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Financial Challenges to Making Faecal Sludge Management an Integrated Part of the Ecosan Approach: Case Study of Kumasi, Ghana

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Abstract Many sub-Saharan African towns currently face a “faecal sludge crisis”, because large amounts of faecal sludge from unsewered toilets (pit latrines, septic tanks etc.) are dumped into the environment. This causes public health problems and environmental degradation. The objective of this research was to investigate how faecal sludge management (FSM) can be made an integrated part of a sustainable ecological sanitation (ecosan) approach, with an emphasis on financial sustainability. Kumasi, a city in Ghana, West Africa, with 1.48 million inhabitants was chosen as a case study. Our research shows that the FSM of the city can be independent of donors’ financial support and thus financially sustainable if the potential revenue in both households and farmers is realised. This potential revenue was evaluated by (i) analysing the relevant functional groups and their relationships, (ii) a Capacity-to-Pay approach for households whereby they would spend up to 0.5% of their income on the toilet pit/septic tank emptying service (including a cross-subsidy approach), and (iii) on the farmers’ Willingness-To-Pay for compost (treated faecal sludge) based on a price of US$ 1.4 per 50 kg bag of compost. This additional revenue, which should be allocated to the System Manager (Kumasi Metropolitan Assembly) in the proposed financial scheme, was estimated to be US$ 57,000 per month from households and US$ 18,000 per month from farmers (based on 6300 m^3/month of faecal sludge collected in Kumasi and a simplified financial analysis of the system).

Keywords co-composting, ecosan, capacity to pay, FSM, stakeholders, sustainable

Introduction

In sub-Saharan Africa, more than 75 % of houses in large cities and up to 100 % in towns are served by on-site sanitation facilities, such as non-sewered household and public toilets, aqua privies, pit latrines and septic tanks (Strauss *et al.*, 2003). In these urban areas, the excreta disposal problems have become serious: thousands of tons of sludge from on-site sanitation installations – so-called faecal sludge (FS) – are disposed untreated and indiscriminately into lanes, drainage ditches, onto open urban spaces, into inland waters, estuaries, and the sea. This situation causes serious health and environmental problems, especially for low-income areas and has thus been termed “the faecal sludge crisis” (Steiner *et al.*, 2002).

The faecal sludge crisis problems can be minimised if appropriate faecal sludge management (FSM) is introduced with regard to emptying of sanitation facilities, FS transport, treatment and its safe disposal or reuse (Steiner *et al.*, 2002). The existing financial and institutional arrangements in most cities are however not allowing the success of faecal sludge management (FSM) programmes.

A new approach to sanitation is ecological sanitation (ecosan), which has been proven in many projects to provide benefits such as water savings, minimising surface and groundwater pollution and water-related diseases, and recycling water and nutrients to agriculture (Winblad and Simpson-Hébert (2004)). Ecosan is a new paradigm in sanitation provision, which is not limited to a specific technology but encompasses all sanitation systems that aim to be sustainable in all aspects (institutional, environmental, financial, technical and social) and which allow “closing the loop” (i.e. returning nutrients and soil conditioners back to agriculture). Many sanitation experts regard ecosan and FSM programmes as two separate entities. It is our view however that FSM should be considered as an integral part of an ecosan approach to solving developing cities’ sanitation problems.

The two major challenges for improving FSM are ensuring that FS is transported to the appropriate treatment site, and that the product produced from treated FS, such as compost, is marketable to local, urban and peri-urban farmers. Reuse of faecal sludge should be preferred over disposal on landfill mainly because commercialisation of treated sludge can generate revenues (Klingel *et al.*, 2002). Establishing sound financial structures and flows is an important prerequisite to resolving these challenges (Steiner *et al.*, 2003).

In this paper, we analyse financial challenges to making FSM into a part of an ecosan approach to dealing with African cities’ sanitation problems in a sustainable manner with a focus on the financial sustainability. The city of Kumasi in Ghana was chosen as a case study in order to capitalise on previously published research that has been conducted there (e.g. Cofie (2003) and Kaelin (2005)). In Kumasi, FSM issues are institutionally better tackled than in many other towns in West-Africa. But even here, the system relies heavily on government subsidies through donors’ support.

It should be pointed out that in parallel to improving the faecal sludge management, it is also important to advance those types of on-site sanitation systems, which allow a more direct realisation of the ecosan approach, such as for example urine diversion dehydration toilets. This would typically result in lower transport and treatment costs, and not produce a liquid effluent of poor quality, such as the liquid effluent produced from many faecal sludge treatment plants, which is subsequently being discharged to receiving water bodies.

Methodology

We identified the key stakeholders in the FSM system in Kumasi, which we then analysed by (i) structured interviews with beneficiaries of the service (20 households of different income levels were interviewed) and with system operators (five faecal sludge collection companies were studied); (ii) discussions with the director of the Waste Management Department of Kumasi; and (iii) key informant interviews with other staff of the same department. The fieldwork was organised from IWMI’s local office at Kumasi, during the period 17 Oct 2005 to 8 January 2006. All dollars quoted in this paper are current US$. All details of the methodology and calculations are provided in Vodounhessi (2006).

Analysis of current situation in FSM in Kumasi

Faecal sludge quantity, collection and treatment

Kumasi is a city in Ghana in West Africa located 300 km Northwest of the capital city Accra. In 2004, Kumasi’s population was 1.48 million inhabitants, of which 38% were using unsewered public toilets, 30% used household water closet facilities connected to a septic tank, 8% used the unhygienic bucket latrines system, 8% used Ventilated Improved Pit latrines and 2% used pit latrines (Mensah, 2005). The remaining 10% and 4% were connected to a small scale sewerage system or practised open defecation, respectively. Based on the specific FS production of 1.0 L/cap/day for septic tank sludge and 0.2 L/cap/day for sludge production from toilets without water use (Heinss *et al*., 1998), the total FS production of Kumasi was estimated to be 23,100 m^3 per month. Of this amount, 18,300 m^3 comes from toilet pits or tanks that can be emptied. The remainder ends up in the sewage system and the bush respectively.

The FS collection from public toilets, individual households and institutions is presently assured by 22 collection companies, of which five companies are publicly owned. These companies use vacuum suction trucks of a capacity of 5 to 8 m^3 (most of them are 5 m^3).

The collection companies discharge the collected FS at the privately operated FS treatment plant (FSTP) at Dompoase and there is now no longer illegal FS dumping in the city. This has been successful through the strictness of the District Assembly rules and the community participation in denouncing defaulters. The FSTP is located at the Dompoase solid waste landfill site and consists of five anaerobic, one facultative and two maturation ponds to treat FS and landfill leachate. The facility became operational in January 2004. The treated liquid effluent is mixed with the underground drainage from the solid waste landfill and discharged into Sisai River without further treatment, despite questionable effluent quality (based on visual observation; no analytical data available).

The former FSTP, a pond system at Buobai, was in operation during 2001-2003, but is currently no longer operational because the sedimentation ponds are full and yet to be emptied. Also, the community surrounding the plant was not satisfied with the quality of the effluent discharged in the neighbouring river.

In 2005, an average of 1255 tanker loads of faecal sludge were discharged monthly at the Dompoase FSTP, which amounts to 6,300 m^3 of FS collected monthly from the city (corresponding to approximately 1890 ton d.s./year based on a total solids content of 25 g/L (Steiner *et al*., 2002)). Compared to the total “collectable” amount of 18,300 m^3, this represents a collection coverage of only 34% (the “unaccounted-for” load would thus be estimated as 12,400 m^3 per month). This calculated figure of 34% appears however unrealistically low, which may be due to the assumed specific sludge production figures (taken from Heinss *et al*. (1998)) being too high for Kumasi.

Functional groups active in FSM in Kumasi

We grouped the key actors involved in the financial mechanism of FSM in Kumasi according to their function as follows:

- **Sources of revenue of the system** (FSM services beneficiaries), which are people benefiting from the services, currently only the households and some institutions (police, army, prison, TELECOM). Farmers can also be included in this group in the future.
- **System Operators**, which are companies making a profit from the system, they include the FS collection companies, the public toilet managers and the private operator of the FS treatment plant (the latter two are not analysed in detail here).
- **System Managers**, which are institutions that are supposed to stimulate the revenue of the system from its various beneficiaries and to allocate this revenue amongst operational stakeholders to avoid excess profit (the Waste Management Department of Kumasi Metropolitan Assembly (WMD/KMA) is the System Manager here).

- **External supporters** of the system, which are institutions who provide external funds for the financial support of the system (Government of Ghana, donors such as the World Bank).

Simplified analysis of current financial flows in FSM in Kumasi

The financial analysis presented here is a simplified analysis which is meant to serve as a tool for assessing current short-comings and opportunities, but not to give a full account of the financial situation of the stakeholders.

The main capital cost item for the collection companies is the purchase/replacement of their suction trucks. In total, there are about 20 trucks in operation in Kumasi, and the replacement value of a second-hand suction truck imported from Europe is about US$ 16,000 (Strauss, 2006). Assuming a useful lifetime of 10 years, and a real interest rate of 10% (i.e. without inflation) we calculated the annuity cost of capital and divided this by 12 to obtain the monthly capital expenditures (CAPEX), see Table 1.

The operating expenditure (OPEX) of the FS collection companies was estimated as follows: one household's pit usually fills one truck, and a household which needs two trips to empty its pit or septic tank, has to pay the emptying fee per trip. For each trip, workers and truck drivers take money for the fuel and for their lunch before providing the service. The money for the discharge fee at the FSTP (US$ 2.2 per truck load, regardless of volume) is paid to KMA at the end of the month, and the oil is bought for the truck every week.

The OPEX was therefore calculated from these operating costs per trip multiplied with the monthly number of truck loads arriving at the FSTP (on average, 1175 FS truck loads per month were delivered from households and public toilets to the FSTP in 2005, according to records kept at the FSTP; another 80 truck loads stem from public institutions such as army, prisons, police, but these beneficiaries do not pay a FS collection fee and are thus excluded from the revenue analysis). Further operating costs include staff salary (number of workers times their monthly salary), the maintenance cost (taken from Kaelin, 2005) and income tax of 7.5% of the profit before tax. Based on these considerations, we calculated the monthly OPEX value as shown in Table 1.

The income from the FS collection fees paid by the households or public toilet managers was calculated as follows: (i) the tariff for this service provision currently ranges from US$ 33 to US$ 66 per truck load with an average of US$ 45 used by most of the companies; and (ii) the average monthly number of 1175 faecal sludge truck loads that comes from households. We estimated that about US$ 52,200 per month comes from households as current effective revenue in the FSM system (people who use public toilets pay a user fee which the public toilet manager uses to pay the FS emptying fee for the public toilet).

The main expenditure of the WMD/KMA in faecal sludge management is the faecal sludge treatment plant (FSTP). The costs of the FSTP in 2005 as given by the WMD Director were US$ 10,000 per month for OPEX and US$ 400,000 for the total capital cost for the FSTP built in 2003. We used a 15-year depreciation period and a 10% real interest rate to calculate the monthly cost of capital (CAPEX) for the FSTP as shown in Table 1.

The key observation from the simplified financial flow (see also Figure 2) is that the System Manager (WMD/KMA) collects only five percent (US$ 2,600 per month) of the system's total monthly revenue of US$ 52,200. However the total expenditure of the System Manager is about US$ 14,400. This is only possible through the Government's and Donors' (World Bank) financial support, and some contribution from the Local Government (KMA) from a part of housing tax. The financial cost recovery of the System Manager is thus estimated at only 18% (Table 1), where a value of 100% or more would indicate financial sustainability. Even the O&M cost recovery is not achieved (26% O&M cost recovery), implying that even if all the assets of the system were donated, the system would not be financially sustainable.

Table 1 Cost recovery of the current FSM system and its components (in US$/month), with CAPEX being the monthly cost of capital (using real interest rate of 10%).

Functional groups	OPEX (A)	CAPEX (B)	Net revenue (C)	O&M cost recovery = C/A	Financial cost recovery = C/(A+B)
Collection companies	$ 37,200	$ 4,300	$ 49,600	133%	119%
WMD/KMA	$ 10,000	$ 4,400	$ 2,600	26%	18%

Proposed financial mechanism

To reach a financially sustainable FSM system (desired system following an ecosan approach), the sources of revenue from the beneficiaries, the households and farmers, need to be firstly increased and secondly re-allocated. We assessed the household's capacity to pay (CTP) for the faecal sludge emptying service by assuming that households can spend 0.5% of their income on this service (a commonly used "rule of thumb" value is that poor households in developing countries can spend up to 5% of their income on water and sanitation services). Since the CTP is a proportion of household income, households in low-income areas would pay less for FS services in absolute terms than households in high-income areas, which would meet equity principles by using a cross-subsidy approach.

For the 20 households interviewed for this study, we compared the current households' expenditures on sanitation services (FS emptying fee or public toilet user fee) with the CTP figure, as shown in Figure 1. For this analysis, households were grouped into three types of living standards (types of houses). The average monthly income of the three groups was US$ 83, US$ 178 and US$ 556 for the low, medium and high income areas, respectively. It can be seen that households in low-income areas are currently paying 3.5 times their CTP, while those in high income areas are paying 3.5 times less than their CTP. Households in low-income areas currently have the highest expenditures for sanitation services in absolute and in relative terms. That is partly due to the bad state of their toilet pits/tanks, which need to be emptied more frequently. The lowest number of years between events of emptying was found in low-income areas (1.6 years between emptying events), compared to 5.6 years in high-income areas, because the pits in the low-income areas have a smaller capacity and more users than the septic tanks of the more affluent households.

Based on known household incomes in Kumasi, we estimated the total revenue that can be expected from households for the emptying service (for household toilets or public toilets) to be US$ 109,200 per month assuming that the collection coverage remains constant at the earlier calculated value of 34% (there were 282,000 households in Kumasi in 2004; average household size is 5.3).

In practice, the challenge is how to convert the theoretical CTP-based fee into the practical emptying fee (paid after the service provision), because the number of years between emptying events varies as a function of toilet pit capacity and number of users. The other issue is the effectiveness of the collection of a monthly CTP-based fee in poor areas, where households earn and expend their money on a daily basis. A micro-finance system (where households are organized to collect a daily fee that can reach the CTP-based fee at the end of the month) or a collection system based on the housing tax might be adequate solutions.

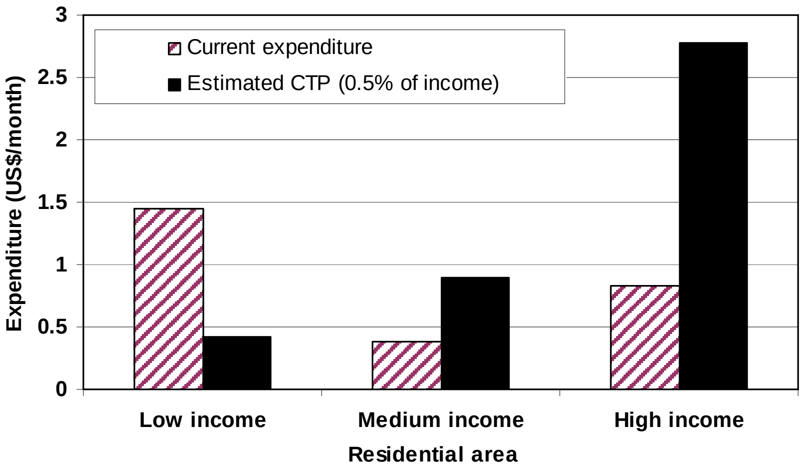

Figure 1 Household's current monthly expenditures on sanitation services (FS emptying service or public toilet user fee) and their capacity to pay (CTP) for residential areas of different living standards (based on 20 households).

Regarding income from sale of fertiliser (compost) to the farmers, the current FSTP would have to be upgraded to include co-composting of organic solid waste and faecal sludge (Cofie, 2003). The outcomes of the Buobai pilot plant study for the co-composting process (Steiner *et al.*, 2002) were used to estimate the cost of the full scale composting plant. The full scale composting plant would have to treat about 6300 m^3 of faecal sludge per month, which is 150 times the throughput of the pilot plant. Using economy of scales principles, we estimated that the full-scale composting plant would cost US$ 909,300 for total capital (equivalent to a CAPEX of US$ 10,000 per month, using 15 year life-time and 10% real interest rate). The *additional* operating costs for the FSTP due to the co-composting plant were estimated at US$ 6,300, which was again based on the pilot plant findings. The new CAPEX and OPEX figures for the upgraded FSTP are shown in Table 2.

A previous study on the willingness to pay (WTP) for compost made from faecal sludge and solid waste found that all farmers who currently used conventional compost, and 83% of the non-compost users, perceived municipal co-compost as positive or 'good' material for soil amelioration and crop growth (Cofie, 2003). In addition, about 70% of them said that they were willing to pay for it. Those farmers who did not express a willingness to pay argued that they first had to test the product to know its effectiveness in terms of yield and returns.

Based on the reported farmers' WTP, we estimated that at a compost price of US$ 1.4 per 50 kg bag (Drechsel *et al.*, 2004), all the produced compost would be sold. The potential revenue that can be expected from farmers is thus estimated to be US$ 18,000 per month with a compost supply of 7700 tons/year in Kumasi compared to a potential demand for compost of 14,920 tons/year.

In the proposed financial mechanism as shown in Figure 2, the extra revenues of the FS system from the households' CTP and the farmers' WTP are allocated to the System Manager (WMD/KMA). The CAPEX, OPEX and profit for the collection companies would remain the same. The new financial scheme gives a very high financial cost recovery for the System Manager (Table 2) of 253%. Sustainable financial cost recovery of greater than

100% could already be achieved for the System Manager even without any compost sales and at lower CTP value than the 0.5 % value proposed in our analysis.

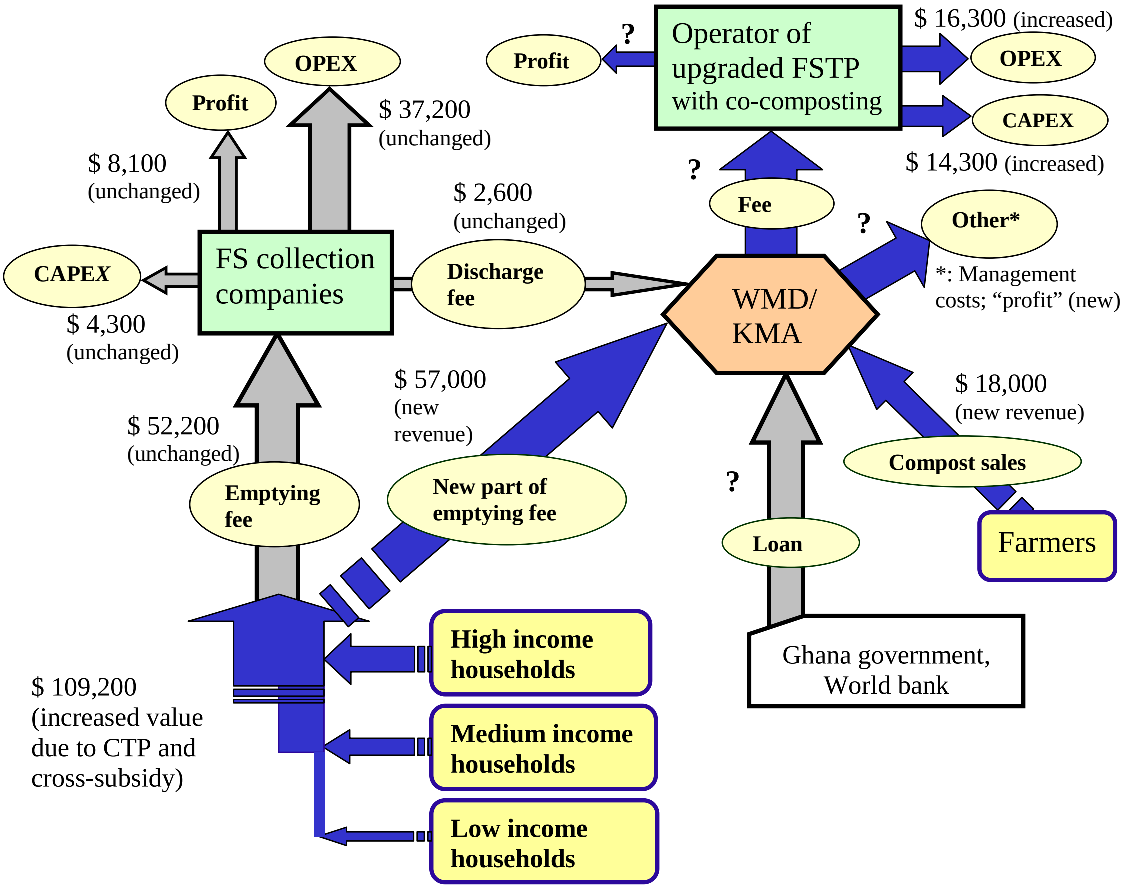

Figure 2 Proposed financial flows for FSM in Kumasi (all in US$ per month) based on collected faecal sludge of 6,300 m^3/month and a simplified financial analysis. Dark arrows indicate new or increased money flows; grey arrows are unaffected money flows.

Table 2 Cost recovery of the proposed financial flow for the FSM system in Kumasi (in US$ per month); for the collection companies, figures are same as in Table 1 (CAPEX is monthly cost of capital, using real interest rate of 10%).

Functional groups	OPEX (A)	CAPEX (B)	Net revenue (C)	O&M cost recovery = C/A	Financial cost recovery = C/(A+B)
Collection companies	$ 37,200	$ 4,300	$ 49,600	133%	119%
WMD/KMA	$ 16,300	$ 14,300	$ 77,600	476%	253%

Conclusions

We used Kumasi in Ghana as a case study to investigate how to improve the financial sustainability of faecal sludge management in sub-Saharan African cities based on a simplified financial analysis of this complex process that has many stakeholders. In 2005, about 6,300 m^3/month of faecal sludge (FS) was collected by the 22 FS collection companies active in Kumasi and discharged at Dompoase FS treatment plant. The current revenue of the system is estimated to be about US$ 52,200, which comes from the households via the pit/septic tank emptying fee of their own toilets or the public toilets that they use.

Using the capacity-to-pay (CTP) and cross-subsidy approach, we estimated that there is a potential revenue of US$ 109,200 per month that can come from households, taking a value of 0.5% of household income to be spent on FS collection services. In addition, the potential revenue from compost sales (if the FSTP is upgraded for co-composting of dewatered faecal sludge with municipal solid waste) was estimated to be US$ 18,000 per month (based on the farmers' willingness to pay of US$ 1.4 per 50 kg bag). The additional revenue should be allocated to the System Manager, which is the Waste Management Department of the Kumasi Metropolitan Assembly (WMD/KMA).

The CTP and cross-subsidy approach can be taken as a new tool for decision makers to overcome sanitation problems in a financially sustainable manner. The proposed financial mechanism would aid the FSM process to become part of an ecosan approach because financial sustainability would be achieved and treated FS would be returned to agriculture (thus "closing the loop").

References

Cofie, O. (2003) *Co-composting of faecal sludge and solid waste for urban and peri-urban agriculture in Kumasi. Pilot project implemented by IWMI in collaboration with SANDEC, KMA and KNUST*. Final report, IWMI, Kumasi, Ghana.

Drechsel, P., Cofie, O., Fink, M., Danso, G., Zakari, F. M., and Vasquez, R. (2004) *Closing the rural-urban nutrient cycle. Options for municipal waste composting in Ghana. Final Scientific Report on IDRC project 100376*. IWMI, West Africa, Accra, Ghana.

Heinss, U., Larmie, S. A., and Strauss, M. (1998) *Solids separation and pond systems for the treatment of faecal sludges in the tropics. Lessons learnt and recommendations for preliminary design*. EAWAG/SANDEC, Dübendorf, Switzerland.

Kaelin, D. (2005) *Short financial assessment of cesspit emptying companies in Kumasi (Ghana)*. EAWAG/SANDEC, Dübendorf, Switzerland.

Klingel, F., Montangero, A., Koné, D., and Strauss, M. (2002) *Fecal sludge management in developing countries. A planning manual*. EAWAG/SANDEC, Dübendorf, Switzerland.

Mensah, A. (2005) *Action plan for the improvement of waste management in Kumasi Metropolis*. Waste Management Department, Kumasi.

Steiner, M., Montangero, A., Koné, D., and Strauss, M. (2002) *Economic aspects of low-cost faecal sludge management. Estimation of collection, haulage, treatment and disposal /reuse cost*, EAWAG/SANDEC, Dübendorf, Switzerland.

Steiner, M., Montangero, A., Koné, D., and Strauss, M. (2003) *Towards more sustainable faecal sludge management through innovative financing - Selected money flow options*. EAWAG/SANDEC, Dübendorf, Switzerland. www.sandec.ch/FaecalSludge/Documents/Money.flow.models.pdf.

Strauss, M., Barreiro, W. C., Steiner, M., Mensah, A., Jeuland, M., Bolomey, S., Montangero, A., and Koné, D. (2003) *Urban excreta management - Situation, challenges, and promising solutions*. IWA Asia-Pacific Regional Conference, Bangkok, Thailand, October 19-23. www.sandec.ch/FaecalSludge/Documents/Urban_Excreta_Management_IWA_Bangkok_03.pdf.

Strauss, M. (2006) Personal communication, EAWAG/SANDEC, Dübendorf, Switzerland

Vodounhessi, A. (2006) *Financial and institutional challenges to make faecal sludge management integrated part of ecosan approach in West Africa. Case study of Kumasi, Ghana*. MSc Thesis WM 2006.05, UNESCO-IHE Institute for Water Education, Delft, The Netherlands.

Winblad, U., and Simpson-Hébert, M. (2004) *Ecological Sanitation - revised and enlarged edition*, Stockholm Environment Institute, Stockholm, Sweden