EAWAG

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SANDEC News

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Farmer carrying excreta to the field
Photo: Dongbin Huang, Kunming (China)

Dear Reader,

The main purpose of this newsletter is to inform you about SANDEC's research activities and to find potential partners who would be interested in collaborating with us on specific research questions. I would also like to take this opportunity to draw your attention to some new developments within SANDEC.

In the past, our research activities were clearly divided into the fields of sanitation (management of faecal material and wastewater), water treatment and solid waste management. The articles on pages 3-7 in this Newsletter give an overview of our most recent and ongoing research activities in these sub-sectors.

On the other hand, the articles on page 2 reflect a new philosophy and approach of SANDEC's future research priorities. We are convinced that satisfactory sanitation coverage in urban and peri-urban areas of developing countries can only be achieved if water and environmental sanitation are conceived in an integrated way, taking into account all their potential impacts and synergies. For example, reuse of wastewater and plant nutrients contained in faecal material and municipal solid waste is the most effective way to reduce the demand for waste treatment and disposal provided that public health is not impaired. Therefore, we have decided to put more emphasis on the interlinkages between the different subsectors and to include urban agriculture in our work profile. As a first step in this direction we have conducted a systematic overview of urban agriculture to identify the water and waste-related issues of food production in urban areas. Furthermore, we consider the method of "Material Flow Analysis" a promising tool for integrated and holistic environmental sanitation planning (see articles on page 2).

I hope you will enjoy our SANDEC News. Please let us know by e-mail (dallatorre@eawag.ch) or by returning the card enclosed if you like to receive future issues of our SANDEC News as printed copy or per e-mail. Our Newsletter is also available as a pdf-file on our homepage (www.sandec.ch).

Roland Schertenleib
Director SANDEC

A Systematic Overview of Urban Agriculture in Developing Countries

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Urban farmers become involved in urban agriculture mainly for reasons of food security and income generation. However, urban agricultural activities are also of key importance from a public point of view. They can highly contribute to enhancing public health by providing more food and a diversified diet. Urban agriculture can also improve resource management through excreta, wastewater and organic solid waste reuse. To reach these goals, activities in the following processes have to be pursued: agricultural practices, soil quality management, irrigation, animal feed, public health management, urban planning, and policy development.

A literature review has been conducted to obtain a systematic overview of urban agriculture in low- and middle-income countries and to identify research needs. The crosscutting issues between urban agriculture and environmental sanitation, comprising excreta, wastewater and solid waste management, are of key importance.

SANDEC plans to conduct research to quantify benefits, risks, opportunities, and constraints of urban agriculture with regard to resource and waste management. The role of urban agriculture in regional water and organic material flows will be analysed. Research will also be conducted to determine the environmental and food quality impact of wastewater and organic waste reuse.

Consult the PDF document of Bettina Baumgartner and Hasan Belevi (2000), "A Systematic Overview of Urban Agriculture in Developing Countries" at http://www.sandec.ch/

Sustainable Regional Development in Mekong Countries: Problems and Opportunities

Hasan Belevi, hasan.belevi@eawag.ch

Seven Swiss research institutes are involved in a scientific programme financed by the Swiss National Science Foundation ("National Centers of Competence in Research", NCCR) and entitled "NCCR North-South Research Partnerships for Mitigating Syndromes of Global Change". The objectives of the envisaged 10-year programme are the following: a) to promote disciplinary, interdisciplinary and transdisciplinary research on sustainable development, b) to help strengthen institutions and train staffing partner countries in these fields of research, and c) to support societies and institutions of partner countries in their effort to address syndromes of their regions. The programme will be implemented through research partnerships between Swiss research institutes and their partners in the South.

In this context, one of the eight international "pre-synthesis" workshops in countries of the South was held in Hanoi in 2001. 28 professionals from Cambodia, Laos, Switzerland, Thailand, and Vietnam attended the workshop whose objectives were to conduct brainstorming sessions on core problems in the Mekong countries and to formulate possible research topics as contribution to the NCCR research programme.

Additional information on the workshop can be obtained from the author.

Organic Waste Management Using Material Flow Analysis in Kumasi, Ghana

Hasan Belevi, hasan.belevi@eawag.ch

Kumasi is the Ghanaian capital of the Ashanti region. Its 982,000 inhabitants spread over a total area of 254 km^2. Breweries, sawmills and poultry farms are important industries generating organic material fluxes. The available sanitation systems comprise unsewered public toilets, bucket latrines, pit latrines, WC/septic tank systems, and a sewerage system. Open defecation is also being practised. Part of the faecal sludge produced in the unsewered system is collected and treated in ponds. Some of the solid waste generated is collected and disposed of in a landfill.

The annual organic material and nutrient fluxes were determined for Kumasi. Mass fluxes of goods (fertiliser, food, municipal solid waste, compost, etc.) and mass fluxes of nutrients (carbon, nitrogen and phosphorous) were either assessed by literature data, determined by field measurements, or calculated by mass balances over a process or process chains.

As illustrated by the figure below, about 80% of the nitrogen transferred to the environment flow through private households. Therefore, households are the key processes with regard to organic material and nutrient fluxes, as they are characterised by a major turnover of materials and waste production. Consequently, measures taken at the household level, as well as appropriate household waste management strategies could greatly enhance resource recovery and environmental protection in Kumasi.

About 1700 tons of nitrogen are disposed of annually in landfills. Additionally, about 3600 tons of nitrogen are discharged into surface waters and about 1700 tons reach the soil. Part of these nitrogen fluxes could be recycled by co-composting faecal sludge and municipal solid waste, and the finished compost used as soil conditioner and fertiliser. Therefore, a hypothetical co-composting plant has been added to the system, and various different scenarios have been calculated. A "realistic" scenario, comprising only the waste fluxes transported currently by truck to the landfill, is linked to the hypothetical co-composting plant. According to this "realistic" scenario, the nitrogen demand of about 30% urban and peri-urban agriculture could theoretically be met by co-composting faecal sludge together with solid waste currently disposed of in landfills. To meet this objective, 57% of the compost produced have to reach urban agriculture and the remaining 43% peri-urban agriculture.

Furthermore, it is possible to reduce the nitrogen loads into groundwater and surface waters by about 17%, and the soil discharge by about 50%. However, surface water and groundwater pollution can only be reduced significantly if excreta collection coverage and treatment from private households are increased.

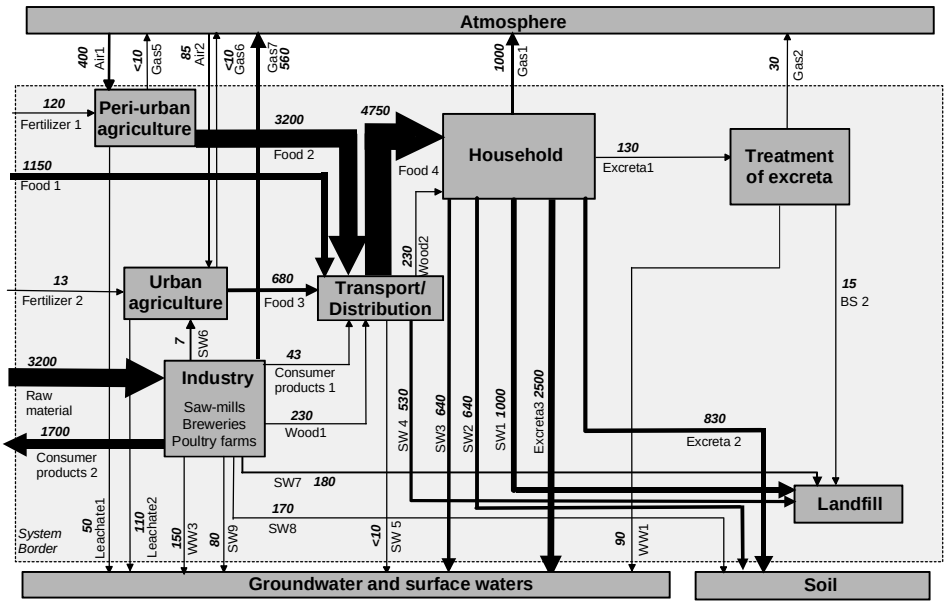

Figure 1: Annual nitrogen fluxes in Kumasi, Ghana in t/y
Fluxes are estimated with a 20-30% error margin
SW: Solid waste, WW: Wastewater, BS Biosolids

Faecal Sludge Treatment and Management –
Research, Extension and Dissemination

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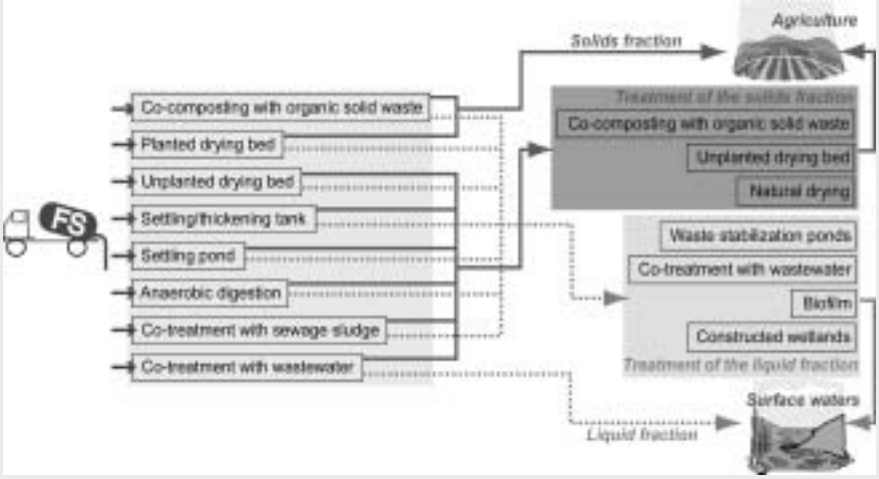
Programme Outline

The objectives of this programme are to establish guidelines for the management and treatment of faecal sludges; i.e., sludges from on-site sanitation systems (unsewered private and public latrines/toilets, aqua privies, septic tanks), and to strengthen the institutional capacity in this field. Collaborative field research on faecal sludge (FS) management and treatment is currently ongoing in Argentina, Ghana, Francophone West Africa, and Thailand. A planning guide for FS management is in preparation. Dissemination of acquired knowledge and experience, including an active exchange of experience gained by practitioners, will be a future target of the programme. Information on completed treatment option studies is available in SANDEC News 1-4, in various other publications, on our homepage or from the authors. Treatment options currently under investigation are outlined below.

Box 1 Treatment Options



Box 2 Constructed wetlands pilot plant at AIT with a core of accumulated and dewatered biosolids

Drained liquid	Accumulated biosolids
• Flow = 70% of loaded septage • COD, SS, NH_3-N removals = 97, 99 and 85%	• 50% of loaded solids retained • TS = 30% • Viability of helminth eggs ≤ 3 %

Suggested design for Bangkok-type septage (6-28 g TS/l) and climate (24-32 ºC): 250 kg TS/m^2/year

Box 3a Performance of septage pretreatment (sedimentation) pond in Alcorta, Argentina

Biosolids accumulation

- Solids accum. ratio = 0.016-0.02 m^3/m^3 of loaded septage
- TS of accumulated and thickened biosolids = 18%
- Depth of solids reached in 6 months loading = 50 cm
- In-pond dewatering to 60% TS in 7 months (T=9-24 °C, total rainfall = 540 mm)
- No conclusive results yet as to the inactivation of helminth eggs

Recent Field Research in FS Treatment

Choice and scale of investigated options

SANDEC has selected specific treatment options from an array of alternatives considered to be suitable for use in developing countries (Box 1). To date, two pond-based options, constructed wetlands, and co-composting have been or are currently investigated. One of the pond systems was studied in Accra, Ghana. It comprises settling/thickening tanks and a series of ponds to treat the separated liquid. The second pond scheme, currently in operation in Argentina, consists of septage settling/thickening ponds followed by two lagoons co-treating the septage liquid and municipal wastewater.

Constructed wetlands (CW)

A constructed wetlands pilot scheme planted with *Typha angustifolia* (cattail) and equipped with a natural venting system has been operated by AIT, Bangkok, since April 1997 (Box 2). Close to 1 m of dewatered and largely stabilised and hygienised biosolids have accumulated to date, thus, making bed emptying necessary in 2002. The equivalent of 80 m (!) of Bangkok's septage, loaded directly onto the beds during the 5-year period, did not lead to any bed clogging. Future investigations will focus on the need for ventilation, characteristics of the filter body after five years of septage loading, and on biosolids removal operations. Contact: Asian Institute of Technology, Environment & Resources Management Group, Dr. T. Koottatep and N. Surinkul, thamarat@ait.ac.th narongsurinkul@hotmail.com.

Co-treatment in ponds

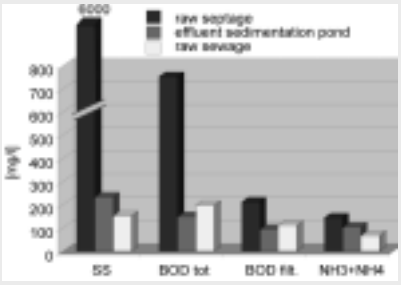
Until 1998, the waste stabilisation pond system – 2 ponds in series – of Alcorta, Prov. of Santa Fé, Argentina, treated FS and wastewater by co-mixing. Excessive solids accumulation in the primary pond due to septage admixture led to the construction of twin, alternatively batch-operated pretreatment ponds for septage (Box 3a).

These cater for the separation of the bulk of septage solids and for anaerobic degradation of the liquid during the loading period, as well as for in-pond solids dewatering during the resting/consolidation period. The effluent exhibits contaminant levels similar to those in the raw municipal wastewater. The two are co-treated in the original pond system. Box 3b shows the total and filtered BOD, SS and ammonia concentrations in the raw septage, in the effluent from the septage ponds and in the raw wastewater. Contact: Centro de Ingenieria Sanitaria, Univ. of Rosario, Prof. A.M. Ingallinella, cis@fceia.unr.edu.ar

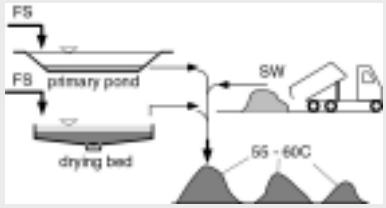
Co-composting

A pilot plant for combined composting (co-composting) of FS and organic solid waste (sorted municipal waste, market waste, animal husbandry manure, wood chips) has been commissioned in Kumasi, Ghana in March 2002 (see Box 4 for functional sketch). FS, which will be composed of sludge from unsewered public toilets and of septage, will be dewatered to the required solids content by sludge drying beds or thickened in a primary settling pond. Dewatered FS will be mixed with the organic waste and windrow-composted for a period of approximately one month (thermophilic phase) followed by a maturing phase of 1-2 months. Mixing ratios of 1:3 are envisaged for dewatered FS and sorted waste windrows. Mature compost, produced at a rate of 2 tons/month, will be tested in cultivation experiments to ascertain its marketability. Contact: International Water Management Institute, Africa Office, Dr Olufunke Cofie, iwmi-ghana@cgiar.org

Box 3b Septage pretreatment in Alcorta, Argentina



Box 4 Co-composting process as used in the Kumasi, Ghana, pilot plant



FS Management Planning

Nam Dinh (Vietnam) faecal sludge management planning study

In 2001, a study was conducted in Nam Dinh, North Vietnam, to devise a plan for improved long-term FS management strategies, and to propose an appropriate treatment option allowing marketing and use of hygienically safe biosolids. The study forms part of the Nam Dinh Urban Development Project (UDP), a joint endeavour of Nam Dinh authorities, the Governments of Vietnam and Switzerland, and the consulting company contracted for UDP. Sludges collected from on-site sanitation systems cause health hazards and drain clogging as they are still discharged untreated into drains and watercourses or used untreated in agriculture and aquaculture. Septic tanks are and will be the predominant form of excreta disposal system. The study proposes two management options to increase septic tank emptying frequency. Three potentially feasible options for treating septage were evaluated as to their treatment performance, operational requirements and safety, land use, and costs. All three options allow production of hygienically safe biosolids, suitable for agricultural use. Constructed wetlands were proposed as the favoured treatment option for Nam Dinh. The study report may be ordered from SANDEC. A conference paper, summarising the study's main features, can also be ordered or downloaded from SANDEC's homepage, http://www.sandec.ch/sos/references.html

Extension and Dissemination

Collaboration with CREPA

CREPA, the Regional Centre for Water Supply and Sanitation for Francophone West Africa, has launched a four-year action research programme on FS management and treatment. SANDEC, who is CREPA's discussion partner for this programme, provides technical assistance, while gaining additional knowledge in FS management and treatment, which it will disseminate in the future. The project, currently in its 1st phase, comprises a state-of-practice assessment of FS management, identification of gaps-in-knowledge on FS treatment adapted to the conditions of West Africa, and formulation of FS management plans for selected cities in Senegal, Ivory Coast and Benin. The 2nd phase will last from 2002-2004 and comprise action research in FS management and treatment, including production of stakeholder-directed guidance tools. Upon conclusion of this project, CREPA will have acquired the status of resource centre in FS management and provide planners and engineers with training and consulting activities on these issues. Contact: CREPA (Progeboue Project), Dr Amah Klutsé, crepa@fasonet.bf

Dissemination & extension activities

A complete listing of SANDEC's publications and reports on FS management, most of them downloadable, is now available on our homepage, htt://www.sandec.ch/sos/references.html To assist practitioners in the field, we shall further enhance dissemination of literature by expanding our homepage with easily digestible and ready-to-use technical news. Capacity building in FS management will be a future focus.

Call for Information

Although **anaerobic digestion and use of the biogas produced** may offer a potentially viable option for FS treatment, it remains a debatable alternative. The option does in fact look attractive as it yields energy and contributes to reducing global warming. The technology is widely used in industrialised countries as treatment option for sludges from sewage treatment plants. Respective installations are, however, fairly sophisticated and may not be sustainable in developing countries. SANDEC has not yet come across any low-cost anaerobic digestion–cum-biogas plants operated with faecal sludges collected from urban on-site sanitation systems. We are interested in obtaining information on such schemes, as the option may warrant investigations and will broaden the knowledge on its sustainability under DC conditions. Respective information on such schemes should be sent to:
martin.strauss@eawag.ch
agnes.montangero@eawag.ch

Call for Collaboration

Institutions engaged in R+D, extension or training in the field of FS management or wishing to engage and build up respective capacity, are invited to contact SANDEC for further deliberations on possible forms of collaboration and extension,
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agnes.montangero@eawag.ch

Document Retrieval and Selected References

Documents produced by SANDEC on FS management and treatment may be obtained free of charge from caterina.dallatorre@eawag.ch or downloaded from SANDEC's FS homepage, htt://www.sandec.ch/sos/references.html

Ingallinella, A.M., Sanguinetti, G., Koottatep, T., Montangero, A., Strauss, M. (2001). *The Challenge of Faecal Sludge Management in Urban Areas – Strategies, Regulations and Treatment Options*. Paper presented at the Specialised Conference on Sludge Management, Regulation, Treatment, Utilisation, and Disposal, Acapulco, Mexico, Oct. 25-27. [215 kb].

Klingel, F. (2001). *Nam Dinh Urban Development Project. Septage Management Study*. Nam Dinh, Vietnam, 1 November 2001. EAWAG/SANDEC and Colenco (Vietnam).

Klingel, F., Montangero, A. and Strauss, M. (2002). *Faecal Sludge Management Planning Guide* (in press).

Koottatep, T., Polprasert, C., Oanh, N.T.K., Montangero, A., Strauss, M. (2001). *Sludges from On-Site Sanitation – Low-Cost Treatment Alternatives*. Paper presented at the IWA Conference on Water & Wastewater Management for Developing Countries, Kuala Lumpur, Malaysia, Oct. 29-31. [366 kb].

Montangero, A. et Strauss, M. (2001). *Gestion des boues de vidange.* Atelier de planification, CREPA, Ouagadougou, Burkina Faso, juillet 2001. [960 kb].

Montangero, A. and Strauss, M. (2002). *Faecal Sludge Treatment.* Lecture Notes, IHE Delft, 14 February. [730 kb].

SODIS – A New Method Gradually Used Worldwide to Improve the Drinking Water Quality

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SODIS is a simple solar water disinfection method using sunlight to inactivate pathogens causing diarrhoea and, thus, improve the drinking water quality. Contaminated water is filled into transparent plastic bottles and exposed to full sunlight for five hours. During exposure, the sun destroys the pathogens and disinfects the water through the effects of radiation in the spectrum of UV-A and increased water temperature. For SODIS to be effective, a **solar radiation intensity of at least 500 W/m^2 is necessary for a period of five hours**. This is equivalent to five hours of midlatitude sunshine in summer. Since radiation and temperature have a synergetic effect on the water, the disinfection process only requires a third of the solar radiation intensity if the water temperature rises above 50 °C. The water is safe for consumption after one hour of exposure at 50 °C.

The SODIS method was presented in detail in SANDEC News No. 3, including the results of comprehensive laboratory and field tests. The socio-cultural acceptance, application procedure and financial viability were studied in demonstration projects in local communities of Colombia, Bolivia, Burkina Faso, Togo, Indonesia, Thailand, and China. The evaluation of the demonstration projects revealed that users appreciate the sustainable and simple water treatment method. An average of 84% of the users stated that they would "certainly" continue to use SODIS after conclusion of the demonstration project. About 13% of the users would "maybe" use it in the future, while only 3% refused to use SODIS, as their health was not impaired by the present water quality.

	I will continue to use SODIS			
Country	certainly	maybe	probably not	definitely not
Colombia	90	8	0	2
Bolivia	83	8	0	7
Burkina Faso	70	30	0	0
Togo	83	8	0	7
Indonesia	90	5	3	2
Thailand	87	8	0	3
China	55	45	0	0
average	84	12.8	0.4	3

Fig.1. Survey results of SODIS acceptance

The key to this success is attributed to the fact that, although SODIS is a simple and low-cost method, it does actually improve users' health and only requires locally available waste products, such as plastic bottles and sunlight - a free source of energy. In addition, SODIS also reduces the need for traditional energy sources, such as firewood or kerosene. Therefore, it has a positive influence not only on the household budget by reducing the costs of medical care and the amount of purchased fuel, but also on the workload, especially of women and children who have to collect less firewood. SODIS has a positive effect also on the environment as it reduces deforestation and air pollution.

Despite its apparent advantages, worldwide SODIS use is still rather limited.

Fig. 2. Much needs to be done yet for SODIS dissemination worldwide

SANDEC has, therefore, started worldwide SODIS dissemination and promotion campaigns aimed at promoting the introduction of this method in areas where safe drinking water is unavailable. SANDEC supports local partners in developing information material for introduction and implementation of SODIS strategies. In addition to collaboration activities with local governments and organisations, SANDEC also promotes SODIS publicity campaigns on an international level. The SODIS website is used as platform for the exchange of information and experience, http://www.sodis.ch

SANDEC's role in the SODIS project is to:
- Act as reference centre
- Support research activities
- Promote SODIS worldwide
- Coordinate SODIS dissemination
- Enhance information exchange

Since 1999, local SODIS initiatives and activities were launched in several Latin American countries, in Indonesia, Thailand, South Africa, Sri Lanka, Nepal, Kenya, India, Mexico, Angola, Brazil, Uzbekistan, etc.

The Swiss government, donor agencies, private industries, local organisations in developing countries, and foundations provide funding for SODIS activities. In October 2000, the *Avina Foundation* agreed to support a major programme for the promotion and dissemination of SODIS in Latin America. In June 2001, the *SOLAQUA Foundation* was established and registered with the objective to promote appropriate and simple water treatment methods in general, and to support dissemination of SODIS in developing countries in particular. The *SOLAQUA Foundation* focuses on backing SODIS initiatives in Asia and Africa. Local initiatives to disseminate SODIS in developing countries can apply for funding. Support may be granted if certain criteria are fulfilled.

Selection criteria for SODIS projects:
- Need for water treatment
- Climatic conditions
- Institutional potential
- Quality of the project proposal
- Financial aspects
- Potential for sustainability
- Reputation and potential of the applying institution

Lessons Learned During SODIS Implementation Projects

Experiences gained during implementation of SODIS activities revealed the importance of the following points:

- The SODIS dissemination projects in Bolivia have shown that a very effective way to spread and promote the method at grass roots level is through local leaders. These can be health promoters, persons involved in community development, teachers or other locally respected individuals.
- The best approach is to integrate SODIS into already existing projects of community health education or water and sanitation.
- As experienced by YDD, local availability of the required material is crucial for sustainability of SODIS application. The restricted number of plastic bottles available in Indonesia could only treat a limited amount of water. Therefore, YDD initiated a local scheme to purchase and transport used plastic bottles from the city to the villages.
- During implementation of the field study, YDD discovered that local community health workers and educated people, such as teachers, did not directly support SODIS, as they did not trust the method. They adopted a "wait and see" attitude, thereby, slowing down SODIS implementation.
- The drinking of hot boiled water is quite common in Indonesia. Dissemination of SODIS should concentrate on regions where people drink raw water.
- Repeated visits to communities, recently trained in SODIS, revealed that users had made a number of mistakes in applying the method. Although SODIS is a simple method, communities have to be trained carefully as well as monitored and guided closely for several months after training.
- "Does it work and does it really kill germs?" were the main questions asked by users in Kenya. To answer these questions, a series of bacteriological faecal coliform tests were conducted with a DelAgua membrane filter/incubation kit from August 2000 to April 2001. The community members were convinced of its effectiveness only after seeing the test results of their water.

Current SODIS Research Projects

So far, health improvements of SODIS users were not investigated systematically. Therefore, the Swiss Tropical Institute will be conducting, in cooperation with local Bolivian partners (Unicef, SODIS Bolivia, CASA), a health impact study of SODIS in the area of Mizque, Bolivia, in 2002/03.
CASA (Centro de Aguas y Saneamiento Ambiental) at the Universidad Mayor de San Simon in Cochabamba, Bolivia, and researchers at EAWAG are currently conducting studies with the SODIS method to assess inactivation of Salmonella, Giardia cysts and Cryptosporidium oocysts.

Solid Waste Management – Biological Treatment of Municipal Solid Waste

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Decentralised Composting of Municipal Solid Waste

Inadequate collection and disposal of waste poses serious health risks to the population and leads to environmental degradation in most cities of the developing world. A possible option to improve the current solid waste situation is to enhance resource recovery activities. Inorganic material recycling of municipal solid waste is often already practised by the informal sector. However, reuse of organic waste material, which often makes up more than 50% of the total waste, is still fairly limited. Experience revealed that large centralised and highly mechanised composting plants have repeatedly failed in the past due mainly to high investment and operational costs and limited revenues from product sales.

The overall objective of SANDEC's research programme in Solid Waste Management is to develop tools to assess the potential of decentralised composting schemes as management and treatment option for a city's solid waste system.

Why decentralised?

- Combined with primary collection services, decentralised schemes can decrease dependency from municipal services, create employment and enhance environmental awareness in a community.
- Decentralised schemes are more flexible as they adapt rapidly to changes in user needs, thereby, allowing close quality surveillance of the service and product by the users.
- Use of a small-scale, labour-intensive technology in decentralised schemes is generally better suited to the local socio-economic conditions.
- Decentralised composting recovers waste close to its source, thus, saving further waste transport costs.

SANDEC's research activities focus on three components considered to be important indicator criteria for potential decentralised waste composting schemes.

- Market demand for the compost product.
- Proven technical, financial, institutional, and organisational set up of decentralised schemes.
- Cost analysis of decentralised approaches in relation to the municipal budget.

Market Demand Study

Experience has shown that numerous waste composting projects have failed in the past as little attention had been paid to compost market demand analysis. One of SANDEC's collaborative research projects deals with compost market demand studies

in the cities of Karachi, Pakistan (Box 1), Dar es Salaam, Tanzania, and Viet Tri, Vietnam. Methodological and operational experience gained by these studies will be evaluated and disseminated to all those interested in determining market demand for compost within their specific local context.

A market demand study should first focus on the following basic questions:

- What available waste raw material flows can be used for composting?
- How is organic solid waste currently used? What existing treatment steps are associated with the use of organic waste?
- Who are the current and potential compost customers, and what are their requirements as regards quantity, quality and price?
- How do the various potential and current customers perceive compost?
- What compost alternatives (competing products) are currently used?

Contact the authors if you are interested in conducting compost market demand studies in your city.

Box 1 Organic Waste Management in Karachi - Potential Demand for Compost

SANDEC has conducted a compost market demand study in the city of Karachi in collaboration with the Association for the Protection of the Environment (APE), an NGO based in Karachi. For more information on this study, contact either the authors or APE at dapdcet@khi.compol.com

Karachi's population of approximately ten million generates about 6000 tons of waste per day, of which roughly 40% are organic biodegradables. Two large markets produce daily 170 tons of practically pure organic waste. Although this waste constitutes an excellent raw material for composting, it is currently transported and dumped.

The study reveals little evidence of compost use in the city of Karachi. This can be attributed to a lack of composting activities, awareness of its benefits and know-how on compost use. All potential users have rated the problem of water shortage/availability on a much higher scale than the supply of nutrients and organic material to the soil.

Past experience with composting activities in Karachi has not been very successful. In the early 1980s, a private company set up a large scale composting plant. The plant, a second-hand import from Scotland, was designed for a capacity of 1000 t/day, however, due to coordination difficulties with the municipal collection services, the required amount of waste was unavailable. The project also misjudged an export market for compost in the Middle East. After a short operating period, the plant closed down due to financial constraints.

In the last few years, two NGOs initiated small-scale organic waste treatment schemes using market waste. Potential customers of the product are, however, not convinced by the quality of their product, and demand is generally very low.

Currently, the compost's main competing products were identified as:

- Animal manure, from buffalo pens in and around the city, is available in truckloads at 0.9 US$ per ton. Since demand for animal waste is low compared to the actual quantities generated, cattle holders often resort to its disposal in storm drains.

Fig. 1. Roadside nursery in the city of Karachi (photo N. Ahmed)

- A mixture of processed animal intestines and blood from slaughterhouses is sold to nurseries, government departments and individual clients. This product is a highly valued fertiliser by gardeners.
- Sweet sand, called "bhallo mitti", is a non-saline wind-drifted sand, mined at different locations in the city. Sweet sand is mixed with animal manure and sold to nurseries and private gardeners.

It will be difficult for compost to compete with these cheaply available products. Composting units would require, especially in their initial stage, a certain threshold subsidy to account for their contribution to the municipal waste management costs. Water shortage or its limited availability could also be a major challenge for a waste composting scheme.

Lessons Learned from Existing Schemes

Existing waste composting units show a wide range of technical and organisational structures, some successful, others failing to reach their target. SANDEC is currently collecting standardised information on existing composting schemes. Case studies on the potentials and difficulties of decentralised schemes focus not only on scientific aspects of the composting process (e.g. raw material, process duration, hygienisation, and other quality criteria), but also on financial aspects (e.g. investment and operational costs), organisational set up, institutional framework, demand for human resources, and specific local socio-cultural context. Box 2 summarises some results of a study conducted in Dhaka.

The authors welcome suggestions for assessment studies on existing decentralised waste composting schemes in low- and middle-income countries.

Box 2 Decentralised Composting in Dhaka, Bangladesh

An assessment study has been conducted on the decentralised composting scheme of Mirpur in Dhaka, Bangladesh in collaboration with Waste Concern, wastecon@dhaka.agni.com.

In 1995, the NGO "Waste Concern" initiated a decentralised collection and composting scheme in Mirpur, a residential area of Dhaka, Bangladesh. Mixed domestic waste is collected daily door-to-door by tricycles. After sorting the waste manually on the composting site, organic waste is converted into compost using the "Indonesian Windrow Technique", a labour-intensive aerobic and thermophilic composting procedure (Fig. 2). This technique involves piling of organic waste around a triangular tunnel structure to provide passive aeration to the system. Frequent turning of the piles during the first 3-4 weeks ensures that all parts of the decomposing waste are hygienised by exposure to high temperatures (45-60 °C). An additional three weeks of compost curing produces a mature compost for wide use in gardening (Solvita Maturity Index 6). A temperature curve is shown in Fig. 3.

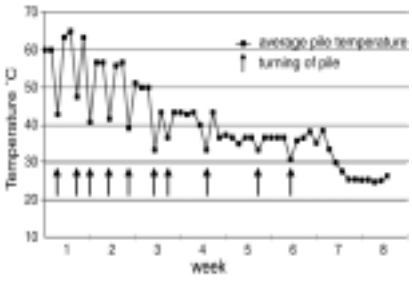

Fig. 3. Compost pile temperature curve as a function of time

At the time of the study, the Mirpur composting scheme was collecting 1.66 tons of waste per day. However, the site runs currently at a maximum daily waste capacity of three tons. The study has collected key data on the Mirpur composting scheme. The information includes technical and operational aspects (site layout, process steps, mass flows, monitoring of physical and chemical parameters), evaluation of financial parameters and current waste management legislation in Bangladesh.

Fig. 2: Mirpur composting shed, Dhaka, Bangladesh (photo Isabelle Rytz)

The main criteria determining the success of this composting site can be summarised as follows:

- Reliable collection services by the Mirpur scheme find the approval and financial support of the community through payments of the waste collection fee.
- The local Lions Club provided the plot, as land prices of 300 US$/m^2 in the Mirpur area would have been prohibitive for the financial viability of the composting unit.
- The marketing strategy of the scheme is based on a collaboration with large distributors of fertilisers. The main bulk of the compost is sold to such a distributor, who blends it with additives to meet customer needs. The product is then sold through its existing distribution networks.
- Consumer acceptance was enhanced by the fact that agricultural use of this compost was approved by the Ministry of Agriculture.

Economic Viability

Decentralised composting schemes can be analysed in relation to costs and revenues. In addition, municipalities save on waste transport and disposal costs. Furthermore, recovery of the organic waste fraction can lead to cost savings as a result of reduced negative environmental impacts.

Such information is an important prerequisite for strategic decisions on a municipal level. An example of simple cost savings for a municipality by a decentralised waste composting scheme, such as the Mirpur composting plant in Dhaka, is given in Box 3.

The authors welcome suggestions and proposals for economic valuation studies as described above.

Composting as Source of Income for the Urban Poor

In collaboration with the Water, Engineering and Development Centre (WEDC) in Loughborough, UK, SANDEC and partners in the United Kingdom, Bangladesh, India, and Sri Lanka, have initiated a "Knowledge and Research (KAR)" project funded by DFID (Department for International Development, UK). Its objective is to enhance recycling of solid waste by promoting composting as source of income for the urban poor. Therefore, support to ongoing pilot projects in South-east Asia will be provided, and guidelines developed to upscale and replicate them at other locations. At the current stage of the project, regional reviews on composting units are conducted with local partners.

Anaerobic Digestion, a Municipal Solid Waste Treatment Option in Developing Countries

Simple biogas plants, mainly treating animal waste (manure) in rural settings, have been constructed in developing countries for about thirty years. Scientific data on simple biogas systems treating municipal solid waste is, however, scarce. SANDEC is collecting information and know-how on the biogas technology for municipal solid waste management, with focus on its technical, economical and ecological suitability in cities of low- and middle-income countries.

The authors welcome information on existing cases of anaerobic digestion of municipal waste in low- and middle-income countries, local contacts and specific expertise.

Box 3 Cost saving estimate for Dhaka City Corporation (DCC) based on activities of the Mirpur composting facility

Item	Amount	Cost savings
Reduction of waste to be transported to the disposal site	509 t/year	8346 US$/year
Saved landfill area	77 m^2/year	1889 US$/year
Cost savings		**10 235 US$/year**

At the time of the study, the Mirpur scheme was collecting 1.66 t/day with a recovery rate (organics and recyclables) of 84%. According to DDC data, municipal waste collection and transport costs total 16.4 US$ per ton. Purchase costs for landfill area amount to 24.5 US$/m^2. This figure does not include landfill construction and management costs. The above calculation assumes an average landfill disposal height of 6 m and a waste disposal density of 1.1 t/m^3. Since the Mirpur facility is currently running at full capacity of 3 t/day, cost savings for DCC amount to 18 518 US$ annually.

On the Bookshelf

Apart from the publications cited in the context of the articles, we recommend the following books/publications:

- **Water Quality: Guidelines, Standards and Health. Assessment of Risk and Risk Management for Water-related Infectious Disease**
  L. Fewtrell, J. Bartram, 2001. ISBN 92 4 154533 X. Price: CHF 126.--/US$ 113.40. For developing countries: CHF 88.20. Order No. 1150489. Available from: WHO Marketing & Dissemination, 1211 Geneva 27, Switzerland. Fax: +41-(0)22-791 48 57. E-mail: bookorders@who.ch

- **Water, Sanitation and Health. Electronic Library (WSH CD-ROM)**
  A compendium of WHO information on water sanitation and health, 2001. ISBN 92 4 154549 6. Price: CHF 250.--/US$ 225.00. For developing countries: CHF 70.00 /US$ 63.00. Order No. 0990013. Available from: WHO Marketing & Dissemination, 1211 Geneva 27, Switzerland. Fax: +41-(0)22-791 48 57. E-mail: bookorders@who.ch

- **Global Water Supply and Sanitation Assessment 2000 Report**
  WHO, Geneva, 2000. ISBN 92 4 156202 1. Price: CHF 35.--/US$ 31.50. For developing countries: CHF 24.50. Order No. 1150482. Available from: WHO Marketing & Dissemination, 1211 Geneva 27, Switzerland. Fax: +41-(0)22-791 48 57. E-mail: bookorders@who.ch

- **Strategic Planning for Municipal Sanitation – A guide. First Edition, July 2000**
  This guide has been produced by GHK in collaboration with WEDC and WSP-South Asia. It contains the outputs of a research project to develop practical guidelines for the implementation of strategic sanitation concepts. This guide is currently available only on the GHK Research and Training website at www.ghkint.com. For further information, please contact Kevin Tayler or Jonathan Parkinson. Phone: +44-(0)20-7736 82 12. Fax: +44-(0)20-7736 07 84. E-mail: taylerk@ghkint.com parkinsonj@ghkint.com

- **Guidance Manual on Water Supply and Sanitation Programmes**
  WELL, Water and Environmental Health at London and Loughborough. Published by WEDC for DFID, 1998. ISBN 0906055 58 X. Available from: WEDC, Department for International Development, 94 Victoria Street, London SW1E 5JL, UK.

- **Ecological Sanitation**
  St. A. Esrey, J. Gough, D. Rapaport, R. Sawyer, M. Simpson-Hébert, J. Vargas, U. Winblad, 1998. ISBN 91 586 76 12 0. Available from: Sida/Svensk special distribution, Finspangsgatan 51, S-163 53 Spanga, Sweden. Fax: +46-8-760 58 95. E-mail: order@special.lagerhus.se

Announcements

SANDEC is currently preparing a manual on **SO**lar water **DIS**infection, SODIS. The manual is written for project officers and technical field staff intending to implement SODIS projects. It contains technical information on the effects of SODIS, its advantages and limitations, detailed description of the application procedure, and important factors to be considered during SODIS application.

The English version of the manual will appear in August 2002. Contact: Regula Meierhofer: Fax: +41-(0)1-823 53 99. E-mail: regula.meierhofer@eawag.ch
Homepage: www.sodis.ch

SOLAQUA Foundation supports SODIS promotion and dissemination projects
Although SODIS is a simple and low-cost method (see article on page 5), much effort and resources are still required to disseminate information and train communities without access to safe drinking water in SODIS application. To enhance this process, the SOLAQUA Foundation has been established to support SODIS promotion and dissemination in developing countries. Qualifying organisations, which plan to disseminate SODIS and train local communities in SODIS application, may submit a project proposal to the SOLAQUA Foundation and request financial assistance.

Information on the application process is also available from the SODIS Homepage:
www.sodis.ch/
Text/Projects/Application_Format.htm

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