Sustainable Sanitation
Practice

EcoSan Club

Issue 13, 10/2012

- Faecal sludge management in Bangladesh
- Analysis of faecal sludge management in Cameroon
- Optimizing faecal sludge management in Burkina Faso
- Towards sustainable pit latrine management through LaDePa

Faecal Sludge Management

partner of:
sustainable sanitation alliance

Impressum

published by / ***Medieninhaber, Herausgeber und Verleger***

EcoSan Club
Schopenhauerstr. 15/8
A-1180 Vienna
Austria
www.ecosan.at

Editors / ***Redaktion***

Elke Müllegger, Günter Langergraber, Markus Lechner • EcoSan Club

Journal Manager / ***Journal Management***

Fritz Kleemann

Contact / ***Kontakt***

ssp@ecosan.at

Aim and Scope / ***Offenlegung der Blattlinie gemäß § 25, Abs. 4 Mediengesetz***

Sustainable Sanitation Practice (SSP) aims to make available high quality information on practical experiences with sustainable sanitation systems. For SSP a sanitation system is sustainable when it is not only economically viable, socially acceptable and technically and institutionally appropriate, but it should also protect the environment and the natural resources. SSP is therefore fully in line with SuSanA, the Sustainable Sanitation Alliance (www.susana.org). • SSP targets people that are interested in sustainable sanitation systems and the practical approach to it. • Articles are published after blind review only. • Sustainable Sanitation Practice is published quarterly. It is available for free on www.ecosan.at/ssp.

Sustainable Sanitation Practice (SSP) hat zum Ziel praxisrelevante Information in hoher Qualität im Zusammenhang mit „sustainable sanitation" bereit zu stellen. „sustainable" also nachhaltig ist ein Sanitärsystem für SSP wenn es wirtschaftlich machbar, soziokulturell akzeptiert, technisch als auch institutionell angemessen ist und die Umwelt und deren Ressourcen schützt. Diese Ansicht harmoniert mit SuSanA, the Sustainable Sanitation Alliance (www.susana.org). • SSP richtet sich an Personen, die sich für die praktische Umsetzung von „sustainable sanitation" interessieren. • Artikel werden nur nach einer Begutachtung veröffentlicht. • Sustainable Sanitation Practice erschient vierteljährlich, kostenlos unter: www.ecosan.at/ssp.

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Publisher: EcoSan Club, Schopenhauerstr. 15/8, A-1180 Vienna, Austria • chairperson: Günter Langergraber • website: http://www.ecosan.at/ • scope: EcoSan Club was funded as a non profit association in 2002 by a group of people active in research and development as well as planning and consultancy in the field of sanitation. The underlying aim is the realisation of ecological concepts to close material cycles in settlements.

Medieninhaber: EcoSan Club, Schopenhauerstr. 15/8, A-1180 Vienna, Austria • Obmann: Günter Langergraber • Gegenstand des Vereins: Der EcoSan Club wurde 2002 als gemeinnütziger Verein von einer Gruppe von Personen gegründet, die in Forschung, Entwicklung, Planung und Beratung in der Siedlungshygiene - Sammlung, Behandlung oder Beseitigung flüssiger und fester Abfälle aus Siedlungen - tätig waren und sind. Das Ziel des EcoSan Clubs ist die Umsetzung kreislauforientierter Siedlungshygienekonzepte (EcoSan Konzepte) zu fördern, um einen Beitrag zum Schutz der Umwelt zu leisten.

Cover Photo / ***Titelbild***

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Editorial

Management of faecal sludge is often neglected but essential for the functioning of sanitation systems and the well-being of urban dwellers. Issue 13 of Sustainable Sanitation Practice (SSP) on „Faecal sludge management" presents studies from different regions that mainly show the non-existence of faecal sludge management in most regions. Additionally, the last paper describes of a new technological solution (the LaDePa machine) for producing hygienically safe organic fertiliser from sludge form VIPs. The LaDePa machine was developed in eThekwini municipality (Durban), South Africa. The paper also presents an Issue 13 of SSP includes 4 contributions:

1. the analysis of faecal sludge management in 3 cities in Bangladesh,
2. the analysis of faecal sludge management in 2 cities in Cameroon,
3. the description of the development of an optimized sludge management system in Ouagadougou, Burkina Faso, and
4. the description the LaDePa machine.

In the next issue of SSP (issue 14, January 2013) will publish selected contributions from the 1st WATERBIOTECH conference (http://www.waterbiotech.eu/) that was held in Cairo, Egypt, from 9-11 October 2012. Information on further issues planned is available from the journal homepage (www.ecosan.at/ssp). As always we would like to encourage readers and potential contributors for further issues to suggest possible contributions and topics of high interest to the SSP editorial office (ssp@ecosan.at). Also, we would like to invite you to contact the editorial office if you volunteer to act as a reviewer for the journal.

SSP is available online from the journal homepage at the EcoSan Club website (www.ecosan.at/SSP) for free. We also invite you to visit SSP and EcoSan Club on facebook (www.facebook.com/SustainableSanitationPractice and www.facebook.com/EcoSanClubAustria, respectively).

With best regards,
Günter Langergraber, Markus Lechner, Elke Müllegger
EcoSan Club Austria (www.ecosan.at/ssp)

Content

Absence of faecal sludge management shatters the gains of improved sanitation coverage in Bangladesh

The paper presents an analysis of systematic data collected from three cities in Bangladesh on current management practices and highlights the importance of improved sludge management.

Author: Aftab Opel

Abstract

In recent years, Bangladesh has managed to achieve a significant reduction of open defecation although still about half the population in the country do not have access to improved sanitation. In absence of any sewerage system, the predominant onsite technologies has created a new challenge of faecal sludge management that is still a 'never thought of' agenda at the policy level. This study in three cities of Bangladesh is part of a multi country study in Asia and Africa which shows that in absence of any safe emptying, transportation, dumping and treatment mechanism most of the sludge generated are going again to the surface water that ultimately shatter the gains achieved through increase sanitation coverage. Most septic tanks or pits in the cities require emptying which is mostly done by the manual sweepers. On the other hand, except Dhaka, no cities have any designated dumping site or treatment plant for faecal sludge. Consequently, manual sweepers dump the sludge in nearby open drain or water-body. In Dhaka too, most safety tanks and pits are connected directly with the drainage system linked to open water body within the city or outside. This practice ultimately regenerates the risks of faecal matter re-enter into the domestic environment. Poorer groups who mostly dwell in unsafe environment are most sufferer of this; however, the risk remains also high for those who practice safe sanitation.

Introduction

Access to safe sanitation is increasing globally. However, achieving access is not just the end of the problem itself; it is the beginning of new set of challenges which demand systematic and much higher level of interventions. Pits get full quite soon and they need to be emptied to keep the toilets usable. Emptied sludge needs to be transported to safer places and treated properly so that they do not contaminate environment. If these three aspects are not dealt properly, it is not possible to get the full benefits of achieving increased access to safe sanitation. There has been some development in the treatment and management of waste water but unfortunately, emptying, transportation and treatment of faecal sludge (FS) have not yet received adequate attention.

Cities in developing countries are the worst sufferer of this service gap since most cities in the developing countries have high population density, rapid and unplanned growth, inadequate and often inaccessible service provisions. In cities where most households practice on-site sanitation, the emptying septic of tanks or pits, and transport of sludge to a safe dumping site for treatment becomes an emerging need. There is no doubt that if safe disposal of sludge is not ensured, gains achieved by increased sanitation coverage cannot be realized.

The importance of improved faecal sludge management (FSM) in reducing public health and environmental impacts is widely acknowledged. Research suggests that improved excreta management could reduce the

Key facts:

- The situation of faecal sludge management in 3 cities in Bangladesh (Dhaka, Khulna and Faridpur) has been analysed
- Most households rely on simple pits, VIPs and septic tanks.
- Manual emptying is predominant in all 3 cities.
- Only Dhaka has a designated area for disposal of faecal sludge, however, treatment for faecal sludge is provided in none of the cities
- In general there is a big lack of faecal sludge management in Bangladesh

diarrhoeal morbidity by 36 per cent (Carr 2001). A meta-analysis of 25 studies which investigated the association between sewerage and diarrhoea or related outcomes, including presence of intestinal nematodes show that sewerage systems typically reduce diarrhoea incidence by about 30 per cent or perhaps as much as 60 per cent when starting sanitation conditions are very poor (Norman, Pedley and Takkouche 2010). However, as most of the developing countries are still struggling to gain universal sanitation coverage; they are yet to put adequate emphasis on this important environmental need. This paper provides evidence from three cities of Bangladesh where in an absence of safe emptying, transportation and treatment facilities, most faecal sludge re-enters the environment with full potential for harming public health.

Sanitation context in Bangladesh

Sanitation is still one of the biggest challenges for Bangladesh although it has made some good progress in increasing sanitation coverage over the past years. A well-coordinated effort by the government, non-government development agencies and other development partners as well as the introduction of the innovative Community-led Total Sanitation approaches have made it possible to bring down the proportion of open defecation from 43 % in 2003 (SACOSAN 2008) to 4.4 % of the population in 2011 (BBS, 2011). Despite this significant gain, the challenge still remains high as about half of the population do not have access to safe sanitation (BBS and Unicef, 2010). This report suggests that only about 54 % of the population has access to improved sanitation facilities which eliminate the potential for contact with human faecal matter, largely through water seals in toilets. Besides, 25 % and over 15 %t of the population has access to shared latrines and unimproved sanitation facilities (largely open pit latrines) respectively.

Faecal sludge management scenario in Bangladesh

No formal FS management system exits in Bangladesh. The only treatment plant exists in Dhaka was constructed in 1980 by DWASA (Dhaka Water Supply and Sewerage Authority) and was upgraded in 1992 has a treating capacity up to 1.25 million m^3 of sewage and has 4 sludge lagoons for the treatment of sludge produced by the plant. The sewerage network in the city serves the need of around 20 % of sewage generated in the city (Rahman 2009) and only 1 % of the sludge generated in the country. This means that 99 % of the sludge generated throughout the country remains untreated, most of which goes directly to the surface water.

Emptying in urban and rural areas is overwhelmingly done by the manual sweepers. Two NGOs in Dhaka and three other Municipalities provide pit emptying service through vacu-tug machines. However, their service is constrained by a number of factors. The manual emptying is most hazardous as the sweepers usually do not use anything other than some buckets and a plastic drum for transport. These manual sweepers do not even use hand gloves to avoid contact with sludge. In few instances, they use pump machines to pump out liquids from the septic tank or pit and then manually empty the remaining solid manually. This saves time but the liquid is usually pumped out to nearby drains, cannels or water-bodies. Thus, the method is extremely harmful for both the emptier and the environment.

The limited mechanical emptying systems available in few cities, other than Dhaka, are not efficient enough and not a popular option although considering the market size (described in a later section), they have huge potential. In an absence of a proper dumping site for faecal sludge and treatment facilities, emptying and transportation through this system have only limited benefits. In the end, collected sludge through this system is dumped into open drains, canal and water-bodies. On the other hand, the NGO-run emptying service is Dhaka is environmentally sound since the collected sludge is put into the sewer lines which then end up in the treatment plant. However, since a high number of septic tanks in Dhaka are connected illegally with the storm sewerage or other drainage systems, there is not much demand for the service provided by the NGOs.

The study and the methodology

This study was conducted in three cities in Bangladesh: Dhaka, Khulna and Faridpur, provides analysis of household level practices, preferences and aspirations of sludge management. Dhaka accommodates more than one-third of the total urban population and about 9 % of the total population of the country. Although, the average income is high in Dhaka, in absolute terms, a large number of people remain poor. Slums house nearly one-third of all residents of Dhaka and they continue to absorb most of the new migrants (Islam 2005). Khulna is the third largest city in Bangladesh. The population of the city was estimated to be around 1.2 million in 2009 and population density was 21000 per km^2. In Faridpur a total of 135,837 people live in an area of 22.39 km^2. The city is considered to be a high density city with an estimated growth rate of over 3.91 per cent annually. About 10 % of the city dwellers live in slums and squatter settlements in the city.

Data was collected during June to September 2011. Statistically representative samples were drawn randomly in Khulna and Faridpur cities. In Dhaka, septic tanks and pits in the whole city do not require emptying as they are either covered by the sewerage networks or connected to the storm drainage or other drainage systems. Therefore, sample households were drawn from several pockets areas mainly in the fringe of the city which require emptying. A total sample of 467 household for Dhaka, 395 households for Faridpur and 358 households for Khulna were selected and interviewed using a semi-structured questionnaire. In addition, relevant stakeholders were

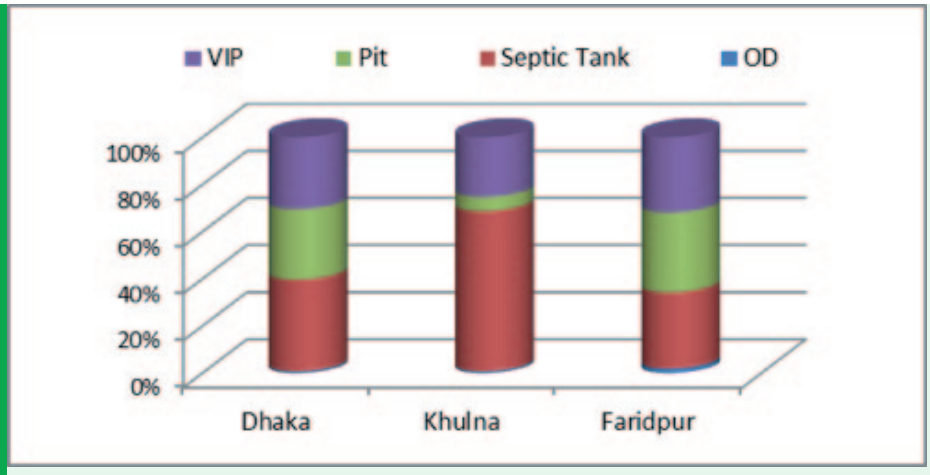

Figure 1: Latrine technologies

consulted, secondary data were reviewed, pits and septic tanks emptying work were shadowed to generate accurate information.

Results and analysis

Latrine technology and usage practices

In Khulna, most household latrines have septic tanks and the number of pits is much less compared to the other two cities. In Faridpur and Dhaka cities, the distribution of septic tanks, pits and VIPs is almost equal (Figure 1).

Probably because of less land availability, the size of septic tanks and pits is smallest in Dhaka compared to the other two cities. Average size of septic tank is biggest (19.8 m^3) in Faridpur. The size of the pits is also biggest in Faridpur compared to the other two cities (Table 1).

Table 1: Average size of septic tanks and pits (in m^3)

Tank type	Dhaka	Khulna	Faridpur
Septic tank	13.7	14.4	19.8
Pit	2.5	3.1	3.3

Access type of toilet

Households predominantly use personal toilets (Table 2). In Khulna, the higher percentage of households use shared latrines. In some low income housing complexes, multiple families share a latrine. On the other hand, community latrines are mainly constructed by the NGOs in low income settlements which are usually used by an average of 20 families.

Table 2: Access types of toilets (in %)

Access type	City		
	Dhaka	Faridpur	Khulna
Personal	22.9	84.1	62.0
Joint	73.4	15.7	36.9
Community	3.7	0.2	1.1

The average number of households sharing a latrine is much higher in Dhaka compared to the other two cities. Average 7.6 households share a latrine in Dhaka while 3.4 households share a toilet in Faridpur and 5.7 households per toilet in Khulna. However, the average user per septic tank/pit is much higher in all the cities; 31.5, 14.8 and 7.2 respectively in Dhaka, Khulna and Faridpur cities. The difference between the user numbers in latrines and septic tank/pit is mainly because in slum settlements several toilets share a common septic tank/pit.

Emptying methods

In all three cities, manual emptying is the predominant practice (Table 3). Compared to the other two cities, a higher percentage of households use mechanical emptying in Dhaka particularly because collected sludge cannot be dumped randomly in the slum settlements in Dhaka due to community pressure. That's why people prefer mechanical emptying so that sludge can be transported outside the neighbourhood. Mechanical emptying service is comparatively easily available in Dhaka being provided by two NGOs that also have other WaSH programmes in many of the studied slums. In the other two cities, this frequency is much less. Particularly in Khulna, only 2 % of the households empty their pits or septic tanks mechanically. There is another option whereby emptiers use pump machines to drain out the liquid part from the tank first and then empty the solid part manually but this is seldom practiced.

Table 3: Methods of emptying (in %)

Method of emptying	Dhaka	Khulna	Faridpur
Manual	69.4	96.3	86
Mechanical	30.1	2.0	13
Semi-mechanical	0.5	1.7	1

Emptying frequency

In Dhaka, most households emptied their tanks or pits at least once while this is much lower in Faridpur. This is probably correlated to the size of tanks/pits and number of users per toilet. Tank and pit sizes were higher in Faridpur and lower in Dhaka. Again, frequency of emptying is also higher in Dhaka probably for the same reason. More than a quarter of the tanks/pits have to be emptied more than once a year in Dhaka (Table 4).

Table 4: Frequency of emptying (in %)

Emptying	Dhaka	Khulna	Faridpur
Emptied at least once	92.5	83.0	77.0
Never emptied	7.5	17.0	23.0
Emptying frequency			
2-3 times / year	26.3	6.8	13.2
Once per year	4.9	0.0	2.6
Once every 2 years	29.3	16.7	23.8
Once every 3 years	15.5	11.9	10.3
Once every 4 years	6.8	11.6	13.2
Between 5 - 10 years	13.6	35.0	26.2
Over 10 years	3.5	18.0	10.6

In choosing a particular emptying process, most people consider the ease of availing of the service. For other people, the choice depends on a combination of factors, such as cost, flexibility of timing and ease of availing of the service. All these factors favour manual emptying. Therefore it is likely that most people use a manual emptying service (Table 5).

Table 5: Reasons of choosing a particular type of emptying

Factors of choice	%
Cheap	23.8
Easy to avail	75.0
Flexible timing	10.0
Personally known	6.4

On the other hand, accessing mechanical emptying services from the municipality in the case of Khulna and Faridpur cities is quite a lengthy and bureaucratic process. If someone choses to use the service of a municipality, he has to go to the municipality to collect a form, fill and submit it to the appropriate department. He will then be given a date of inspection by the Municipality. It usually takes 2/3 days to get this date. The purpose of this inspection is to assess the size of the tank and distance of disposal site to fix the rate. Once the rate is fixed, he then has to deposit the money to get the date of the work. It usually takes about a week to complete this processing. Most people usually decide to empty their tank once it is overflowing. Therefore, they cannot wait for so long to use the service of the municipality. As a result, even though some people know about the availability of this service they avoid it. On the other hand, in Dhaka city, most interviewed households who used manual emptying do not know about the availability of mechanical emptying services provided by the NGOs. None the NGOs providing this service do any marketing about it.

Emptying fees

Quite naturally, the cost of manual emptying is comparatively low. As presented in Table 6, mean cost of manual emptying was US$ 17.1, US$ 14.3 and US$ 12.6 in Dhaka, Khulna and Faridpur respectively. Cost of mechanical and manual emptying is almost same in Dhaka. This is due to the fact that in Dhaka the mechanical service is provided by the non-profit organisations at a subsidised rate. The cost of manual emptying is comparatively high in Dhaka because of higher transportation cost. In Khulna and Faridpur cities, the cost of mechanical emptying is about three times higher than the cost of manual emptying. In these two cities, although the services are provided by the Municipalities on no-profit basis, the cost for the households is higher due to corruption by the emptying staff.

Table 6: Expense of emptying and transportation (in US$)

Methods	Dhaka	Khulna	Faridpur
Manual	17.08	14.33	12.60
Mechanical	17.26	39.52	37.52
Semi-mechanical	5.71	17.14	10.71

Willingness to pay for improved service

It is not very surprising that most people in all three cities are willing to pay to improve the prevailing situation of faecal sludge emptying and disposal services (Table 7). In terms of money, the amount they could afford to pay is not very high – the average monthly amount a household could afford to pay is about US$ 1.

Table 7: Willingness to pay for improved service (in %)

Willingness to pay	Dhaka	Khulna	Faridpur
Yes	71.3	80.3	71.8
No	28.7	19.7	28.2

Destination of sludge

It is a great environmental concern that in most cases, collected sludge is not managed in an environmentally safe way. Sludge is released randomly ('here and there') or dumped into open drains or water-bodies which contaminate surface water. In 18.2 % of the cases in Faridpur, 30.6 % of the cases in Dhaka and 24.5 % in Khulna, collected sludge is dumped in a particular place which is a designated site to dump solid waste. But in no cases does this prevent sludge from contaminating surface water (Figure 2).

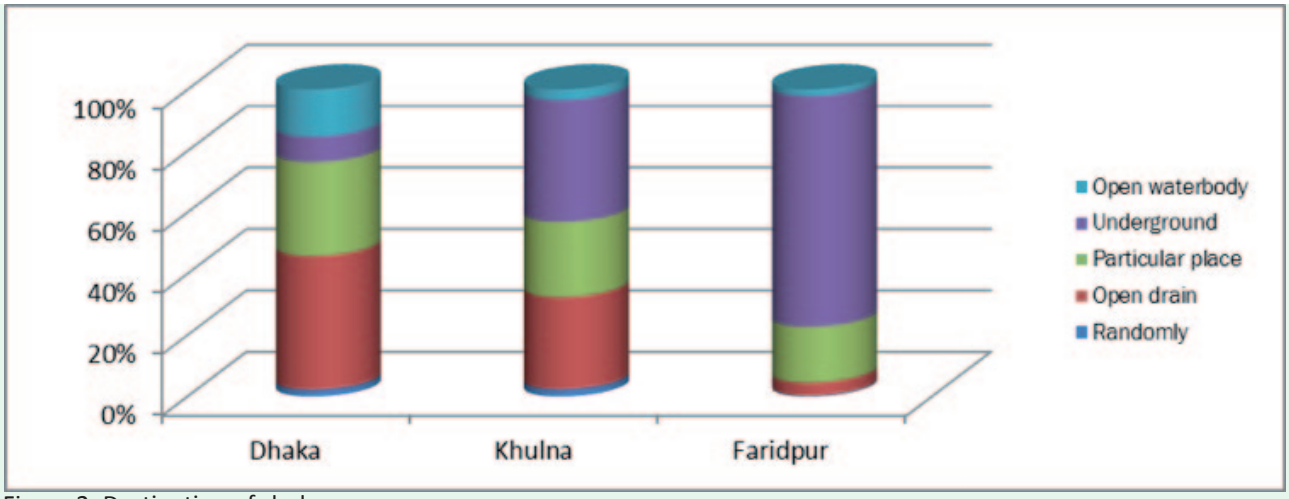

Figure 2: Destination of sludge

Public awareness

Although collected sludge often goes into open, most people stated that they are aware of its negative consequences. In Dhaka, more than 60 % of the respondents expressed their concern that putting sludge here and there contaminates water, affects human health and has negative consequences on environment in general. In the other two cities, although this percentage is lower compared to Dhaka, there is certain level of awareness among people about negative consequences of this act (Table 8).

Table 8: Views about the consequences of sludge disposal (in %)

Parameters	Dhaka	Khulna	Faridpur
Contaminate water	60.2	43.5	27.1
Human health	61.0	42.5	29.6
Environment	63.6	47.6	39.1

Demand vs. Supply of service provision

In the absence of any sewerage network or drainage system, Khulna and Faridpur have relatively larger markets for emptying and treatment service provision compared to Dhaka. Dhaka has a sewerage network and a treatment plant which covers approximately 20 % of the total sludge generated in the city. Although there is no study available; however, it is estimated that nearly 70 % pits/septic tanks in the areas that are not under sewerage coverage in Dhaka are connected to storm drainage system or other type of drains. These tanks and pits do not require any emptying service. As such, effective demand for on-site sanitation is quite low (only about 10 %, as shown in the table below) compared to the sludge generation in Dhaka. On the other hand, as shown in Table 9, coverage under OSS in Khulna and Faridpur is 98.2 % and 98.5 % respectively which demand emptying, safe transpiration and treatment. Therefore, it is assumed that both the cities have high demand of improved and affordable service. This demand is growing rapidly with the growth of population.

Table 9: Demand estimation for on-site sanitation in 3 cities

Description	Unit	Dhaka	Khulna	Faridpur
Market size:				
Total population (in 2011)	Number	15,018,594	1,728,760	146,667
Total Household (in 2011)	Number	3,337,470	384,169	24,840
Production of Faecal Sludge				
Total production of FS*	m^3	2,740,893	315,499	26,767
Coverage under sewerage system	%	20.0	0.0	0.0
Coverage under drainage	%	69.2	0.0	0.0
Open defecation, hanging, etc.	%	0.8	0.8	1.5
Coverage under OSS	%	10.0	98.2	98.5
Coverage under OSS	m^3	541,585	815,276	25,434
Treatment plant coverage				
Number of treatment plant	Number	1	0	0
Coverage by treatment plant	m^3	548,179	0	0
Coverage of treatment plant	%	20	0	0

* 0.5 ltr per person per day including grey water

Table 10: Present coverage by different categories of service providers

Description	Dhaka		Khulna		Faridpur	
	m^3	%	m^3	%	m^3	%
Coverage by informal providers (manual)	562,829	99.7	883,384	99.0	90,005	99.8
Coverage by formal providers (mechanized by NGOs)	1,860	0.3	0	0.0	0	0.0
Coverage by utility department (mechanized)	0	0.0	8,667	1.0	144	0.2
Total	564,689	100.0	892,051	100.0	90,149	100.0

The market share of each category of service providers was assessed for 3 cities, as shown in the table below. The supply-demand gap analysis clearly suggests that the manual emptiers fully control the markets of on-site sanitation in all 3 cities. The mechanized emptying business therefore has huge potential to penetrate the markets which could effectively contribute to the reduction of environmental pollution caused by current improper management of faecal sludge.

Discussion and ways forward

Untreated sludge disposing into open environment is almost equally risky as open defecation. This therefore shatters the gains achieved through increased sanitation coverage. This research shows that in absence of any treatment facility, most sludge is disposed into the open with full potential to re-enter into the domestic environment. A large volume which is buried also risks the shallow aquifer. Manual sweepers dominate the market and manage pit empting and sludge disposal without any safeguard, who risks their own health as well as public health.

On the other hand, dependence on surface water is increasing in Bangladesh due to factors like arsenic contamination in ground water (about 15 % of the ground water sources in Bangladesh is contaminated by arsenic and it is spreading quite rapidly). It is therefore extremely important that the issue of improved sludge management is taken with high importance.

Considerable awareness about the environmental risks of this practice seems to be present among the people who are also willing to pay for better services. However, in absence of any improved services, the traditional method of sludge management continues to run for ages without any sign of improvement.

Despite the fact that there is huge business potential, the mere absence of proper FS management service in Bangladesh by the public and private sectors strongly indicates that there is a widespread lack of understanding and awareness about its health and environmental impacts as well as its economic value. This study also suggests that the regulatory mechanism is unclear, enforcement is seriously weak and government service agencies lack capacity, motivation and resources to handle this huge challenge. Despite good intentions, this state does not allow NGOs to play an effective role to improve the situation.

This study therefore highlights the importance of working at different levels and with different pilot approaches so that the successful working model can be scaled up. The country context as well as the regulatory framework demands that municipalities take responsibility for FS management. However, there is a serious lack of awareness; and huge resource and capacity gaps amongst the municipalities to manage FS. A potential way forward could be awareness raising as well as advocacy and lobbying at the national level based on a demonstrated business model of comprehensive FS management in municipalities by the NGOs in partnership with.

Government-NGO collaboration models could be limited to piloting service delivery models for emptying and transportation by the NGOs while Municipalities to allocate space for dumping and installation and running of treatment plants yielding bio-gas, compost, and so on. Different modalities should be experimented with different types of municipalities (large, medium and small) so that the successful demonstration of pilot schemes would be advocated for nationwide scaling up through public-private partnership.

Disclaimer:

This report is based on research funded by the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.

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Names: Aftab Opel
Organisation: WaterAid
Country: Bangladesh
eMail: aftab.opel@wateraidbd.com

Analysis of faecal sludge management in the cities of Douala and Yaoundé in Cameroon

The paper presents an analysis of faecal sludge management in the 2 largest cities in Cameroon.

Authors: Benoît Mougoué, Emmanuel Ngnikam, Adrien Wanko, Roger Feumba, Issidor Noumba

Abstract

This article focuses on the management system of faecal sludge in the cities of Douala and Yaoundé in Cameroon. Just like in other African cities south of the Sahara in general, the management system of faecal sludge in these two metropolises in particular is characterised by the non-participation of public authorities (councils and the government). This activity is strictly handled by private operators whereby households and enterprises manifest the desire for the service on one hand and the corporations and intermediaries provide the services on the other hand. They function in disorder and their prices vary according to the status of the customer.

Data collection was structured in such a way that the whole process could be understood from the start to the end passing through the intermediaries. To this effect, we proceeded to the counting of lorries at sewage emptying sites, enquiries on the scavengers and customers, direct observation on how its transportation is organized through the follow up of drivers during collection and transportation of faeces. This was followed by household enquiries living around each discharge site so as to evaluate their environmental and social impacts of the surrounding population.

From this study, it can presently be affirmed that government and council intervention limit to tax collection where the money is not even used back in ameliorating the activity. Scavengers operate singly though the settling of police officers, demands of state agents and urban council workers will never cease to exist.

In these two cities, the work of a scavenger necessitates organization and this can only be achieved through the reinforcement of legislation whereby they are grouped into an association in order to safeguard their interest.

Introduction

This article presents the situation in the management of sewage in the Douala and Yaounde cities in Cameroon. These two cities alone play host to more than 50 % of urban dwellers in Cameroon with a population of 2.2 and 2.5 million inhabitants respectively in 2010. Douala is a flat coastal city with a very poor drainage system while Yaounde with an average altitude of 700 m above sea level is situated in the south Cameroon plateau. Generally, the drainage systems that are dominated by local latrines are so mediocre. Collective drainage network covers less than 0.5 % of the population of the two cities. Septic tanks on their own part are used by less than 20 % of the inhabitants. Such tanks are mostly found in planned quarters but are poorly constructed in most cases, built by less trained builders in total disrespect of the norms prescribed by civil engineers.

These septic tanks, though not as deep as the traditional toilet, are emptied by professionals using tankers. The emptied faeces are transported to the outskirts of the two city centres where they are emptied on unmanaged sites with sometimes difficult accessibility due to the non-maintenance of the road.

The work of a scavenger is poorly organised in Cameroon because of legislative lapses and the lukewarm attitude of public authorities who only content themselves with tax imposition at the decanting sites and allow operators to operate in disorder. These public authorities do not impose fixed prices and these prices are in function of

Key facts:

- In general, faecal sludge management is Douala and Yaoundé is poor.
- Although dump sites for faecal sludge are available in both cities no treatment is provided
- Service provides are only very little organised

the bargaining power of the operator. Though the prices are fixed according to the volume of the truck, they also integrate many other aspects.

Materials and methods of investigation

This article centres on the evaluation of managing sewage in the cities of Douala and Yaoundé. Data collection was structured in such a way that the whole process could be understood from the start to the end passing through the intermediaries.

Evaluating the organisation of sewage management in Douala and Yaounde

The perception in organising the management of emptied faeces in the two Cameroonian metropolitan cities has enabled us to present the situation, interpret the regulations in force in the domain and analyse the flow chart of institutions implicated in the domain so as to better understand the respective roles of the actors involved. In this wise, the different actors involved were identified, their level of implication analysed through a compilation of their flow charts either at the level of ministries, urban communities or district councils. This approach enabled us to better understand the roles state actors play.

Simultaneously, emphasis was laid on the identification and analysis of the practices of private operators who are professionals in the domain (mechanical scavenger, sewage intermediaries etc.). They were counted simultaneously at the discharge sites and stationing parks in the two cities. Furthermore, we analysed the conditions of becoming a scavenger through the arrêté of MINSANTE (i.e. arrêté N°0003/A/MSP/SESP/SG/DPS fixing conditions of opening, exploitation, renewal, suspension or withdrawal of accord of a private hygiene/ drainage enterprise for a period of 3 years) and the accord that is delivered by competent services, the real authorisation to engage in the profession is delivered by the urban council in the case of Douala.

Monitoring sewage tankers and interview of customers

In the two metropolises sewage tankers were systematically identified at their discharge points (Nomayos in Yaounde and “Bois des singes” in Douala). The identification exercise was conducted for 3 months in Yaounde (November 2011 – January 2012) but this period was reduced to 2 weeks in Douala, given the fact that the Urban Council was already registering the number of trucks that empty their tanks at the “Bois des Singes” site.

The trucks registered were then selected using two criteria: frequency at the discharge site and the free and clear consent of the truck driver. In total 7 drivers out of 17 in Yaounde, being 41.2 % and 7 out 49 truck drivers in Douala, being 14.3 % accepted to respond to the enquiries in respect of this study.
Trucks were followed up at the convenience of drivers placed besides the driver from 6 am to 6 pm (12 hours for a day) for 8 consecutive days in Douala and 14 in Yaounde. Multiplying the number of days by two in Yaounde was due to the low frequency of emptying fecal material in the city. To this effect we established an observation scale for each truck to fill during the period of operation. The time sat at the carbine with the driver enabled our collaborator to familiarise with the driver in order to obtain maximum information on the functioning of the management system of emptied faeces and the practices of the operators.

During this period of the follow up of trucks, all the customers were interviewed who gave an appraisal on the manner in which this activity is carried out, that is the levies charged, eventual negotiations, the network of emptying sewage, relations with scavengers amongst others. In total 52 customers in Yaounde and 60 in Douala were interviewed.

Sewage quantification and characterisation

A combination of two methods was applied in quantifying sewage. These consisted of 1) counting trucks at the entrance of emptying sites in Yaounde and Douala, and 2) their classification according to the volume of the tanker and household demand for sewage services. Rapid calculation led to the estimation of average dejection per inhabitant in the two cities. Considering population projection from the 2005 national census, we could estimate the weekly production of sewage in the two metropolises.

Characterising on the other hand is a practical operation which consisted of sampling faeces at the level of households as well as at the level of emptying sites during the process of emptying. Thirty samples, amongst which there were 11 at the level of households and 20 at the emptying sites, were sampled on the spot. All the bowls of sewage in Douala were conditioned and taken to Yaounde by bus where the contents were analysed. The laboratory analyses were carried out in the Department of Botany in the Faculty of Science, University of Yaounde I.

Analysis of the management of emptying sites and their impacts on the surrounding population

A good knowledge on how this activity functions led us to the analysis of the emptying sites in the two cities. To this effect, transects were realised with exploratory limits during which photographs were taken to illustrate some important facts.

An investigation was also carried out on the population to determine the extent or poor execution of emptying on the inhabitants and the environment. Some 56 households were involved in this exercise in Yaounde

and 27 in Douala within a perimeter of 300 m around the emptying or decanting site.

Subsequently, focus groups were organised together with the riverain population, council authorities of the two cities and the local services of the Ministry of Public Health, Environment and protection of Nature etc. In the case of Douala for example, the convention of managing the "Bois des Singes" site was analysed signed between HONDAE CIG and the Urban Council (These two structures are linked by convention N°18/CUD/SG/DEGCO/2010).

Materials and implementation

Engaging in this study necessitated the use of materials such as GPS for precise location, use of individual protection materials (gloves, helmets, boots and protection eye glasses), plastic containers for sampling, icebox, long ladle, bactericide gel, camera, questionnaire, guides with resource persons etc. This hypothetico-deductive and practical methods resulting in field verification led to the achievement of results with a high degree of accuracy.

Management of sewage in Douala and Yaoundé

The collection and transportation of sewage

About 18 trucks were identified in Yaoundé that belong to 9 enterprises involved in the sewage business. Among these, 3 trucks are owned by hotels which serve in emptying their own cesspits and other customers when need arise, while 3 others are owned by individuals. The volumes of these trucks vary between 8 and 16 m^3. Yaoundé has two parking points for the trucks and these points are only known by potential customers who come there at their convenience to negotiate for services and prices with the drivers. Other customers get to them through intermediaries.

In Douala, the economic capital of Cameroon, 49 trucks were identified that are distributed in volumes (Table 1).

The 49 trucks are owned by 16 different enterprises (with a maximum of 4 trucks per enterprise). It should be noted that some district councils in the city also own sewage trucks (e.g. Douala 1 and 4 district councils). Nine other truckss are owned by individuals. There are no official parking points for the trucks in Douala but most of them can be found stationed behind the Guarantee bus stop in Akwa where they pay no parking fee. The problem of parking presently put scavengers and the Douala Urban Council in conflict.

The three ways of emptying sewage presented for Yaoundé equally applies in Douala. However, manual emptying here is a lucrative activity where some people have specialised in it. These specialists mostly intervene after mechanical sucking has taken place in order to remove solid waste in the pit that cannot be removed mechanically (sand and other objects).

In Cameroon, the work of a mechanical scavenger is guided by an accord issued by the Ministry of Public Health, but in Douala one would notice that out of the 16 enterprises and 9 individuals operating in this business, only 4 are in possession of the ministerial authorisation and 9 function with an authorisation from the Urban Council. Such a situation clearly illustrates the lukewarm attitude of local and national authorities in controlling the handling of faecal material.

The management of sewage in Douala and Yaoundé faces the problem of lack of institutional and legislative coordination. There is no centre that can actually boost the development of this activity but there are centres whose objectives are to extract as much money as possible even if nothing is reinvested back in the activity. That is why the urban councils, district councils and state de-concentrated services go out in the field to collect taxes from the scavengers. Repeated inspections without concertations with the actors or programming of their passage in the field appear as inconvenience to the scavengers who revolt and are pushed to carry out clandestine activities at nearby depressions. To this effect, the nervous attitudes of the controllers who organise patrols at the convenience hinder the smooth functioning of the sewage corporations in the two cities.

Additionally, legislative texts and the in-adaptation of existing ones hinder better organisation of sewage handling in Douala and Yaoundé. One should equally denounce and deplore the existing texts which expose scavengers and especially drivers to risks of contracting diseases. These people handle faeces without wearing EPI such as gloves, boots, working attire, protective eye glasses, helmets, scarfs, etc. The texts in force do no oblige them to respect minimum hygiene conditions or carry out regular medical check-ups. Today the reformulation of texts in regards to the treatment of sewage in Cameroon is imperative which has to be taken seriously.

Inadequate financial means is another handicap to the scavengers. Most of them are owners to their enterprises and they operate with old trucks that are subjected to constant breakdowns. During transport of faecal material, the cover of some sewage tankers remains

Table 1: Distribution of trucks according to their volume (in m^3) in Douala

Volume of truck	4	6	7	8	8.5	9	9.5	10	12
Number of trucks	1	6	1	16	4	4	1	10	6

Fig.1: Location of the rubbish dump in Nomayos (in red) (Berteigne, 2012).

open and the faeces fall along the road rendering the environment. Inadequate financial means and administrative inspections hinder necessary reparations.

In Douala, the average age of sewage tankers is 28 years. They are mostly second hand trucks whose first registration dates back to the 1980s in Europe. In Yaoundé this average age stands at 22. During the peak periods of activities, scavengers over work themselves since there is no relay personnel. This has a consequence on output and safety.

Management of dump sites

The collection and transportation of sewage in Yaounde are carried out by sewage enterprises while land has been provided by an individual as rubbish dump. This dump is managed by the villagers of Nomayos and Mbankomo Council who charge a levy at each discharge. In Douala, the evacuation of faecal material is haphazard. Hundreds of cubic of metres of sludge collected from individual and public toilettes as well as septic tanks are disposed of in the wild without treatment.

The dump site of Nomayos in Yaounde

Located at 1 km along the Yaounde-Douala highway, the Nomayos dump is linked to the main road by a track which is plied by trucks on daily basis. Close to this site is the Avo'o River in which faecal material is emptied. It should be noted that this river forms part of the Nyong river system which is exploited upstream for portable water distributed in Yaounde and Mbalmayo (fig.1).

In effect, the exposed sewage that flows at the neighbouring swampy area are untreated (Fig. 2). An attempt to manage a decantation can by the scavengers themselves did not yield satisfactory results.

In Nomayos village, a management committee whose objectives is to safeguard the interest of the riverain population was put in place to manage the finances obtained from levying sewage trucks. A solidarity fund was created that could assist the villagers in times of need. The management of this fund generated conflicts that led to the closure of the site for two weeks in June 2012. Inspite of these conflicts, the village committee continued holding sessions in order to manage the income generated from the Nomayos site. The money raised is not reinvested for the maintenance of the site by the Mbankomo Council. Worst still this money is used by a few individuals for their personal interest as the municipal tax collector confirmed.

The consequence of this anarchical disposal is that the site, the loader of the organic matter, as well as plastic waste are polluted enormously. The polluting effect is aggravated by uncontrolled dumping. It was observed, however, that when the access road to the site becomes impracticable, the tankers dump the sewage directly into a water body just at the entrance to the site. The outlet or mouth of this stream is a lake where many of the

Figure 2 : Sewage disposal at Nomayos

Figure 3: Location of the Douala dump site (in red) (Berteigne, 2012)

village people come to fish. At times, the tankers empty the waste on the way to the site.

The "Bois des Singes" dumping site in Douala

Huge quantities of sewage are actually collected in the town of Douala, transported and dumped in a place called 'Bois des Singes'. The collected sewage is dumped in nature without appropriate treatment, thereby creating severe public health risk, sight and olfactory nuisance and contaminating water.

This zone, which is situated within mangroves and close to the Wouri Estuary, the main river that drains the town of Douala, is known as the green zone following the urbanisation plan of the town. That is, a zone prohibited for house construction, although that is not the case today as people have constructed there and are living under precarious conditions due to interaction pathogens in the sewage, with neither electricity nor potable water. Within a radius of 300 m around the site, we found about 26 already inhabited houses and many others under construction. This dump site is situated in the south of the town and unlike Yaounde, this site is found within the urban space of the town of Douala (figure 3).

Unlike the Nomayos dump site in Yaounde, the Douala dump site has been carved out and managed by the Douala Urban Council (DUC) since 2003 (Competing, 2007) and the site is managed a private body (HONDAE CIG) that signed an exploitation convention with DUC. An obligatory ccess fee of FCFA1500/trip is the lone condition required from those dumping sewage in the site. Part of this fee (75 %) serves as running cost of the operator, while 25 % of the royalty is deposited with the DUC to ensure maintenance of the site and the access road in theory.

DUC built a ferry-boat for the reception of sewage, which suddenly went bad. The sewage is actually dumped before the ferry-boat and it flows towards the mangrove, which is situated below the site (figure 4).

Although the volume of sewage dumped in the 'Bois des Singes' site is twice as much as that in Yaounde, the revenue generated in this site is too little (23000 EUR). Some scavengers refused to pay the fee on grounds that DUC does not maintain the access road to the site as stipulated in the protocol accord signed with HONDAE CIG.

The impact of this dump site to the surrounding population is enormous and the rate of squatting in the site by the surrounding population is high. In the field, we observed that 126 inhabitants had already occupied 26 houses within 300 m round the site, while 112 other houses were under construction. If nothing is done, the population living around this site will move up to 900 by the time the rest of the houses under construction must have been completed (Figure 5).

All land occupation in this site is recent in the sense that the first households censored in the site were constructed in 2009. 89 % of household occupants around the site

Figure 4: Dumping lorry at the entrance of the ferry and the outlet of the sewage

Figure 5: Concrete foundation (on the left) and an earth-filled one in a valley (on the right)

affirmed to have witnessed poor health during the last two weeks before the passage of the researching team. After enquiry it was observed that the most affected were women (41 %) and children (27 %). This morbidity rate is twice as high as that observed in Besseké zone (40 %), a neighbourhood in Douala IV Council characterised by spontaneous settlement and which is very far away from the sewage disposal site.

Costs of the service

The prices of draining sewage are relatively high in Yaoundé. The average cost (based on 130 responses) is 88000 FCFA (134 EUR) when it is the toilet of an individual that is to be drained (knowing that the minimum wage is 28500 FCFA). The price increases when the toilet drained belong to the administration or enterprises.

It should be underscored that some scavengers were reticent to give this information. As earlier said, the scavengers often depend on hotel, which are owners of tanker Lorries and the price for draining the toilets of these hotels is 20000 FCFA. The average price for draining a toilet was then calculated after reducing this amount. The price for draining a cubic meter of sewage in Yaoundé is 17000 FCFA/m^3.

Toilet draining prices in Douala are lower, ranging from 15000-40000 FCFA (average 33000 FCFA). These prices are two to five times lower than those charged in Yaoundé for several reasons.

- The distances between the customers and the dump site are quite reduced on the average than in Yaounde, the political capital, thereby engendering a logical reduction in fuel consumption.
- The volumes of septic tanks in Douala are generally smaller with reduced depths. Thus, less fuel is consumed by the suction pumps.
- The state of access route to the disposal point is better thereby reducing maintenance cost.
- Competition among scavengers in Douala is relatively higher (as many as 2.5 times more tanker lorries than in Yaounde although the populations are almost the same). In effect, some scavengers practise price cuts, reducing them to as much as 15000 FCFA per trip.
- Dumping fee is only 1500 FCFA with no access tax, unlike in Yaounde where each tanker lorry pays 50000 FCFA/month.

Average draining price per m^3 is 8500 FCFA in Douala, or half of the price charged in Yaoundé (17000 FCFA). In Douala there is greater price dispersion around a mean, which is 35000 FCFA per draining trip. A reconstitution of exploitation cost of scavengers based on data got from 7 tanker lorries that responded to the survey instruments in Douala and Yaoundé respectively, showed that average draining cost in Douala is 28000 FCFA per trip and 55400 FCFA per trip in Yaounde. The net surplus saved in Douala is only 7300 FCFA as against 33300 FCFA in Yaoundé. We can therefore affirmed that the steep competition between operating scavengers in Douala and their poor organisation profit households, which benefit sewage draining services at lower costs. This conclusion may vary slightly in the sense that in Douala, customers need to request the services of a scraper after the passage of the tanker if they want to completely get rid of sand and other debris that remain in the septic tank after draining.

Sewage production and collection

A considerable quantity of sewage produced is not drained

Specific sewage production as of lower value quantification is 0.69 km/inhabitant/day in Douala and 0.74 km/inhabitant/day in Yaoundé. On the average, the standard deviation is higher in Yaoundé (Table 3).

Table 3: Sewage production in Yaoundé and Douala (Berteigne, 2012)

Locality	Indicator	Drained volume (m^3)	Specific sewage production (kg/inhabitant//day)	Number of days separating two draining periods
Douala	Mean	**7.38**	**0.69**	**1451**
	Standard deviation	2.34	0.80	1062
	Maximum	12.25	3.36	200
	Minimum	4.11	0.09	2700
Yaoundé	Mean	**7.26**	**0.74**	**1885**
	Standard deviation	3.73	0.71	2699
	Maximum	13.75	1.86	8760
	Minimum	2.106	0.04	60

Table 4: Quantity of sewage produced in Yaounde and Douala (m^3) (Berteigne, 2012)

Town	Computed quantity at dump site (m^3)		Specific production (m^3)		Request for sewage draining	
	Gross	With uncertainty	Gross	With uncertainty	Gross	With uncertainty
Yaoundé	730	900	1850	1350	2300	1260
Douala	1785	2271	2444		3423	

Depending on the method of evaluation used, total sewage production in Yaoundé varies between 1850 and 2300 m^3/week. In Douala, this production varies between, 2444 and 3432 m^3/week (Table 4).

Upper value quantification in Yaounde indicates that there is a consequent deviation between the potential quantity of sewage produced in the town and that collected and dumped in Nomayos. In Yaounde, only 2/3 of sewage in septic tanks is drained. This can be explained by many factors. First of all, field observation was done during the dry season, whereas, all stakeholders in the sector acknowledge increase of activity during the rainy season. In addition, a growth rate of 5 % per year was attributed to the entire population of Yaounde, whereas, even if this value was to be true, it would hold for the neighbourhoods at the outskirts of the town and not the centre and the old neighbourhoods where the population is relatively stable.

In Douala, on the contrary, the volumes calculated at the dump site were coincided with the potential production evaluated using the specific production method.

Sewage produced mainly by households

Households are the main customers of manual sewage draining in the two towns: 56 % of the customers in Yaoundé and 77 % of those in Douala (Figure 6).

In Yaoundé, restaurants and hotels represent 17 % of the customers or the third highest proportion after administrations and households. Administrations represent close to 25 % of the sewage draining customers in Yaoundé. In Douala, on the contrary, administrations did not feature among the customers during the time of study. Companies and others such as restaurant and hotels made up 12 % of the customers. This observation is justified by the economic and administrative functions of the towns of Douala and Yaounde respectively. Following the type of sewage draining works, the draining of septic tanks is the most common in the two towns (Figure 7).

In Yaoundé, 90 % of sewage draining works are on septic tanks, followed by latrines and public toilets at a marginal proportion (less than 5 %). Septic tanks are by far the most drained and this can be explained by the cost of draining. In effect, it is clear that owners of septic tanks are among the well-to-do households, cesspits are often a reserve of inhabitants of semi-structured or completely spontaneous neighbourhoods. This last type of toilets is often drained manually or is abandoned by the owners when they are full. Besides, cesspits in Yaounde are very deep, and therefore have a life span of more than 15 years. Draining of cesspits in Yaounde is difficult since many of them are stuffed with solid non-biodegradable objects that are aspirated with difficulty.

In Douala, on the contrary, besides septic tanks (77 %), a proportion of pit latrines (23 %) are drained. These latrines are not deep and are generally wet due to risen underground water, all of which facilitate manual draining.Following the quantity of excrement produced and the sewage dumped in Nomayos in Yaounde or in 'Bois des Singes' in Douala, there exist a considerable

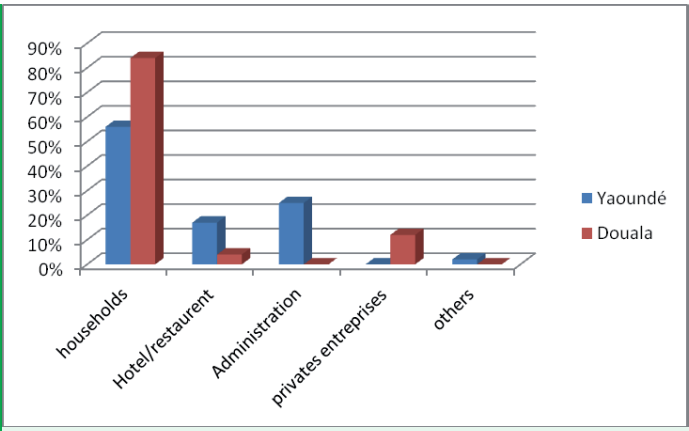

Figure 6: Distribution of sewage producers in Douala and Yaoundé

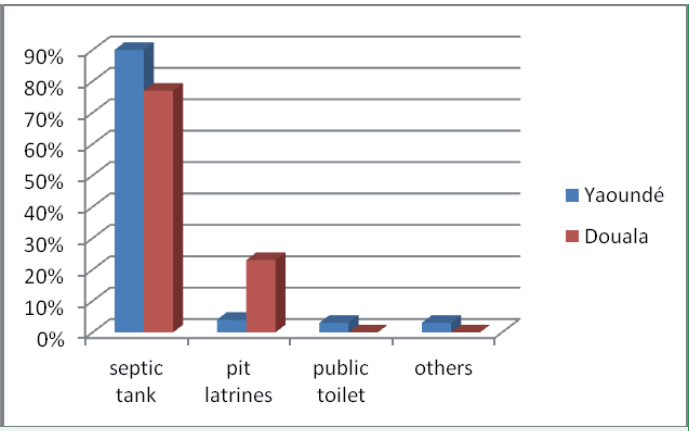

Figure 7: Types of sewage draining works in the two towns

volume of sewage in the two metropolises that is not dumped in the cited sites, or which scavengers dump illegally in depressed zones, thereby increasing pollution pockets in these towns.

Analysis of the poor functioning of the sector

Management of sewage by diversified and less organised actors

In the two cities of Yaounde and Douala, a multiplicity of actors called "scavengers" intervene to ensure the functioning of the sector. They operate as individuals focusing on the gains to make and expected interests.

First of all, we notice the presence of bosses who are amateurs that have succeeded to render the trade of scavengers a profitable business from which they can even feed. These are greedy business people who want to make a fortune or veracious civil servants who invest in buying lorry tankers, evading administrative procedures and recruiting drivers who help in running their enterprise. The name enterprise is just for convenience as the headquarters is often the home of the boss who is interest in the daily returns.

The drivers-owners of the lorry tankers are sole proprietors of their enterprises. They are at the head of their own business where they reap their essential allowances. They are keen about the good functioning of the sewage management sector and they are attentive to all information emanating from State or municipal services.

The drivers of the tankers are the nerve centre of the sewage draining enterprise. They embark on the search for customers and ensure the transportation of sewage up to the dump sites. They serve as a link between the boss and the customers. They charge and collect draining money, which they subsequently hand to the bosses.
The motor-boys are the stuffing asses. These are labourers who carry out odd tasks such as adjusting and rinsing the tubes, opening and closing the cesspits, opening the sluice valves at the dump sites, etc. they are permanently in contact with the excrement and are exposed to disease attack. In the course of time they turn the stool without being irritated and without putting on individual protective equipment (IPE). Gloves, protective glasses, boots and mufflers seems useless to them; being in direct contact with excrement without IPE, a motor-boy gets set to open the sluice valve of a lorry tanker that is ready to dump sewage at the "Bois des singes" site in Douala (Figure 8).

There are intermediaries who go after allowances. They enter all corners of neighbourhoods to propose sewage draining services or use their human relations to capture as many customers as possible whom they take to the different drivers following their bargaining power or dealings. They constitute an important link in the life of the sewage management sector. Carefully flattered by the drivers, they do not hesitate to practise higher bid and at the same time, they make profit from the customer and the driver who pays him the stipend that was negotiated in advance.

The customers captured by scavengers are no other than owners of houses whose toilets are full. They are constantly searching for better services at a cheaper

Figure 8: Opening a sluice valve of a tanker at "Bois des singes"

price. In Yaounde and Douala, every household has a potential sewage draining service provider.

Purported landlords of the dump site, particularly in Yaounde, generate substantial income from this activity due to the simple fact that they use a piece of vacant land, which they claim ownership, whereas it is actually State land. In effect, for each trip, the driver pays a fee of 5000 FCFA in Yaoundé to dump the sewage collected in the town, while in Douala, it is 1500 FCFA. The purported landlords are bent to participate in environmental pollution. Besides the purported landlords, in Yaounde, the people of the village of Nomayos have organised themselves to equally benefit from the fallouts of the untreated sewage that is dumped in their village. They share the dumping fee paid to the Council of Mbankomo and quite often do not hesitate to organise strike actions. Last June, they blocked the site for two weeks, forcing scavengers after serious negotiations to increase the fee to 15000 FCFA/trip.

The municipalities are locally represented by urban council and the rural councils. Their role is only to sign authorizations acknowledging permit to carry out the activity when solicited. They also benefit from the taxes paid by scavengers in the sites of Nomayos in Yaounde and 'Bois des singes in Douala without carrying maintenance in return. These local councils partially ensure the parking of scavenger's trucks and the circulation of these trucks within the town.

The State assumes just its regulatory role and sporadically regulates the profession of scavengers by adopting some laws. Through the deconcentrated services of the Ministries of Environment and Nature Protection and of Sustainable Development, it organises sporadic inspection missions to the dump sites. These missions are not backed by any real intention to have mastery of the sector, or as a strategy through which the sewage management sector could be restructured and organised. No one doubts the fact that growing interest attached to environmental issues each time, instigates the government of Cameroon to adopt consequent legislative texts the following years to re-orientate development initiatives of the sector geared towards the treatment of excrement in urban milieu.

It should be underscored that, in the field, the sewage management sector is characterised essentially by the absence of synergy between the stakeholders. In effect, urban and rural councils at the periphery act in disperse ranks, in isolated manner and do not have concerted interventions. Under such circumstances they phase out in the field, undermining the effectiveness of their actions.This is the same situation with State specialised services.

Corporative organisations that scavengers have attempted to form up to now, be it in Yaounde or Douala, have been weakened by internal squabbles and the lack of will power of the members. Due to the weakened nature of these bodies, they have never been represented at the level of the administration or the promoters of sewage draining societies.

A sector characterised by multidimensional problems

Suboptimal organisation of sewage management in the towns of Yaounde and Douala allows for the emergence of side problems, which hinder locally, the development of this activity. From the analysis, some of them are of interest.

The sewage management sector in the two towns is characterised essentially by poor organisation of the sector due to laxity of the managing authorities of these agglomerations. In fact, there exists no structures that co-ordinate the activities of scavengers. Consequently, only few of them fulfil the required administrative formalities. In Douala, for instance, only four enterprises have obtained approbations from MINSANTE, which allow them to operate legally. In Yaoundé, no sewage draining enterprise has been approbated. At moment, it suffices to acquire a lorry tanker to go about the trade with all ease in the two big cities of the country. Thus, it is understood that the sewage management sector is not regulated by the competent authorities.

The difficulty in managing sewage in the two metropolises of Cameroon engenders anarchy in the prices paid to scavengers, problems of managing dump sites in Yaounde and Douala and instigates intentional dumping of faeces in depression zones. Following inability of the State to manage sewage adequately, the current dump sites are real microbial breeding grounds and these microbes spread the polluting matter to the immediate and even far off environment.

The poor organisation extends to the scavengers who evolved in isolated or dispersed ranks. As such, they are powerless and cannot withstand the pressure from their bosses, police harassment, cheating attitude of customers and bottle necks of State agents.

In addition to these organisational problems, are not negligible financial problems. To start sewage draining business, it requires that a promoter invests heavily in the buying of a lorry tanker; acquire administrative documents such as insurance, technical inspection, packing permit etc. Quite often, the promoter is forced to resort to loans either from banks, thrift and loans or various relations. Datelines for repayment are always moments of agony to the promoter. The amounts gathered, however, are often enough to buy only second-handed lorry tankers of more than 20 years, which often witnessed break downs thereby making it difficult to respect the terms of the agreements contracted when the credits were got.

Amateurism of the promoters of sewage draining corporations is a torn in their flesh. Quite often, they are less prepared to manage an enterprise and as such do

Figure 9: Access route to the dump site of Nomayos in Yaoundé

not have a viable business plan with confusion setting in between managing their personal revenue and that of the enterprise. This attitude is justified by the many interruptions of activities observed every year or the non-payment of driver due to lack of liquidity.

In addition to the aforementioned issues, we can include the inability to manage the access roads to the sites, an issue that hinders appropriate dumping of sewage Access to the Nomayos dump site is almost impracticable due to permanent presence of pools of water (Figure 9).

Attempted solutions to ameliorate sewage management in urban milieu of Cameroon

The daily management of sewage in Yaounde and Douala, characterised by laissez-faire, is not adequate to ensure sustainability of the activity despite its importance in the regulation of urban life. Counter actions ought to be taken in order to ameliorate the current situation.

As a matter of urgency, the State and the two urban councils need to concert in order to identify the main problems plaguing the sector and manage them following the required norms and to secure appropriate dump sites for these two metropolises. This action will lead to the build up of a large treatment system that will serve for the reception of faeces and to the putting in place of a mechanism for treating the sewage before disposing it into nature, as well as managing the access road. These basic issues, undoubtedly call for a better handling of the sector through reinforcement of legislation, the putting in place of modalities to protect scavengers who are in permanent contact with the pollutants, and the organisation of the profession of the scavengers.

Such intervention from the State will surely lead to a better internal organisation of the scavengers of each town into a corporation. In the past, attempts to bring scavengers into an association were not brought to fruition. The initiators of the project lacked the required charisma and wanted to safeguard their immediate interest as individuals. Scavengers in the two towns today are expressing that wish to come together in order to defend their common interest, uphold the principle of equity in the treatment of customers by all exploiters or operators in the sector, and ensure the protection of use rights in terms of tariffs practised and to offer quality services. Conditions for taking this measure are provided for by law n°90/053 of 10 December 1990 where it allows for liberty of association in Cameroon.

One of the major problems in the management of sewage is access to funding, which is very necessary in the running of the enterprise when the lorry tankers have serious break downs. This often causes the tankers to be down for long affecting the bosses as well as the employed staff. We can envisage a mechanism through which a relationship is created between banking institutions and scavengers where loans are granted and guaranteed by the State under certain conditions.

Conclusion

Human settlements produce excreta that is either disposed in nature or stocked in cesspits. This human waste is repugnant since it is known to be highly polluting and is the cause of many infections. It can lead to serious illness if poorly handled. This is effectively what is happening in the towns of Yaounde and Douala. In these two agglomerations, excrement that collects in various cesspits, is at times drained by professionals and dumped in sites that are not maintained at urban periphery. This poor disposal constitutes a danger to the surrounding populations who inhale the pungent odour, use the sewage as manure in their farms or come in contact with it while carrying out their daily chores without foreseeing the consequences that can ensue.

The scavengers themselves are no longer inure to the excrement. Due to repeated manipulation of the sewage, they become accustom to it and easily accommodate the

situation. They rarely make use of IPE and this exposes them to many infections, some of which are incurable. The management of sewage requires the intervention of the State and the municipalities, not only to collect taxes, which are often poorly used, but after all, to create enabling conditions for the dumping of sewage in well maintained sites. In this regard, those managing urban affairs ought to:

- put in place realistic and practical modalities for draining and dumping of sewage in urban milieu;
- favour the grouping of scavengers into associations for the defence of their interest;
- put in place a concertation plate-form between the local stakeholders of the sewage management sector in urban milieu; and favour intensive communicational actions;
- maintain the dump sites following the norms regulating waste disposal at the peripheries of the two big towns;
- regulate the contract between customers and the scavengers by pasting the accepted prices in public places; and
- adequately treat sewage before dumping it into nature.

An adage says that sanitation is the dignity of man! Despite its established importance, this burning issue does not seem to be currently preoccupying to authorities managing urban affairs in Cameroon.

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Name:Benoît Mougoué
Organisation: Department of Geography, University of Yaoundé 1
Town, Country: Yaoundé, Cameroon

Name: Emmanuel Ngnikam
Organisation: National Polytechnic Higher School in Yaoundé
Town, Country: Yaoundé, Cameroon

Name: Adrien Wanko
Organisation: ENGEES
Town, Country: Strasbourg, France
eMail: awanko@engees.u-strasbg.fr

Name: Roger Feumba
Organisation: ENGEES
Town, Country: Strasbourg, France

Name: Issidor Noumba
Organisation: Faculty of Economy, University of Yaoundé 2
Town, Country: Yaoundé, Cameroon

Optimizing the faecal sludge management scheme in Ouagadougou, Burkina Faso

This paper shows the benefits of involving local stakeholders such as collection and transport operators and municipal representatives in the development of an optimized faecal sludge scheme.

Authors: Magalie Bassan, Tetouehaki Tchonda, Mbaye Mbéguéré, Linda Strande

Introduction

In 1996, the National Utility of Water and Sanitation (ONEA) in Burkina Faso was one of the first West African National Utilities to adopt a National Sanitation Strategy including faecal sludge (FS) management. ONEA is thus responsible for the challenging task of organising effective FS management for about 90 % of the population served by on-site systems in Ouagadougou, the capital city.

The French Agency for Development (AFD) provided funding to establish a three-year partnership between ONEA and the Department of Water and Sanitation in Developing Countries (Sandec) at the Swiss Federal Institute of Aquatic Science and Technology (Eawag). One of the main goals of this unique collaborative partnership is to implement sustainable solutions for FS management by joint research, stakeholder capacity strengthening, and the design of guidelines and tools. This article presents the activities conducted in collaboration with ONEA to develop an adequate institutional framework for FS management in Ouagadougou, and strengthen the capacities of the collection and transport companies.

Initial assessment of the situation

FS production in Ouagadougou is estimated at 500–1000 m^3/day, with an increase during the rainy season (Koanda et al., 2010; Bassan et al., 2010; Pöyry, 2010). To avoid the discharge of this liquid waste into the environment, ONEA plans to construct four FS treatment plants with unplanted vertical-flow drying beds in the two main cities of the country, Ouagadougou and Bobo-Dioulasso. The end product of the drying beds (leachate and biosolids) will be further treated for potential use in agriculture.

An institutional assessment was conducted to understand the stakeholders, legal documents and activities that need to be taken into account for the design of the institutional framework. The stakeholders involved in FS management were assessed, and representatives of the stakeholder groups participated in informative and consultation workshops. They include ONEA's staff, FS collection and transport entrepreneurs, but also local universities, ministries in charge of water, environment, land and health, municipal technical services and policy, local press, AFD and NGOs. The analyses revealed a lack of human resources dedicated to sanitation in several institutions, a weak coordination of the stakeholders, a need in capacity strengthening concerning the FS management modes and technologies, and the necessity to develop measures to ensure institutional efficiency.

Key facts:

- Three years of collaboration between ONEA and Eawag/Sandec to assist the planning process for faecal sludge treatment plants in Ouagadougou
- Need for an increased communication among the local stakeholders to allow an optimized management scheme for the faecal sludge
- Need for an increased recognition of faecal sludge collection and transport operators by the official stakeholders and the population in order to ensure the sustainability of the management chain
- Design of several official documents (partnership agreement, decree, license, …) regulating the collection and transport of faecal sludge to ensure its discharge at the treatment plants in environmentally acceptable conditions, and the coordination of the local stakeholders.

The current sanitation policy in Burkina Faso comprises four main components that unfortunately do not define the responsibilities and quality standards for the FS supply chain, or their enforcement (Bassan et al., 2012):

- The code of environment requires everyone to dispose of urban waste properly (Assemblée des députés du peuple du Burkina Faso 1997).
- The decree regulating urban waste storage, collection, transport, treatment, and disposal, requires FS to be transported to treatment or discharge sites in special vehicles.
- The discharge standards set limits for pollutants release into the air, water and soil.
- The code of public hygiene appoints local authorities to manage urban waste and provide sanitation services.
-

The analysis revealed that the collection and transport operators require strong recognition at the institutional level, as well as capacity strengthening. This is a crucial condition to ensure the sustainability of the FS management chain. Indeed, they face difficulties in disposing of the large quantities of FS produced in Ouagadougou due to the long distances to illegal discharge areas and harassment by police and the population. They are not involved in urban planning programmes, do not benefit from government assistance, have poor business management skills, and often operate in poor hygiene conditions. On account of financial difficulties, only 60 % of the FS collection and transport operators surveyed in 2007 were still active in 2010. Thus, focus should be placed on strengthening the organisation of these stakeholders.

Institutional development and capacity strengthening

The crucial information obtained during visits, interviews, workshops and informal meetings allowed the organisation of a consultation platform to define an optimized management system for FS. The following official draft policies and documents were developed:

1. A decree on FS collection and transport in Ouagadougou regulating:
   - Type of FS and obligation to discharge in authorised sites.
   - Provision of an official address by the collection and transport operators, registration of information related to their activities and payment of discharge fees at FS treatment plants.
   - Safety equipment and health measures required.
   - Right of collection and transport operators to establish their service price.

2. A municipal license authorising the collection and transport operators who adhere to the above decree to deliver their services for a period of three years.
3. A partnership agreement between ONEA and the municipality defining their responsibilities in terms of awareness raising among the population, establishing discharge and treatment sites, enforcing a regulatory framework and assisting the collection and transport operators (Figure 2).

The consultation activities of the collection and transport operators conducted from June 2010 to 2012 allowed to improve their recognition by the other stakeholders. Several information workshops were also held to discuss their difficulties and develop solutions. Their professional association was thus reorganized, and

Figure 1: The collection and transport operators often lack of management skills, safety measures, and operate in poor hygiene conditions (photo: T. Tchonda)

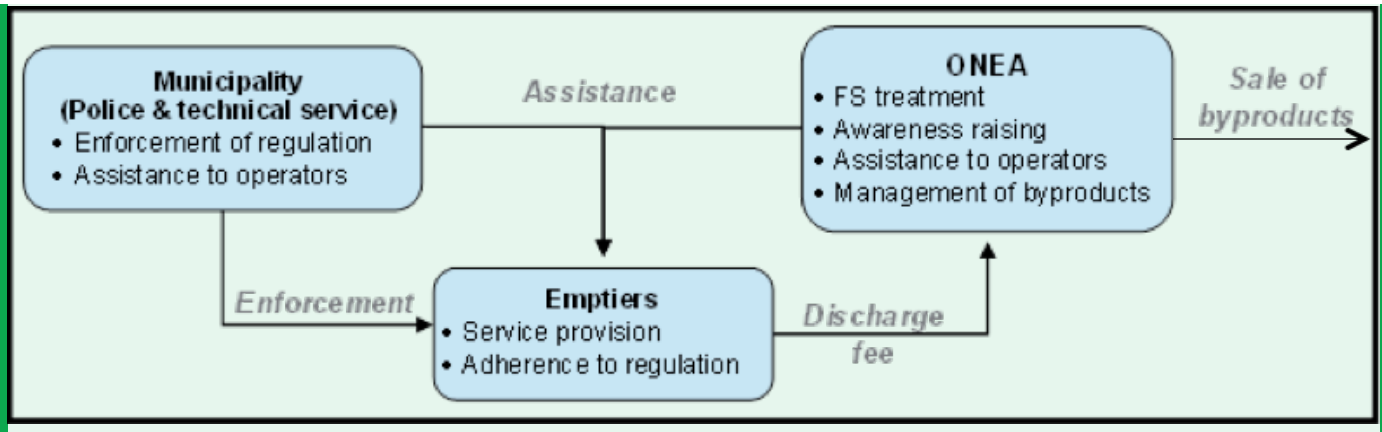

Figure 2: Stakeholders' responsibilities (boxes) and their relationships (arrows).

guidelines developed to provide information about on-site sanitation, safety, hygiene practices, and financial management of the collection and transport companies. This document was used as a basis for a training held to strengthen their management practices, improve their capacity to communicate with customers, and initiate associative activities.

Conclusion

The uninterrupted flow of communication throughout project implementation has created a very strong collaborative exchange and trusting environment between ONEA and Sandec. The participative process has also allowed the official involvement of the collection and transport operators, who are often not considered in urban planning, and provided other stakeholders insight into their difficulties and weaknesses. The exchange between the authorities, sanitation experts and collection and transport operators is crucial as it improves the quality standard of these services in terms of hygiene, safety and environmental protection. Both the participative process and the resulting documents may readily be adapted to other cities and countries and contribute to adequate and appropriate FS management.

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Name: Magalie Bassan
Organisation: Eawag (Swiss Federal Institute of Aquatic Science & Technology), Sandec (Department of Water & Sanitation in Developing Countries)
Town, Country: Zurich, Switzerland
eMail: magalie.bassan@eawag.ch

Name: Tetouehaki Tchonda
Organisation: Eawag; Sandec
Town, Country: Zurich, Switzerland

Name: Mbaye Mbéguéré
Organisation: Eawag; Sandec
Town, Country: Zurich, Switzerland

Name: Linda Strande
Organisation: Eawag; Sandec
Town, Country: Zurich, Switzerland

Towards sustainable pit latrine management through LaDePa

This paper shows the LaDePa machine to produce organic fertilisers from faecal matter and describes a potential contractual model for servicing areas using VIPs in eThekwini municipality.

Authors: John Harrison and Dave Wilson

Abstract

Urban pit latrines and their associate challenges, in particular the disposal of sludge, are ubiquitous to the developing world. eThekwini Water and Sanitation (EWS), the municipal entity responsible for providing sanitation services to Durban and its surrounds, has co-invented and piloted an inexpensive, mobile, containerised technology, called LaDePa that can convert pit latrine and other sludge into a usable, pasteurized, dry product, beneficial for all agricultural. By utilising inexpensive, simple and robust mechanics this technology not only addresses the five major technical challenges of sludge management, but also address some environmental and socio- economic challenges in the communities where pit latrines are encountered. EWS intends privatising its pit emptying program anchored on the LaDePa technology. The low capital cost of LaDePa and its mobility obviates the necessity to enter into a Public Private Partnership (PPP) governed by the South African National Treasury regulations. This paper briefly discusses the technology, its environmental benefits, the challenges it addresses, and provides an overview of the procurement model that complies with standard Supply Chain Management requirements.

Introduction

The millennium goal to eradicate the backlog of sanitation, and the setting of Ventilated Improved Pit latrines (VIP) as the minimum basic sanitation standard in South Africa, has seen a proliferation of VIPs being constructed in South Africa and many other parts of the world with very little consideration being applied to how they are going to be serviced, particularly in dense urban settlements, which have their own particular set of servicing challenges. Fifteen years after establishing VIP as the minimum basic sanitation standard in the country, the social and health problems associated with over full VIPs is beginning to emerge.

Further, the legislation governing government procurement and the natural environment, in South Africa has create a legal environment that is generally not conducive to simple VIP servicing solutions.

eThekwini Municipality, the municipal entity that services Durban and its surrounds, in conjunction with Particle Separation Solutions (Pty) Ltd (PSS), a private company operating in the minerals field, have developed a LaDePa (Latrine Dehydration and Pasteurisation) machine which converts VIP sludge into low grade fertilizer. The relatively low capital cost of this machine, employing basic mechanical and electrical technology, is robust, simple to operate and service and can be containerized for mobility. These features make it compatible with the environments where VIPs are generally encountered in urban situations.

Key facts:

- The LaDePa (Latrine Dehydration and Pasteurisation) machine produces hygienically safe organic fertilizer from faecal sludge at low costs.
- It is shown that LaDePa technology is financially feasible when treating more than 2000 tons faecal sludge a year.
- A contractual model between eThekwini municipality and service providers for servicing areas using VIPs is proposed

eThekwini Municipality have piloted this machine and now intend outsourcing their VIP management anchored on the LaDePa machine. The purpose of this paper is to provide an overview of:

- The challenges associated with VIP servicing in South Africa
- The workings of the LaDePa machine
- The contracting model that eThekwini Municipality intends using and
- The reasons for choosing this contracting model

with the view to illustrating how many of the procurement and environmental issues can be overcome by anchoring the servicing around the LaDePa Machine. This paper will also illustrate how compatible the servicing model is with many of the social issues encountered in the communities where VIPs are generally provided. One of the side issues that this paper raises is the need to consider the method of servicing in the design of the VIP structure.

Overview of the Wastewater Technology

The Social Environment

Like most of the developing world South Arica has and still is experiencing a major migration to the urban centers. This has resulted in many informal settlements, which are subsequently being upgraded into low cost housing. Up until recently this housing, in the main, has been dense single level accommodation. The rate of urbanization, the historic backlogs, the lack of resources and the political urgency and ambition not to resettle has meant that urbanization has developed in an environment where the consideration of provision of services has taken a back seat.

Migratory urbanisation has meant that many of the skills that may have been developed in the rural environment are not applicable in the urban one. Further the education level of the migrants is generally poor, leading to poor employability, (particularly at the higher levels), and consequently poor employment levels.

Challenges Associated with the Material

Traditionally servicing of pit latrines has been by relocation (rebuilding) once they were full. However in dense urban locations this is usually not an option due to space constraints. Consequently VIP emptying is the only option in most urban situations. However some of the major challenges associated with the VIP sludge handling, are a direct consequences of the nature of the material itself.

In South Africa where most of the VIP users are “wipers” rather than “washers” the material is generally an odorous, sticky paste with a solids content in the region of 30 %. Due to the lack of affordability, the anal cleaning material is seldom toilet paper, and due to ignorance and lack of services, large quantities of foreign materials and objects, known as detritus, are encountered in the pits. Further, the pits are a major main receptacles for human pathogens.

The nature of the material complicates both the pit emptying and disposal options.

Sludge Disposal Challenges

Apart from the traditional relocation of pit latrines, up until the advent of LaDePa, there have been only a limited number of environmentally acceptable disposal options:

- Burial on site
- Deep burial on a remote site. (Deep trench burial for silviculture)
- Disposal via a sewage treatment works and
- Disposal to a solid waste landfill site.

Deep trench burial for silviculture is still being piloted for SAPPI and the Water Research Commission (WRC) by Dave Still.

eThekwini Municipality piloted disposal to a sewage treatment works with disastrous consequences. Loading of 1,5 cubic meters of VIP sludge per day is approximately equivalent to a capacity increase of one mega liter of wastewater per day on the sewage treatment works. VIP sludge is virtually stable by the time it is removed from the pit, so little further beneficiation to the sludge occurs at a wastewater treatment works: Passing it through a sewage treatment works, increases the load on nitrification and the sludge handling facilities. Further, it also makes little sense in adding water to a relatively dry sludge if the ultimate intent is to dewater it again.

Sewage sludge is considered infectious in terms of the Regulations promulgated under the Environmental Management Act and consequently can only be disposed to a hazardous landfill site. In addition, from an environmental perspective, disposal of sludge to landfill sites wastes phosphates, (a scare and diminishing resource), and other nutrients.

The Environmental Licensing Challenges

The classification of VIP sludge as being hazardous due to it being infectious, raises licensing issues. In terms of the Waste Management Act, licenses are required for both the storage and treatment of hazardous materials. However there is a minimum capacity threshold limit on sewage treatment works of 2000 cubic meters a year, below which Waste License and Environmental Impact Assessments (EIAs) are not required.

The Major Health and Safety Concerns

Human pathogen transmission can occur as a result of

- Overfull pit latrines
- Emptying process
- Uncontrolled disposal methods
- Uncontrolled agricultural use.

Compliance with the Occupational Health and Safety (OHS) Act can also be difficult with poorly educated labour.

The Major Procurement Challenges

The emptying and servicing of VIPs is not technically particularly challenging and is thus suitable for job provision and entrepreneur development in the communities where VIPs are encountered. However the contracting environment around outsourcing such services is fraught with challenges in an environment where the treatment technology is expensive and/or complex. On the one hand, in terms of the Municipal Finance Management Act (MFMA) the maximum span of a contract is three years unless special arrangements are made with National Treasury. While on the other hand, the capital cost of most of most of the established human faecal sludge treatment or recovery plants is high, requiring long term financing arrangements.

This dichotomy of short contracts with long term financing, leads to any number of potential contracting models, but each has its own set of risks to the municipality. The following list of contractual arrangements highlights some of these challenges:

- In the first model the municipality owns an expensive, complex treatment facility but outsources the operation of the plant and the VIP emptying service in a typical three year contract. In this arrangement, the contract period is too short to source and train contract operators on a complex facility, and further, there is little incentive for the operator to operate and maintain this facility in a manner that is compatible with its long service life and financial cost recovery.
- In the second model, the municipality owns and operates the treatment facility, but outsources the VIP emptying operation. However there is a risk to the municipality in that the highly skilled and costly operation of the facility is prone to disruption by under production of a low skilled contractor.
- A third model is to enter into a Public Private Partnership (PPP) where the term of the contract is sufficient for the contractor to purchase, own and operate the treatment facility for a sufficient period for him to enter into a long term financial arrangement, source and train operators and undertake the contract. In South African Common Law, non-removable property automatically becomes the property of the land owner. Thus financial institutions are reluctant to invest in fixed property on public land without rigorous guarantees and sureties. This arrangement, in the main, excludes the very community that the opportunity is intended to serve.

In setting up an outsourcing contract, other important considerations include:

- determining the mode of operation,
- the unit of payment and
- keeping records of the VIPs that have been emptied.

eThekwini's experience is that emptying by sweeping whole areas of VIPs is more efficient than operating on an individual call-out basis. However this means that either some of the VIP are overfull when the sweep occurs or that the process is inefficient because too many half full pits are being emptied. In the most recent sweep eThekwini used the pit as the unit of payment, however on the next round the intention is to pay by volume of material delivered to the disposal facility, provided its moisture content, sand and detritus content is within the acceptable range.

In eThekwini's case, keeping records of the VIPs that have been emptied has been captured by Global Positioning System (GPS) and stored on GIS. Follow up monitoring, based on this GIS record, will be undertaken by the Municipality as a check of the thoroughness of the sweeps in future.

Summary of the Major Challenges

In summary the major challenges associated with VIP management in South Africa are:

- Space and Access – prevents relocation of pit latrines in dense settlements and access for large scale mechanical equipment
- Material handling difficulties associated with the "stickiness" of sludge
- Added transport costs associated with water in the sludge
- Safe affordable, sustainable (both environmentally and financially) disposal options (usually compromised by detritus and pathogen counts in the sludge)
- Human pathogen transmission
- Environmental licensing
- Procurement and contracting.

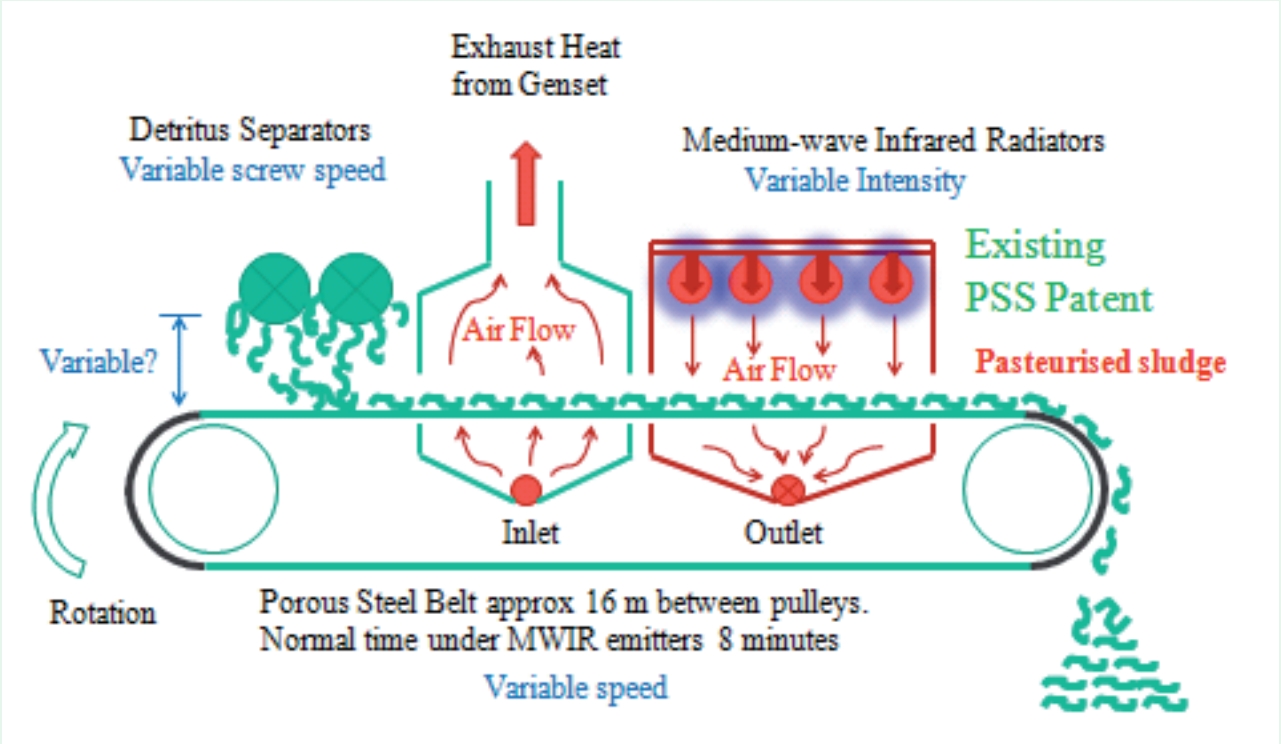

Figure 1 – Diagrammatic view of the LaDePa machine process

Description of the LaDePa Machine

Figure 1 provides a diagrammatic illustration of the functioning of the LaDePa machine. The machine separates the detritus from the sludge by compressing the combination of sludge and its associated detritus in a screw compactor with lateral ports, through which the sludge is ejected, and is then deposited in a 25 to 40 mm thick layer of open pored matrix, onto a porous, continuous steel belt, while the detritus is ejected through the end of the screw conveyor. After pre-drying, using the waste heat from the internal combustion engine of the drive plant, the sludge on the belt, is conveyed through PSS's patented Parceps Dryer where it is subjected to pasteurisation, which also provides sufficient drying to take the sludge through the "sticky" phase making handling simple. PSS's Parseps Dryer technology uses Medium Wave Infrared Radiation and a vacuum to draw air through a porous material or one with an open matrix.

The end product is a low grade organic fertiliser, with about three percent active ingredients. It is free from gross detritus as the holes through which the sludge is extruded are 6 mm diameter, it is free of pathogens and is consequently suitable for all edible crops. When leaving the machine the moisture content is generally in the order of 60 % solids, but is dependent on the influent moisture content. At this moisture content the material is friable, and is well past the sticky phase of sludge.

Figure 2 – The LaDePa machine assembled in a container.

Figure 3 – The LaDePa machine inside the container.

Figure 4 – Pasteurised matter before drying.

If further drying is required, the material is amenable to sun drying. At this point it is no longer regarded as waste or hazardous in terms of the Waste Management Act and therefore storage and sun drying do not require licensing provide basic house cleaning rules are applied

The process can be containerised and powered by an internal combustion engine and generator for mobility. The technology employed is, in the main, straight-forward basic mechanical and electrical engineering, suitable for low skills operation and maintenance by artisans with basic qualifications.

The energy consumed by the plant per person equivalent is approximately half that consumed on a conventional activated sludge plant.

The simplicity of operation allows for simple integration of the sludge treatment process with community needs, as it can be fed by simple pit emptying technology, which in turn provides jobs and up-skilling opportunities to the under skilled.

The Contractual Model

Figure 6 illustrates diagrammatically the contractual relationships that eThekwini intends setting up to outsource its VIP servicing. The Municipality will let two contracts: One with the Managing Contractor who will provide the VIP servicing operation. The second contract will be with the Technology Contractor who will supply the process technology and the machine.

The Managing Contractor will be responsible for:

- managing the VIP latrine emptying process in a safe responsible manner, using a number of small BEE VIP Emptying Subcontractors (VESs) based in the communities they service,
- operating the sludge processing machine and
- disposing the sludge by marketing it as a fertilizer and disposing the detritus to landfill.

Figure 5 – Final product - organic fertilizer from faecal sludge.

In ensuring that the emptying process is safe and responsible the Managing Contractor will be required to train the VIP Emptying Subcontractors and this training will extend to teaching basic business skills to these Subcontractors.

Payment for service will be on volume of sludge delivered, but adjustments will need to be made for sludge that is either too wet or has too much detritus. Both of these risks are seen as risks to the Municipality rather than the Contractor and consequently the Municipality will need to cover any additional costs to the contractors and institute management measures in the form of education campaigns to alleviate the problem in the future. The main contractor will also be responsible for marketing the fertilizer, the income from this being an off set to the contract price. The main reason for payment on volume of sludge delivered is to ensure that the sludge arrives at the machine where it can be disposed of responsibly. With payment based on the number of pits emptied the sludge could land up being unsafely at any convenient disposal point in the environment.

The Technology Contractor will own the technology, the machines and the registration of the fertilizer, but the Managing Contractor will operate the machine. The Technology Contractor will provide the maintenance and servicing of the machine, but there will be a penalty and/or reward to the Managing Contractor to protect

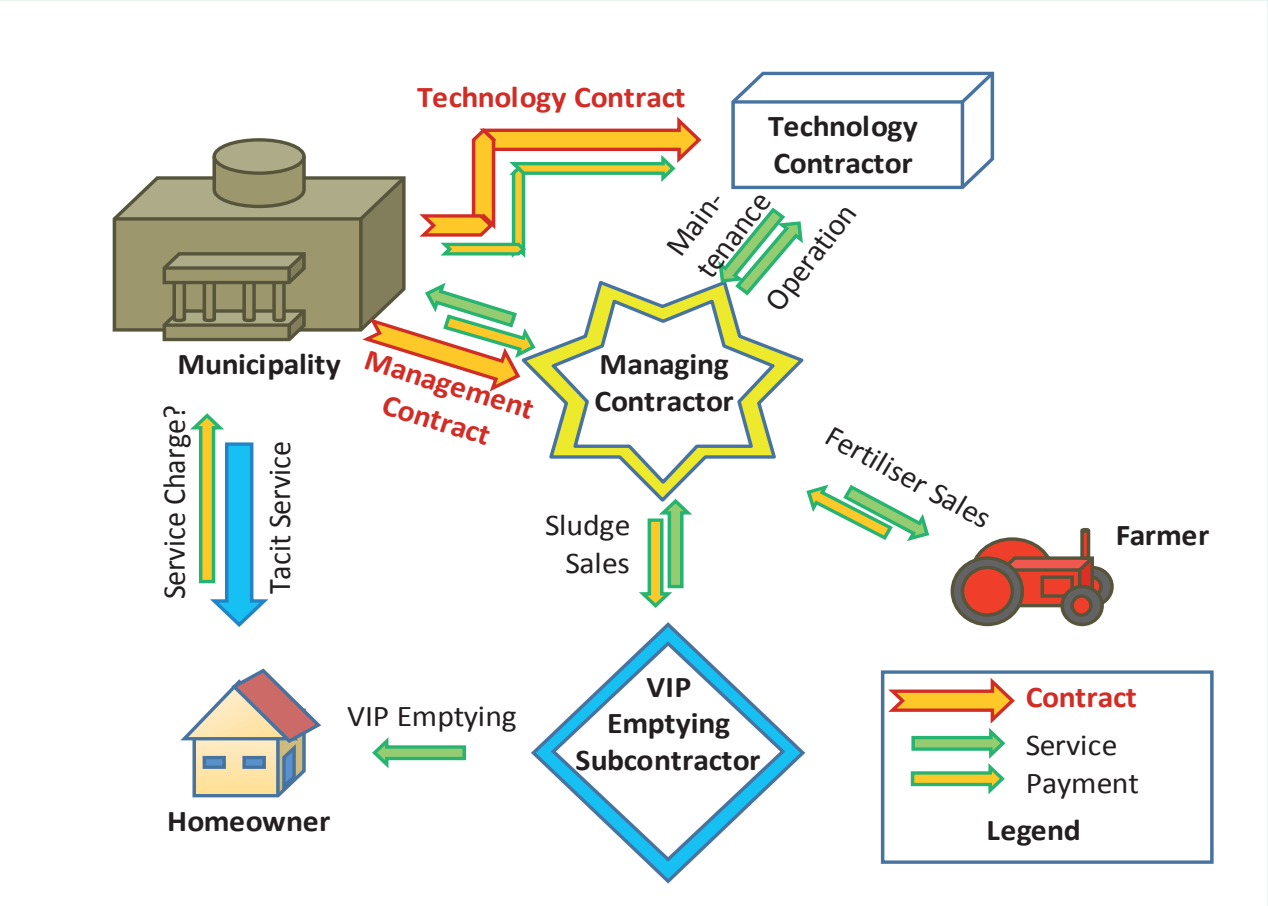

Figure 6 – Contractual Relationships

against abusive operation. Having the technology Contractor take responsibility for registration of the fertilizer, ensures that there are no startup delays due to the registration of the fertilizer.

The equipment is specialized and therefore the Technology Vendor is unlikely to keep equipment this large and specialized as stock items while he is waiting for a contract. There is subsequently likely to be some delay between the award of the Technology Contract and the practical start date of the Management Contract while the Technology Vendor builds his plant. It is for these reasons that it is practical to have the two contracts as separate contracts, as the Technology Contract inessence can now, in the main, be structured as a "lease agreement" with the start of the lease coinciding with the start of the Managing Contract in order to achieve a full three years of production out of the contracts. The delay between award and start date of the Technology Contract allows time for a description of the chosen technology to be included in the Management Contract description at tender stage. Separating the contracts also allows the Municipality the control on the technology choice. At the same time this ensures that the Technology Subcontractor, who rightly should carry the risk for the technology being successful, remains competitive, on subsequent contracts even if the Management Contractor is replaced.

It is worth noting that due to the scarcity of suitable treatment technologies, the Technology Vendor is more valuable to the Municipality and the Country than the Managing Contractor. Separating the two contracts obviates the risk of the Managing Contractor putting the Technology Vendor at risk due to the Management Contractor's default.

This contractual model is based on the objective of distributing the risk to the organization most able to control the risk and in so doing provides the opportunity to control those risks through incentives or penalties. For instance, the distribution of risk suggests that the Technology Contractor should be responsible for the maintenance of the machine. However the productivity of the machine relates to day to day operation of the Managing Contractor and his ability to deliver sludge to the machine and the risks (or reward) associated with the sludge emptying should be carried by the Main Contractor and his VIP Emptying Subcontractors. Similarly, the condition of the sludge (moisture and detritus content) relates among other things to the relationship between the Municipality and its customers, and consequently the Municipality needs to carry this risk.

Income and Savings

The benefit of recycling the sludge also needs to make sense economically, and costs associated with recycling certainly should not exceed the alternative option of disposal. The following compares the costs savings using a LaDePa to treat 2000 tons a year against disposal to a landfill site in eThekwini. There is an economy of scale, and 2000 tons per year is a relatively small plant but has been chosen to show that even at the level at which licensing is not required there is still a saving.

It needs to be noted that this benefit does not allow for delivery cost or the cost of preparing the site for the LaDePa plant.

Other Benefits of LaDePa and the Contractual Arrangements

By removing the detritus, rendering the pathogens sterile and taking the sludge moisture content past the "sticky" phase so that it is easily workable, the LaDePa Machine provides the opportunity to recover the nutrients from the sludge by converting it into a saleable fertilizer. This not only generates additional income to offset some of the VIP servicing costs but it also saves on the disposal costs of an otherwise unsavory waste and thereby saves on the environmental cost. This in itself is a significant breakthrough in VIP servicing.

The low capital cost and the compactness of the LaDePa Machine that allows it to be containerized, obviates the necessity for long term contracts with their associated onerous conditions and the difficulty, in South Africa, of raising private loans secured on public fixed property. Maintaining the sludge processing below the licensing ceiling of 2000 tons a year and maintaining good housekeeping rules, obviates the necessity for a Waste License. Solving these challenges has opened up a myriad of potential contracting models.

The contracting model that eThekwini proposes using in conjunction with the LaDePa Machine, is designed primarily to provide low skill work and up-skilling opportunities in the communities where VIPs are generally encountered in the urban situation. This model makes use of a Main Contractor to provide the up-skilling and take responsibility of the day to day running of the contract. This is achieved as a result of the savings in disposal cost and the additional income from sales of fertilizer. At the choice of the Municipality, subsidized fertilizer sales to community market gardeners can also improve food security and

Table 1: Cost benefit analysis

Disposal cost savings	
2000 tons at R1012 /ton	R 2 259 000
Less 20 % detritus	R 404 800
Income due to sale of product	
Input = 1600 cu m at 20 % solids = 320 cu m solids	
Output = 320 cu m at 80 % solids = 400 cu m (ton) product	
Income = 400 cu m at R 500 / cu m	R 200 000
Total Income and Savings	**R 2 054 000**
Additional Operating Costs (Annual)	
Forman at R 10 000 per month	R 120 000
Labour 4 No. at R 135/day at 260 work days /annum	R 140 000
Diesel at 12 l/hr at 8 hrs/d at 260 work days/annum at R10/l	R 250 000
Pickup Truck at R 450 / day at 260 days	R 117 000
Total Additional Operating Cost	**R 627 000**
LaDePa Annual Cost	
Annualised establishment cost	R 500 000
Maintenance and Royalty	R 600 000
Total Annualised LaDePa Costs	**R 1 100 000**
NETT FINANCIAL BENEFIT	**R 327 000**

Conversion rate: 10 R (Rand) ~ 1 Euro

secondary low skill agricultural jobs. But this is at the expense of the income generated by the sale of the product

The three year contracting cycle for municipalities and the 2000 tons a year environmental licensing ceiling confine the extent of the contract to a population of approximately 50 000, (based on a VIP filling rate of 40 liters per person per year), a third of whom are serviced in each year of the three years cycle. In the event of a hiatuses in the changeover of each three year contract, there may be a need to reduce the magnitude of the population serviced under each contract, and the VIP emptying skills of the Subcontractor may also be lost. However this can be overcome by timeous tendering and procurement before the expiry of the previous contract.

Issues Unresolved

The procurement and contracting model in conjunction with the LaDePa machine does not solve all problems, particularly those issues associated with dishonesty. It is therefore imperative that the client maintains a continuous watchful presence on proceedings in the form of a clerk of works or similar.

It is the intention of Thekwini Municipality to pay the VIP Emptying Subcontractor via the Main Contractor on the volume of sludge removed rather than on number of VIPs emptied. In this instance it is relatively easy for the VIP Emptying Subcontractor to add water, sand or detritus in order to bulk the sludge. At the same time it is the municipality's risk if the sludge is bulked by these components as a natural course of events. Devices are in the early stages of development that will enable field moisture and detritus measurement to be estimated. It is imperative that these measurements are taken both at the VIP site and at the input to the LaDePa machine. In eThekwini's case it is also important that the GPS co-ordinates of each VIP are recorded as they are emptied, as this information is vital in determining the program for subsequent VIP emptying contracts in the area.

Another important issue that is emerging relates to the design of VIPs. In the past VIPs have typically been designed with a deep vault of large volume in order to reduce the frequency of emptying as, until the advent of LaDePa, there has not been a genuine solution to the transport and disposal problems. Deep vaults with difficult access make emptying extremely difficult. In future VIPs designs, more attention needs to be paid to the emptying aspect and where possible it may be pertinent to modify existing VIPs.

Conclusion

In conclusion, the LaDePa plant provides the opportunity for recycling valuable nutrients from the sludge that would otherwise go to waste. At the same time this process is financially more feasible than the alternative disposal option. It also supplies a number of permanent low skill jobs, and has the potential to creates a number of secondary low skill jobs in the agricultural industry. The pasteurization of pathogens improves the human health risks of the product and the reduction of the moisture content makes the material easily workable and also reduces both environmental and financial transport costs.

All these factors contribute enormously to improving the viability and sustainability of the recycling waste in general but feacal waste in particular. It also, for the first time in a water scarce country offers the potential of a viable, dry sanitation alternative to a wasteful waterborne system.

Name: John Harrison
Organisation: eThekwini Water and Sanitation
Town, Country: Durban, South Africa
eMail: johnha@dmws.durban.gov.za

Name: Dave Wilson
Organisation: eThekwini Water and Sanitation
Town, Country: Durban, South Africa
eMail: davewi@dmws.durban.gov.za

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Next issue:

Issue 14, January 2013: **„Selected contributions from the 1st WATERBIOTECH conference, 9-11 Oct 2012, Cairo, Egypt“**

Further information:
www.ecosan.at/ssp

Contact:
ssp@ecosan.at
www.facebook.com/SustainableSanitationPractice
www.facebook.com/EcoSanClubAustria