of South India allowed conclusions to be drawn not only for the Indian context but also for decentralised composting schemes in general. Existing composting schemes normally fall into one of the following four categories exhibiting specific technical, organisational and social characteristics:

- **Backyard and roof composting schemes** are suitable if sufficient space is available and residents are committed. They can be very effective as the technology applied is inexpensive and easy to handle. Since this system is time-consuming and requires some basic knowledge from the households, the support of the responsible municipal offices is essential for dissemination of backyard composting, e.g. through awareness campaigns and training.
- **Community-based systems** are often run by a group of individuals concerned about a clean environment in their neighbourhood. These systems provide up to 1000 households with a waste collection service and compost supply. Only a few municipalities are currently aware of the great potential of such schemes and rarely acknowledge officially their contribution to waste management.
- **Company and institutional composting** used on hotel premises and housing compounds often use technologies similar to the community-based schemes. The advantage is a clear decision-making structure and households are instructed on the best way to contribute to the system. A reduction of the company's waste collection costs is the main benefit drawn from such a system.
- **Medium-size private sector composting enterprises** are generally larger than community-based systems and were observed to focus on the collection of organic market waste. They try to avoid the typical problems of community-based systems (e.g. time-consuming fee collection). These enterprises struggle with volatile markets for their products and high land costs, thereby diminishing their net revenues.

All the schemes create additional jobs for low-income groups. However, many lack a business-oriented management approach and contract agreements with the responsible authorities. Those with formal municipal agreements or partnerships are more readily accepted by their customers. Thus, a clear and continuous municipal waste management strategy increases composting activities and reduces considerably the waste stream to the final disposal sites. Further details and downloads are available on SANDEC's homepage as well as a link to our new ***decomp database.***

Economic Viability

Our research sets decentralised facilities into the overall economic urban solid waste management context. Rather than looking only at the cost/revenue ratio of the individual facilities, which often proved financially unprofitable, the current projects evaluate additional costs and benefits of decentralised composting schemes. The Material Flux Analysis (MFA) allows visualisation of the waste flows and processes of an urban SWM system. By linking this physical information to the costs and revenues of the processes involved, it is possible to calculate a cost revenue balance for the entire systems (e.g. city or community).



Combined MFA & Cost-Centre Analysis

Together with relevant stakeholders, different planning scenarios based on the existing visualised system are developed and the outcomes calculated. SANDEC has applied this approach in three case studies:

- Asmara, Eritrea (in collaboration with the Swiss Federal Institute of Technology Zurich (ETH) and the University of Asmara)
- Bouargoub, Tunisia (with the support of the ppe-gtz programme in Tunisia)
- Dhaka, Bangladesh (in collaboration with AIT, Bangkok)

Changes in waste flows from decentralised composting reduce time and effort in transport activities and extend the life span of existing disposal sites. The preliminary results reveal that savings in transport costs can offset the additional costs of decentralised composting schemes.

Market Demand Study

Experience revealed that many composting schemes struggle with volatile compost markets. To ensure long-term success of a composting scheme, managers should be informed of the demand of different customer groups, their compost quality requirements and the competing products on the market. Based on two different types of marketing studies, SANDEC is currently working on a handbook, which offers guidance on assessing existing and potential compost markets. The handbook will be tested on a relevant case in autumn of 2005.

Landfill Mining - Benefits & Risks

In developing countries, stabilised landfill material is often mined and used as a nutrient source in agriculture. SANDEC and the College of Agriculture, Asmara have conducted a study on the benefits and risks of landfill mining and use in agriculture. The lack of available fertilisers in Eritrea compels farmers to improve their soil with degraded landfill material. Apart from the visual pollution caused by plastic and metal residues, little is known about the risks of invisible pollutants like heavy metals. The results of an analysis of various parameters of mined landfill material correlate with the fact that nutrients and organic matter improve plant growth. However, the extremely high heavy metal contents of the landfill material pose a potential risk to the environment and the food chain. One should carefully examine if the long-term risks of landfill material use on soil undermines the short-term benefits of crop yield. A follow-up study assessed the potential of organic waste composting and reuse in Asmara.

Decentralised Sanitation (DESAN)

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Rationale of the DESAN Programme

The basic concept of collecting domestic liquid waste in water-borne sewer systems and of treating it in a centralised treatment plant goes back more than 100 years and became, in the last century, the conventional approach to sanitation in urban areas. Although these conventional sanitation systems improve significantly the public health situation in those countries which can afford to install and operate them, their economic and ecological sustainability is highly questionable. The large number of people in the developing world who still lack access to adequate sanitation is a clear indication that this approach is not adapted to the socio-economic conditions prevailing in most developing countries.
To date, relatively little is known about suitable alternatives, and a general misconception among professionals and public officials prevails who consider centralised systems as the only valuable solution to urban sanitation.

Programme Outline

The DESA programme focuses on alternative and decentralised wastewater treatment systems. The main objective of this programme is to establish guidelines for decentralised management and treatment of municipal wastewater by (a) identifying innovative and promising decentralised technologies for wastewater treatment (including greywater); and (b) adapting these to the local conditions in partner countries on the basis of lab and pilot scale research.

	Bangkok		Hanoi	
	Lab scale	Pilot scale	Lab scale	Pilot scale
Operating conditions				
HRT	24–48h	48h	20–96h	48h
No of baffles	2 – 3	3	2 – 3	2 – 4
Removal efficiencies [1]				
BOD	81–91%	83%	55–75%	- [2]
COD	80–88%	86%	52–75%	- [2]
SS	62–84%	94%	60–86%	- [2]

1: Average values, depending on the HRT
2: Not monitored yet

Figure 1: Treatment efficiencies of the ABR observed in the laboratory and pilot scale research projects in Bangkok and Hanoi

Collaborative field research on decentralised wastewater treatment is currently ongoing in Thailand, Vietnam and China. Field research is presently conducted on low-cost anaerobic treatment systems such as the anaerobic baffled reactor (ABR) and the anaerobic filter. Research activities on low-cost systems for greywater treatment at household level are being launched.

Recent Research Projects in DESAN

Anaerobic baffled reactor (ABR) with and without anaerobic filter (AF)
SANDEC is conducting research with its partners in Bangkok (Asian Institute of Technology) and Hanoi (Hanoi University of Civil Engineering) on anaerobic systems such as the ABR and the AF. In Bangkok eight lab scale and one pilot scale ABR with AF have been operated by AIT since March 2003. In Hanoi, two lab scale ABR with AF have been operated by CEETIA since July 2001. In 2003/2004 seven full scale units were constructed for private houses, schools and universities in and around Hanoi.

The main research outcomes reveal (Figure 1):

- Average SS, COD and BOD removal efficiencies of 75-90% could be reached with the ABR system.
- Hydraulic retention times (HRT) of more than 48 hours did not significantly increase treatment performance.
- The additional benefit of the AF could not be demonstrated.
- An increase in the number of baffles led to more stable effluent characteristics in terms of SS, BOD and COD.

Several research questions on ABR still remain to be tackled (e.g. adequate post-treatment systems for ABR effluent, long-term treatment performance, O&M). Technical guidelines are expected to be available by 2006.

Development and implementation of a decentralised sanitation concept in Shaxi Town, China
The Shaxi sanitation project is conducted by SANDEC in close collaboration with the Swiss Federal Institute of Technology (ETH). The main objective of the project was to develop a sustainable sanitation concept for the city of Shaxi, Yunnan Province, China.

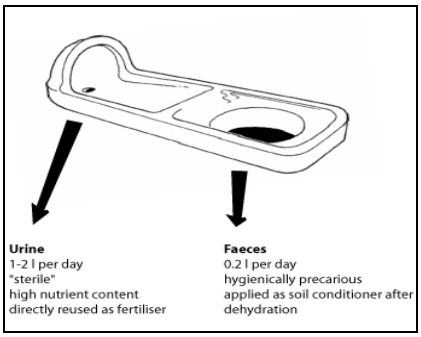

Figure 3: Urine diversion latrines in private households

Two basic concepts were proposed and implemented in parallel:

(a) A simplified sewer system with wastewater pretreatment in an ABR and post-treatment in waste stabilisation ponds (Figure 2) - implemented in the city centre, with two public toilets for market visitors and tourists (Figure 4);
(b) Urine diversion latrines with combined grey and stormwater drainage for private households - reuse of urine and dehydrated faeces in agriculture (Figure 3).

Figure 4: Two ABRs were installed in Shaxi Town according to the outcomes of the research conducted in Hanoi and Bangkok

Additional Information

Documents produced by SANDEC on decentralised sanitation may be downloaded from SANDEC's homepage: www.sandec.ch

Detailed information on the Sib Denx project is available on the project homepage: www.nsl.ethz.ch:16080/irl/shaxi

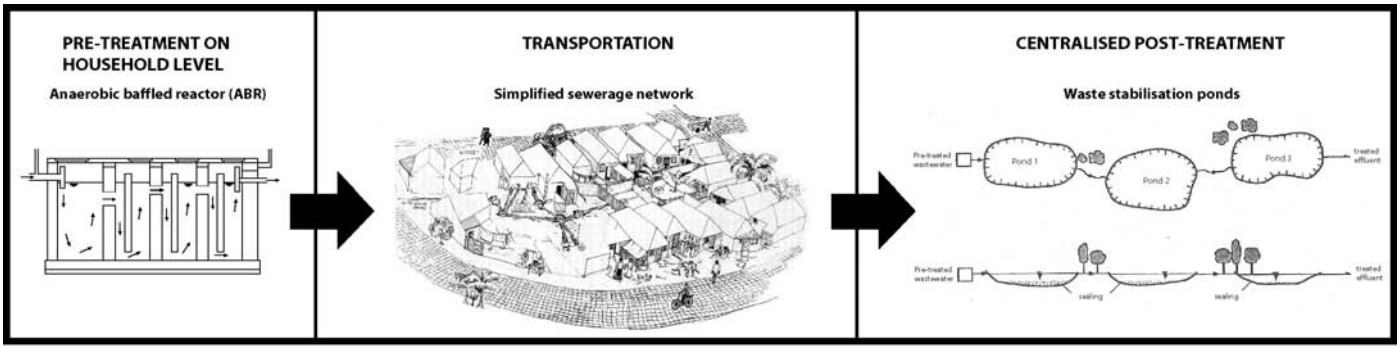

Figure 2: Wastewater management concept developed and (partly) implemented in Shaxi Town, China

Material Flow Analysis – A Tool for Environmental Sanitation Planning

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Material Flow Analysis (MFA) – Potential and Limitations

The current environmental sanitation practices do not allow to close the loop between food production on one hand, and excreta and solid waste generation on the other. Most nutrients contained in excreta are discharged into the environment, thereby causing health hazards and degrading natural resources. In response to the need of more sustainable water and nutrient management, new environmental sanitation approaches will have to be developed both in industrialised nations and developing countries.

These approaches should also allow to:

- Reduce organic matter and nutrient loads into surface and groundwater.
- Avoid misuse of clean drinking water, establish a balance between water consumption and its renewal rate and reduce wastewater generation.
- Minimise the loss of soil organic matter and nutrient depletion, and reduce the energy and raw material consumption required for production of nitrogen and phosphorous fertilisers.

Material Flow Analysis (MFA) is an appropriate method to answer material and energy flow questions since it studies the resources used and transformed during their flow through a region. In industrialised nations, MFA proved to be a suitable instrument for early detection of environmental problems and for development of countermeasures (Baccini and Brunner, 1991).

Developing countries have already used MFA in environmental sanitation. However, application of the method may not be within the reach of planners in developing countries as the method is dependent on such factors as data availability and reliability, as well as means for further data collection (budget, laboratory equipment, etc.).

SANDEC's MFA project aims at developing tools and recommendations to render MFA application more affordable to environmental sanitation planners in developing countries.

Environmental Sanitation in Viet Tri

The following example describes how MFA can be applied to assess potential sanitation measures leading to an improved nitrogen management in Viet Tri, a city of 130,000 inhabitants located 80 km North-East of Hanoi in Vietnam (Thai, 2001, Montangero et al., 2004).

The results obtained indicate that 80% of the nitrogen reaching the households as food are ultimately discharged as faecal sludge or wastewater into surface water, fish ponds or onto the soil, thereby resulting in water pollution (Fig. 1). The quantified flows further tend to indicate that current excreta management and food production practices lead to nitrogen depletion in agricultural soils. However, some flows (nitrogen flows in crops and fertilisers in particular) should be assessed more accurately to determine the nitrogen demand in agriculture. Nitrogen recovery efficiency through management of household food waste is high (90%). Excreta management should be improved to enhance nitrogen cycling in Viet Tri.

The following scenario was simulated:

- Increasing the number of households using urine diversion latrines (half the peri-urban area) and reusing urine and faeces in agriculture.
- Treating septic tank sludge in constructed wetlands, the effluent in duckweed ponds (serving half of the urban centre) and reusing the treatment products in agriculture.

The proposed measures could reduce by 30% the nitrogen load into surface water, fish ponds and the soil. They could therefore limit the risk of oxygen competition in fish ponds and reduce the health risks associated with the use of excreta-contaminated surface water. Moreover, the nitrogen load, originating from excreta and available for crop production (e.g. tree watering with pond effluent and urine, biosolids application for tea, rice and corn production), could increase by 200%.

Despite the lack of available and reliable data, the MFA method was applied in Viet Tri to obtain a preliminary assessment of the nitrogen flows and to develop potential measures. However, reliability of the estimated flows should be verified and sensitive parameters further determined more accurately. Tools and recommendations are required to assist environmental sanitation planners in verifying the reliability of the estimated flows and to design sound data acquisition programmes. A database containing transfer coefficient values of relevant processes applicable to environmental sanitation and food production, specific flows and substance concentrations in the relevant goods is an important element of such a tool.

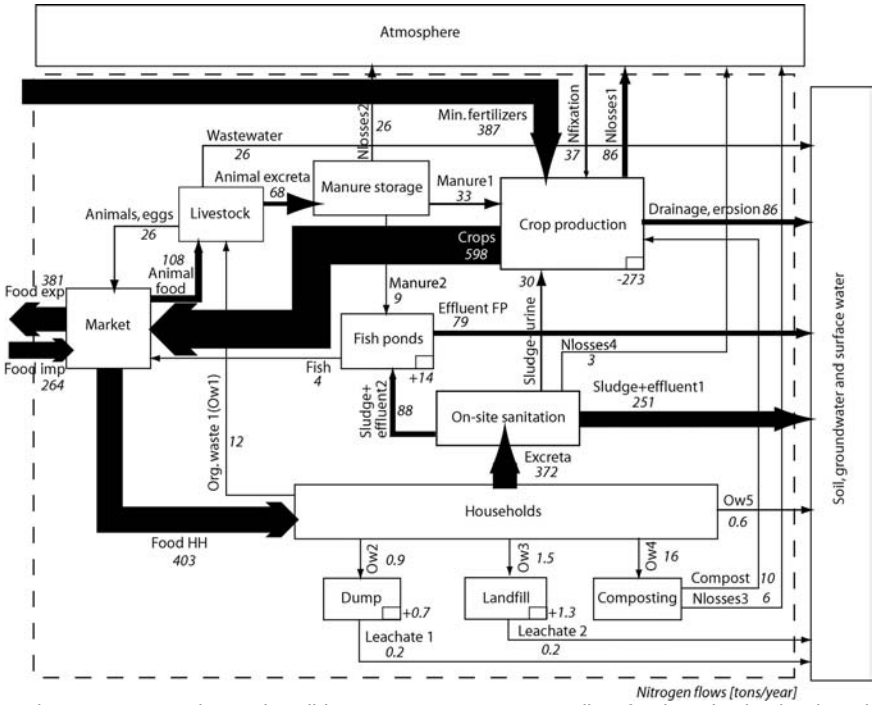

Fig. 1. Excreta and organic solid waste management as well as food production in Viet Tri

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Reuse of Organic Waste in Urban and Peri-urban Agriculture

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An integrated approach to urban environmental sanitation as well as urban and peri-urban agriculture may contribute to solving the problems of rapidly expanding cities in developing countries. To date, reuse of organic waste, as suggested here, has received little attention. A concept based on nutrient balances combined with remote sensing, geographic information systems (GIS) and farming system analysis should allow to gain a better insight into urban and peri-urban material and nutrient flows. This spatial approach aims at providing treated waste based on the demand of urban and peri-urban agriculture and, thus, also at mitigating urban environmental sanitation problems.

Background

Due to the western-oriented view of a modern city held by numerous politicians, the coexistence potentials of rural and urban practices have so far received little attention. Organic urban waste as well as human excreta and food processing waste contain significant amounts of readily available nutrients, which can be basically used as agricultural fertilisers. However, urban waste is often discharged untreated or illicitly dumped into the environment.

Gaps in Knowledge

The lack of information on urban and peri-urban material and nutrient flows in many regions hinders efficient and demand-oriented reuse of organic urban waste (Allison *et al*., 1998, Belevi and Baumgartner, 2003; Drechsel and Kunze, 2001). Strategically comprehensive approaches to urban waste (liquid and solid) management are also lacking, particularly integration of peri-urban agriculture in management concepts. Planning and implementation tools of waste management concepts should therefore increasingly focus on material and nutrient flows.

New Concepts and Tools

A concept for material and nutrient flow analysis was developed on the basis of nutrient balances, which are widespread in Europe and used as a tool to facilitate compliance with environmental standards on farms (Oborn et al., 2003). Remote sensing, GIS and farming system analysis will allow to improving data on material flows in peri-urban agriculture. Remote sensing and GIS also support local positioning of nutrient supply and demand, whereas the farming system analysis allows both to assess the reuse potential of varying systems and to gain insight into the socio-economic conditions of smallholders. Information on cultivated crops

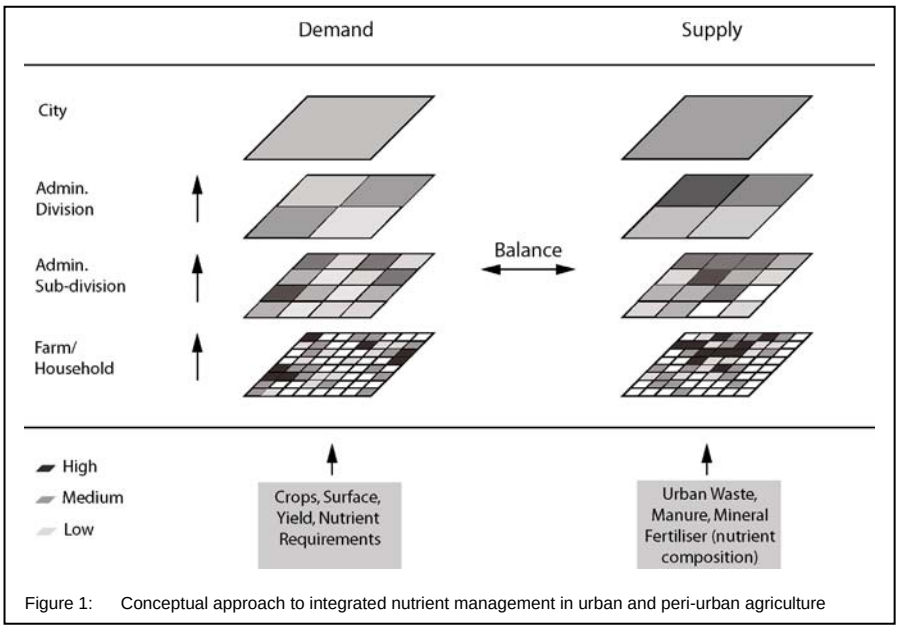

Figure 1: Conceptual approach to integrated nutrient management in urban and peri-urban agriculture

(e.g. surface, yield, and nutrient requirements) can be used to determine the nutrient demand. Furthermore, data on organic urban waste, manure and mineral fertilisers (nutrient composition) are used to calculate the nutrient supply. Nutrient balances will subsequently compare supply and demand. Assisted by remote sensing and GIS, the data recorded on farm level will be aggregated to the next higher administrative level (Figure 1). This process is continued until the supply and demand data are available at the required administrative level (e.g. urban district). The approach is thus based on the HCES (Household-Centred Environmental Sanitation) concept, which advocates the solving of urban sanitation problems at the source (Schertenleib, 2000).

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NCCR North-South: Research Partnerships for Mitigating Syndromes of Global Change

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Rationale of the NCCR Programme

The Swiss National Science Foundation (SNSF) is funding 14 long-term research programmes in areas of vital strategic importance for the advancement of science in Switzerland, for the country's economy, and for Swiss society. One of these programmes, co-funded by the Swiss Development Cooperation (SDC), is the *National Centre of Competence in Research (NCCR) North-South: Research Partnerships for Mitigating Syndromes of Global Change.* The NCCR North-South is a multi-disciplinary, multi-national and multi-cultural network dedicated to mitigation-oriented research and capacity building for sustainable development.

The programme of the NCCR North-South focuses on international research co-operation and promotes high-quality disciplinary, interdisciplinary and trans-disciplinary research. The aim is to contribute to an improved understanding of the status of different syndromes of global change, of the pressures and causes these syndromes exert on different resources (human, natural, economic), and of the responses of different social groups and society as a whole.

As foundation of collaborative structure, the programme consists of eight individual projects (IP), each headed by Swiss core institutions. SANDEC manages one of the Individual Projects (IP3) focusing on environmental sanitation.

The research aim of NCCR North-South is to assess and support sustainable development in three specific contexts/ areas:

- Urban and peri-urban areas
- Semi-arid areas in transition
- Highland-lowland areas

Interdisciplinary exchange is promoted in nine *Joint Areas of Case Studies* (JACS, see Figure 1), where efforts are undertaken jointly by the IPs and local partner institutions.

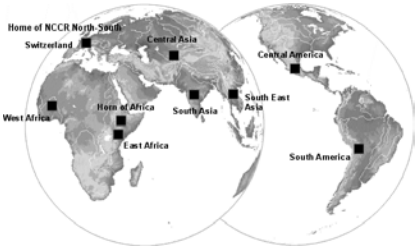

Figure 1: Joint Areas of Case Studies (JACS) of NCCR North-South

SANDEC's Activities in Phase 1 (2001-2005)

SANDEC's Individual Project IP3 aims at enhancing the scientific basis for improving environmental sanitation, for the urban poor (Figure 2). This includes treated human waste recycling for food production in urban areas (urban agriculture) and comprises technical, socio-economic, institutional and ecological aspects.

Geographically, SANDEC's activities centre on the JACS regions of Southeast Asia (Thailand, Vietnam, South China), West Africa (Abidjan, Burkina Faso, Ghana) and Central and South America (Cuba, Mexico, Bolivia). The list below shows selected IP3 projects:

- Material Flow Analysis (MFA) as a tool for environmental sanitation planning in developing countries (PhD Agnès Montangero).
- Assessment of water quality problems and mitigation potentials by using MFA - a case study in the Tha Chin river catchment area, Thailand (PhD Monika Schaffner).
- Integrated assessment and decision support of urban water management in Kunming, China (PhD Dongbin Huang).
- Potentials of introducing source control in sanitation in the city of Kunming, China (Postdoc, Edi Medilanski).
- Use of co-compost under irrigated and rain-fed (peri-)urban agriculture (PhD Noah Adamtey, Ghana)
- Integrated nutrient management in urban and peri-urban areas, Vietnam (PhD Dionys Forster).
- Sustainable faecal sludge management through innovative planning methodologies and approaches in Ouahigouya, Burkina Faso (PhD Halidou Koanda).
- Development of design criteria for constructed wetlands treating faecal sludge in tropical regions: case study of Yaoundé, Cameroon (PhD Ives Kengne) .
- Decentralised wastewater treatment for small-scale communities in Vietnam and Thailand.
- Evaluation of the acceptance and testing of different strategies to disseminate the solar water disinfection technique, SODIS, at different sites in Bolivia.
- Formulating waste management strategies based on household waste practices and perceptions in Santiago de Cuba, Cuba.

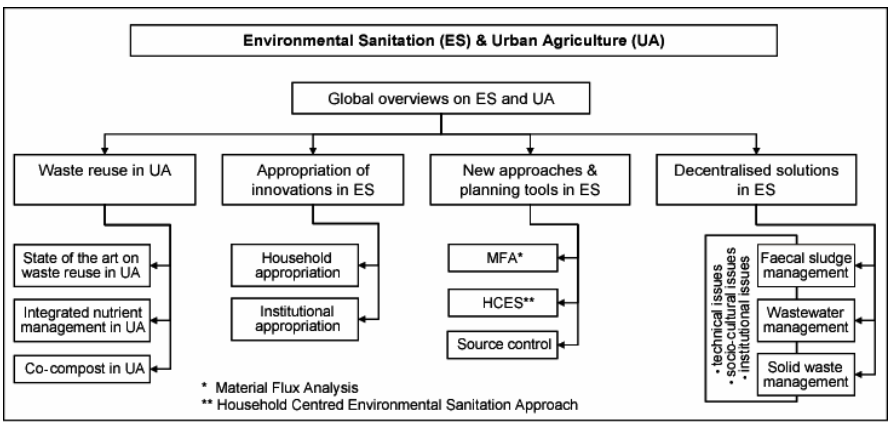

Figure 2: SANDEC's research in the NCCR North-South Programme

Aside from conducting research, SANDEC has been active in *Partnership Actions for Mitigating Syndromes* (PAMS). These projects aim at validating mitigation strategies in partnership with actor groups in the various JACS. Some selected examples:

- Implementation and promotion of urine diverting latrines in a village near Kunming, China.
- Collection and reuse of human urine in Mexico, and ecological sanitation in San Juan Tlacotenco (Tepoztlán), Mexico.
- Development of technical guidelines on constructed wetlands for septage treatment and management (Thailand).
- Promotion of low-cost biogas digesters for renewable fuel production on smaller farms (Kenya).

New Orientation in Phase 2 (2005 -2009)

Phase 2 of the NCCR North-South Programme shall strengthen research collaboration and networks to enhance the transdisciplinary nature of the projects. SANDEC will establish closer ties with the Swiss Tropical Institute (STI) to develop methods for integration of health and strategic environmental sanitation in participatory planning processes. The work package on health and environmental sanitation shall thereby focus on:

- Factors of vulnerability and resilience in different contexts when addressing health, well being and environmental sanitation;
- Factors of improving in excreta and wastewater management;
- Reducing vulnerability of urban and mobile poor populations through improved environmental sanitation.

Additional Information

The following comprehensive homepage informs on all NCCR North-South activities: www.nccr-north-south.unibe.ch

Faecal Sludge Management (FSM)

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FSM – A Must to Avoid Pitfalls in Sanitation!

[see end of article for list of acronyms and abbreviations]

Though a vast majority of urban dwellers in developing countries will continue to depend on on-site sanitation installations and on pit emptying services, many stakeholders in urban sanitation still regard sewered sanitation as the standard and exclusive solution to the urban "shit drama". Others promote and implement on-site sanitation programmes, yet forget to cater to an improved and sustainable collection, use or disposal of pit or vault contents. This leads to pitfalls or own-goals in urban sanitation upgrading. SANDEC has recently intensified its support and field research on the institutional and financial aspects of FSM. Technical research on treatment options of the contents (so-called faecal sludges, FS) of on-site sanitation installations also continued. SANDEC plans to increase its focus on building the capacity of selected institutions and professionals, and disseminating FSM knowledge in the years to come.

Field Research Update and Outlook

Treatment options

Collaborative field research on low-cost FS treatment options comprised:

- co-treatment of septage and wastewater in waste stabilisation ponds (including pretreating FS in settling/anaerobic ponds); collaborating partner: CIS/UNR;
- septage treatment in constructed wetlands (Photo 1; sludge humification; partner: AIT);
- FS dewatering on unplanted sludge drying beds (Photo 2; partners: IWMI/ KNUST/ KMA);
- combined composting (co-composting) of dewatered FS and organic solid waste (partners: IWMI/KNUST/KMA).

Tentative guidance on design and expected performance is now available (Table 1; selected processes and options only). The options are free of process-related, permanent mechanical equipment except for solids removal accumulated in primary settling-thickening units or for pumping FS liquids, if gravity flow is not possible.

Photo 1: Cattail-planted constructed wetlands

Photo 2: Sludge drying beds (Kumasi)

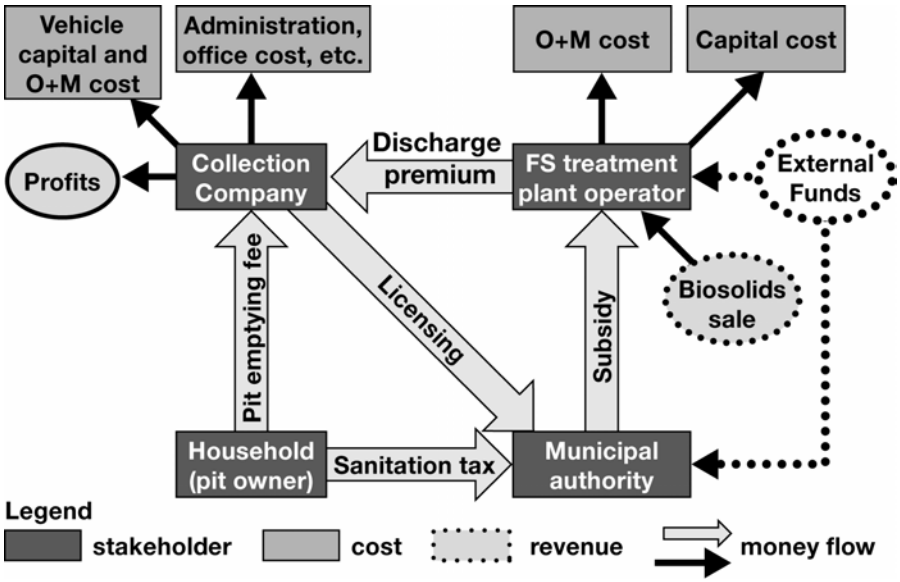

Figure 1: Money flux and stakeholder relationship tool for iFSM (Discharge premium arrow: paying the FS haulers rather than charging them – an incentive-based regulatory tool)

Future collaborative treatment research will focus on expanding the use of constructed wetlands to treat FS other than septage, and use of macrophytes other than *Typha*, and on evaluating different filter bed characteristics and configurations in sludge drying beds.

Financial/Institutional Aspects

The two major challenges associated with improving FSM consist in ensuring that FS is transported to the appropriate (treatment) site, and that the biosolids produced from treated FS are marketable to local, urban and peri-urban farmers or other potential buyers. Identifying, analysing roles, seeking advice of and concerting with key stakeholders - households, FS collection entrepreneurs, municipal and national sanitation authorities, farmers - are essential factors to meeting these challenges. Establishing sound financial structures and flows is a further important prerequisite. The "money flux" model illustrated in Figure 1 can be used as an FS management planning tool.

For all FS to be delivered to the treatment sites, we propose the special strategic element of reimbursing rather than charging FS haulers (Steiner *et al.* 2002; Jeuland 2002; Blunier 2004; Koanda 2004). This regulatory market tool is likely to curb indiscriminate FS dumping and, thus, reduce public health risks and water pollution. The costs of the treatment plant operations must be covered by licensing fees, sanitation taxes, proceeds from the sale of treated biosolids, and/or from subsidies.

Table 1: Selected Options for (Pre)treating Faecal Sludges: Design Criteria and Expected Removal Efficiencies

Treatment process or option	Design and operational criteria	Treatment goals and achievable performance		
		Solids-liquid separation	Removal of organic pollutants in liquid fraction	Removal of parasites (helminth eggs)
Settling/ anaerobic ponds	300-600g $BOD_5/m^3/d$ HRT[1]: ≥ 15 days SAR[2]: 0.02 m^3/m^3 (Rosario) and 0.13 m^3/m^3 (Accra)	BOD_5 > 60-70%	Filtered BOD_5 > 50%	Eggs concentrated in the settled and floating solids
Constructed wetlands (planted drying beds)	≤ 250 kg TS/m^2/year SAR: 20 cm/year (Bangkok; *Typha augustifolia* - cattail); bed permeability unimpaired for 7 years; vent piping required	SS > 80 %	To be treated in ponds or constructed wetlands for enhanced BOD, nutrients or pathogen removal	100% retained on top of the filter media
Co-composting	Dewatered FS (TS = 20-25 %): organic solid waste = 3:1 – 2:1 (vol. ratio) Windrow turning @ 10 days' interval for 8 weeks	- Compost maturity reached after 10-12 weeks - Heavy metal concentrations in compost meet the standards of industrialised countries		No. of viable eggs < reuse guideline

[1] *HRT: Hydraulic retention time*

[2] *SAR: Solids Accumulation Rate*

The entire scheme is sustainable only if:

- households can afford pit emptying
- enterprises can make a profit while adhering to the rules and regulations
- treatment operations meet the established treatment objectives and are profitable or operated at least cost
- the responsible authority can achieve sustainable iFSM at minimal costs.

Photo 3: Private entrepreneurs – stewards for clean cities

SANDEC has conducted financial assessment studies on FS collection enterprises in Bamako (Mali), Ouahigouya (Burkina Faso) and Kumasi (Ghana). The studies reveal that FS collection is a profitable business if haulage distances remain short and if licensing fees and sanitation taxes levied by public entities are channelled back to subsidise the system. In West Africa for example, private entrepreneurs (Photo 3) have taken the lead in managing the stewardship for safeguarding the urban environment through well-managed FS collection (Jeuland 2004). In Ouahigouya (Burkina Faso), a PhD study is in progress to devise stakeholder involvement methods and a methodology to evaluate strategic scenarios for iFSM as an integral component of urban sanitation upgrading (Koanda *et al*. 2004). Furthermore, SANDEC is investigating the impact of stakeholder involvement on iFSM sustainability.

Dissemination, Training and Competence Building

An increasing number of national and municipal authorities, including external support agencies feel the need to improve FSM. We are responding to this need by strengthening our efforts to assist selected institutions in building expertise on technical and managerial aspects as well as on monitoring and applied research in FSM.

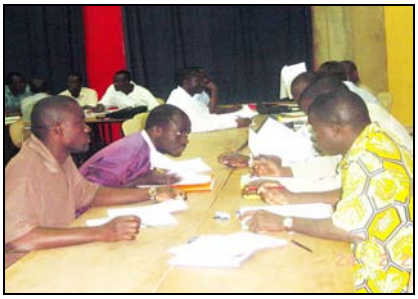

Photo 4: Training of trainers – key elements in building professional competence

The specific ongoing activities comprise:

- Producing guidance documents and briefs on technical and non-technical aspects of FSM.
- Developing training modules and training professionals and trainers in FSM (Photo 4).
- Identifying institutions in the South interested in developing FSM expertise and assisting them in their efforts.
- Liaising with multilateral and bilateral support agencies, often key players, in formulating urban sanitation strategies.

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Acronyms and Abbreviations

AIT	Asian Inst. of Technology (Bangkok, Thailand)
CIS/UNR	Centro de Ingeniería Sanitaria, Univ. Nacional de Rosario (Argentina)
FS	Faecal sludges
FSM	Faecal sludge management
iFSM	Improved FS management
IWMI	Inter. Water Management Institute (Africa Office)
KMA	Kumasi Metropolitan Assembly (Ghana)
KNUST	Kwame Nkrumah Univ. of Science & Tech. (Kumasi, Ghana)

Photo 5: Ghanaian sanitation experts and treatment plant operator at an FS treatment plant in Ghana (left: FS settling-thickening tank; right: stabilization pond for settling tank supernatant)

Some Faces at SANDEC

Halidou Koanda

Halidou is writing his PhD thesis on "Stakeholder Analysis and Involvement for Improved Faecal Sludge Management in Ouahigouya, Burkina Faso". Even though Halidou is a doctoral student at the École Polytechnique Fédérale de Lausanne (EPFL), he forms part of SANDEC's staff given his close collaboration with our Faecal Sludge Management group; just as Hansi Mosler, Sociologist at the Systems Analysis, Integrated Assessment and Modelling (SIAM) Department of EAWAG. During his field work in Burkina Faso, Halidou is hosted and supported by CREPA, one of SANDEC's key research partners in West Africa.
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Ives Kengne

Ives' PhD thesis focuses on "Development of Design Criteria for Constructed Wetlands Treating Faecal Sludge in Tropical Regions: Case Study of Yaoundé (Cameroon)". His thesis is an important complement to the research on constructed wetlands for faecal sludge treatment conducted at AIT, Bangkok, Thailand. Ives started his field work in Yaoundé in January 2005 after spending four months of intensive preliminary work at SANDEC in Switzerland. As a research associate at the Faculty of Science at the University of Yaoundé, he is currently working in close collaboration with Prof. Amougou Akoa and Dr Bemmo.
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Noah Adamtey

Within the framework of the NCCR North-South research programme, and to further enhance SANDEC's activities in urban agriculture, Noah has begun his PhD thesis on "Use of Co-compost under Irrigated and Rain-fed (Peri-)urban Agriculture in Ghana". His research work is conducted in close collaboration with the International Water Management Institute (IWMI) in Accra, Ghana. Noah is also managing the experimental co-composting pilot plant at Buobai, Kumasi. This pilot plant, located at about 15 km from Kumasi's city centre, serves to test and gain knowledge on issues ranging from sludge dewatering, nutrient losses to inactivation of pathogens.
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More from EAWAG

Assessment and Removal of Arsenic from Contaminated Water in Vietnam

Contact: michael.berg@eawag.ch

A research project between the Centre of Environmental Technology and Sustainable Development (CETASD) and EAWAG is currently evaluating and further developing technologies for arsenic removal in groundwater and drinking water at two different treatment plant scales in Northern Vietnam:

Urban supply water plants (capacity 50,000-100,000 m^3/day). Hanoi's public drinking water plants use aeration and sand filtration for iron and manganese removal in the pumped groundwater. A recent research paper reveals that this process eliminates 20-70% of the arsenic in the raw groundwater. In some plants, however, the treated drinking water still contains arsenic concentrations above 50 ug/L. Ammonium, another problematic contaminant in Hanoi's groundwater is not removed by the current treatment technology. Tests to enhance arsenic oxidation and biological denitrification of ammonium are conducted in a pilot plant to improve the arsenic and ammonium removal efficiency.

Private tubewells (capacity < 1 m^3/day). Various locally available sorbent materials have been evaluated for their arsenic removal efficiency on household level. Ordinary sand was found to be the most suitable material, reaching average arsenic removal rates of 80% in some 50 tested households. The detailed report entitled "Household Sandfilters for Arsenic Removal - Technical Report" can be downloaded from
www.arsenic.eawag.ch/publications

Mitigation of Groundwater-Derived Arsenic Hazards in Bangladesh

Contact: stephan.hug@eawag.ch

As part of national and international efforts to find solutions and to develop safe water supply systems in arsenic-affected regions, the Alliance for Global Sustainability (AGS) has funded a collaborative project between the University of Tokyo (UT), the Massachusetts Institute of Technology (MIT), EAWAG, and the Bangladesh University of Engineering and Technology (BUET).

Some of EAWAG's ongoing research aims at optimising simple arsenic removal units. Due to the high concentrations of As(III), phosphate and silicate in Bangladesh, arsenic removal has become a challenging task in this country. Simple sand filtration is insufficient as natural dissolved iron concentrations are too low, and the currently available arsenic removal systems still face serious problems or are too expensive.

Together with researchers from MIT and BUET, field studies are being conducted to determine the chemistry of arsenic release in the sediments. The study aims at developing a model to assess arsenic release and transport and to understand how irrigation wells affect groundwater flow and arsenic mobility. A prime objective is to determine construction criteria for safe and arsenic-free drinking water wells, and to avoid contamination of the deeper aquifers.

A new and SNSF-funded collaborative project between EAWAG, the Institute of Terrestrial Ecology (ITO) and BUET studies arsenic-contaminated rice fields through irrigation with contaminated groundwater. To feed its population of 140 million, Bangladesh increasingly depends on high-yield dry season Borho rice production requiring massive irrigation from predominantly shallow and contaminated tubewells. This study focuses on arsenic transference from the water to the soil and plants, and on arsenic accumulation in terms of time and future potential health hazards.

On the Bookshelf

Apart from the publications cited in the text, we recommend the following new books and publications as key readings in the water supply, environmental sanitation, solid waste management, and urban agriculture sector:

- **WHO Guidelines for drinking-water quality, third edition.** WHO, Geneva, 2004. Available from bookorders@who.ch www.who.int/water_sanitation_health
- **UN World Water Development Report - Water for People, Water for Life**. UNESCO. www.unesco.org/water/wwap/
- **Water and Sanitation in the World's Cities – Local Action for Global Goals.** United Nations Human Settlements Programme (UN-HABITAT), 2003. Available from www.earthscan.co.uk
- **Research for Mitigating Syndromes of Global Change – A Transdisciplinary Appraisal of Selected Regions of the World to Prepare Development-Oriented Research Partnerships.** NCCR North-South, 2004. Available from www.nccr-north-south.unibe.ch
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- **Decentralised wastewater management in peri-urban areas in low-income countries.** Jonathan Parkinson and Kevin Tayler in Environment and Urbanization Vol. 15 No. 1. 2003. Available from www.iied.org
- **Sustainable Composting: Case Studies and Guidelines for Developing Countries**. Mansoor Ali (Editor), WEDC, Loughborough University, 2004. www.lboro.ac.uk/wedc

Announcements

Composting Database

In May 2005 SANDEC will launch the "*decomp database*". This online database provides facts and figures on decentralised composting schemes worldwide while retaining specific focus on low and middle-income countries. Information on case studies is available as fact sheets or reference is made to specific Internet pages. The *decomp database* can be freely accessed and fed with further information sandec.instanthost.ch/

SODIS Wins the Special Award at the Energy Globe Awards 2004

The Energy Globe Award is the most significant environmental award worldwide. Best practice projects and initiatives for a careful and efficient use of our resources are awarded each year in the categories earth, energy, water, air, and youth. This year more than 600 projects from 100 countries have applied for the Energy Globe Award. Due to its media presence, the Energy Globe Award has a special significance for the promotion of SODIS. More information is available from www.energyglobe.at

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