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Operation and maintenance strategies for a sustainable dry sanitation system in Arba Minch (Ethiopia) --Manuscript Draft--

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Abstract:	<p>Given the rapid demographic growth, Arba Minch municipality is increasingly facing difficulties in meeting the sanitation needs of its population. Even if most people have access to an on-site sanitation facility, operation and maintenance receives slight attention. Among the consequences are poor or non-functioning systems, damage to the environment and people's health.</p> <p>Since 2010, 80 urine diverting dry toilets (UDDTs) have been constructed in Arba Minch. For operation and maintenance of these facilities, people have been encouraged to use urine and faeces in their own gardens or bury the material. But experience has shown that many toilet users prefer a collection service and are willing to pay for the service offered. During the timeframe of the CLARA project two small and micro enterprises, which are involved in sanitation related activities, are (financially) supported and their performance is monitored. 'Wubet le Arba Minch' Solid Waste Collectors Association's (SWCA) and 'Engan New Mayet' Compost Production Youth Association (ENM) are both offering services along the sanitation supply chain. This paper presents the results of a two years study (2011 - 2013), with the specific objective to develop a sustainable operation and maintenance strategy for a dry sanitation system in Arba Minch. It clarifies the legal framework of sanitation in Arba Minch; describes the sanitation supply chain for UDDTs inclusive its strengths and weaknesses; provides a profound financial analysis of the two service providers inclusive a calculation if urine and faeces collection can be profitable, and presents business models developed for SWCA and ENM.</p>

Operation and maintenance strategies for a sustainable dry sanitation system in Arba Minch (Ethiopia)

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Abstract

Given the rapid demographic growth, Arba Minch municipality is increasingly facing difficulties in meeting the sanitation needs of its population. Even if most people have access to an on-site sanitation facility, operation and maintenance receives slight attention. Among the consequences are poor or non-functioning systems, damage to the environment and people's health.

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Keywords

Arba Minch (Ethiopia), financing, operation and maintenance, sustainable urban sanitation service chains, UDDTs

INTRODUCTION

It is a fact that operation and maintenance (O&M) of sanitation systems receives less attention compared to construction or is even completely neglected. Among the consequences are poor or non-functioning systems, damage to the environment and people's health. According to Solo (1999), the best way to help the poor in water and sanitation provision is to encourage more small-scale entrepreneurs to enter the market and to compete. Solo (1999) further states that *“the small-scale entrepreneurs follow the recommended business practices far closer to the letter than the large-scale monopolies. They are certainly “demand responsive”. They charge market prices, covering costs and respecting the willingness to pay. They provide appropriate solutions in appropriate places, assume all investment risks and they reach the poor.”*

This paper presents the results of a two years study (03/2011 – 03/2013), within the frame of the EU FP7 funded CLARA project (<http://clara.boku.ac.at/>, duration: 03/2011 – 02/2014). The study links the problem of missing O&M services for on-site sanitation with the solution Solo (1999) recommends. It has the specific objective to develop a sustainable O&M strategy for a dry sanitation system in Arba Minch, Ethiopia. This objective leads to four research questions, which will be addressed:

1. What is the role of Arba Minch Town Administration in providing sanitation services?
2. How are supply chains for sanitation services organised?
3. How is the financial situation of the service providers?
4. What will be required for sustainable financing of operational costs and for replacement of material? What kind of model could deal with this?

METHODS

Framework of the study

Arba Minch is one of the major cities in Southern Ethiopia. The city is located about 500 km from the capital Addis Ababa and has a total population of more than 85,000 inhabitants.

There is a wide range of problems associated with sanitation in Arba Minch. As the town is one of the fastest growing cities in the country, the problem is expected to grow even bigger with time. According to a survey conducted during the CLARA project (CLARA Arba Minch Team, 2013) nearly 90% of the population use a pit latrine or an improved pit latrine. The remaining 10% split into (pour) flush toilets, urine diverting dry toilets (UDDTs), fossa alterna or open defecation.

During the timeframe of the CLARA project two small and micro enterprises (SMEs), which are involved in sanitation related activities, are (financially) supported and their performance is monitored. 'Wubet le Arba Minch' Solid Waste Collectors Association's (SWCA) and 'Engan New Mayet' Compost Production Youth Association (ENM) are both offering services along the sanitation supply chain. SWCA's main activity is waste collection and road cleaning. In 2011 the organisation has extended their business by transporting urine and faeces from urine-diverting dry toilets to the composting site of 'Engan New Mayet' Compost Production Youth Association. ENM on the other side are producing compost from faecal matter, urine, organic waste, agricultural waste and cow dung. They are growing young in-door and out-door ornamental trees as well as plants and seedlings for sale.

Data collection and analysis

Various approaches have been used to collect research data in order to answer the different research questions. A team of national and international researches was active and supported the local CLARA team. This activity, which lasted 2 years (03/2011 till 03/2013) was carried out in the form of participatory observations, informal and key information interviews, document and literature review and workshops. Additionally the cash-flow of SWCA and ENM were monitored over a period of 15 month (07/2011 till 09/2012), which is the basis for the financial calculations in this report.

Sanitation supply chain analysis

Within the framework of the CLARA project it was not possible to conduct a comprehensive sanitation supply chain analysis for both demand and supply side. Thus the research concentrated on the supply side only, with focus on the sanitation supply chain for urine diverting dry toilets. The situation has changed several times over the research period of two years. Consequently, two different scenarios have been developed, which are described below.

Financial analysis

Capital expenditure (CAPEX) and operational expenditure (OPEX) are the key parameters for both the financial and economic assessment of sanitation options. OPEX are the costs that are required to sustain the operation and maintenance of a system or facility (Parkinson et al., 2012). Within the CLARA project, the focus was on a financial analysis, specifically on expenditure and revenue

streams of operational expenditure. As both SMEs' cover expenses with financial support from CLARA, the recorded data are reported separately. This data form the basis for a financial analysis, specifically for cash flow, a calculation if urine and faeces collection can be profitable and projected income statements.

Business plan development

Business plans were developed for 'Wubet le Arba Minch' Solid Waste Collectors Association and for 'Engan New Mayet' Compost Production Youth Association. The method used is based on the "The Business Model Canvas" and the "Business Model Generation" described by Osterwalder and Pigneur (2009).

RESULTS AND DISCUSSION

The legal framework of sanitation in Arba Minch

The primary responsibility to implement the goals formulated in the "The National Sanitation and Hygiene Strategy of Ethiopia" (Federal Democratic Republic of Ethiopia, 2005) lays with the Ministry of Health and on regional level the Regional Health Bureaus. On a local level the city councils are responsible for sanitation and hygiene. For Arba Minch the responsibilities are shared among:

- the Arba Minch Municipality, which is mainly responsible for sanitation services, particularly solid waste management and on-site sanitation. The Town Municipality is formally in charge of the waste collection and the maintenance of the local waste disposal sites. However, in practise the municipality has outsourced the waste collection system to ten solid waste collection associations as well as on-site sanitation, which is mainly privately organised.
- the Water Supply and Sewerage Enterprise (AWSSE), which is responsible for the town water supply. Additionally, the water utility is officially responsible in public toilet provisions and waste water management. But they have not taken over the full responsibility. AWSSE has also the mandate for sewerage, but for economic reasons no sewerage system is planned for the coming years in Arba Minch.
- the Health Office, which is mainly responsible for sanitation and hygiene promotion, budget and resource mobilisation and enactment of bylaws.

Nowadays the Arba Minch Municipality focus on three major activities, which are:

- Improvement of household sanitation in order to minimize open defecation. Within the frame of the SPA program, toilet construction is supported with focus on poor families.
- Support of ENM to strengthen compost production, with the main aim to minimize the amount of wastes to be dumped to the final disposal site.
- Support of SWCA and other solid waste collection associations to strengthen solid waste as well as urine and faeces collection.

Sanitation supply chains in Arba Minch

Since 2006 three projects have supported the Arba Minch municipality to improve the sanitation situation: the EU FP6 funded ROSA project (from 2006 to 2010), the Dutch funded SPA project (from 2009 to 2013) and the EU FP7 funded CLARA project (from 2011 till 2014). All three projects have in common, that they support the Arba Minch town council to develop sustainable sanitation supply chains with the thematic priority on sustainable sanitation. Thus since 2010, 80 UDDTs and 442 fossa alterna have been constructed in Arba Minch.

For operation and maintenance of the UDDTs, people have been encouraged to use urine and faeces in their own gardens or bury the material. But experience has shown that many toilet users prefer a collection service and are willing to pay for the service offered. Thus within the frame of the CLARA project, Arba Minch municipality is supported to develop a sustainable collection and treatment system for urine and faeces. However, during the two years of this study the situation has changed several times. The main developments can be summarised in two scenarios:

- Scenario 1: Collection, transport and composting of urine and faeces.
- Scenario 2: No transportation and composting of urine and faeces.

Scenario 1: Collection, transport and composting of urine and faeces.

In scenario 1 urine and faeces are collected and transported to the composting site for further treatment (Figure 1). The service of collection and transport of urine and faeces is provided by SWCA and was offered from 12/2011 till 07/2012. SWCA's area of operation is the upper town of Arba Minch (Secha), where in total 27 UDDTs have been constructed. Out of the 27 toilet owners, 18 have been under contract to SWCA. For further centralised treatment ENM is responsible, as they are operating the only composting place in Arba Minch which is located in lower town (Sikele). ENM receives the urine and faeces from SWCA and mix it into the compost produced of organic waste collected within the town.

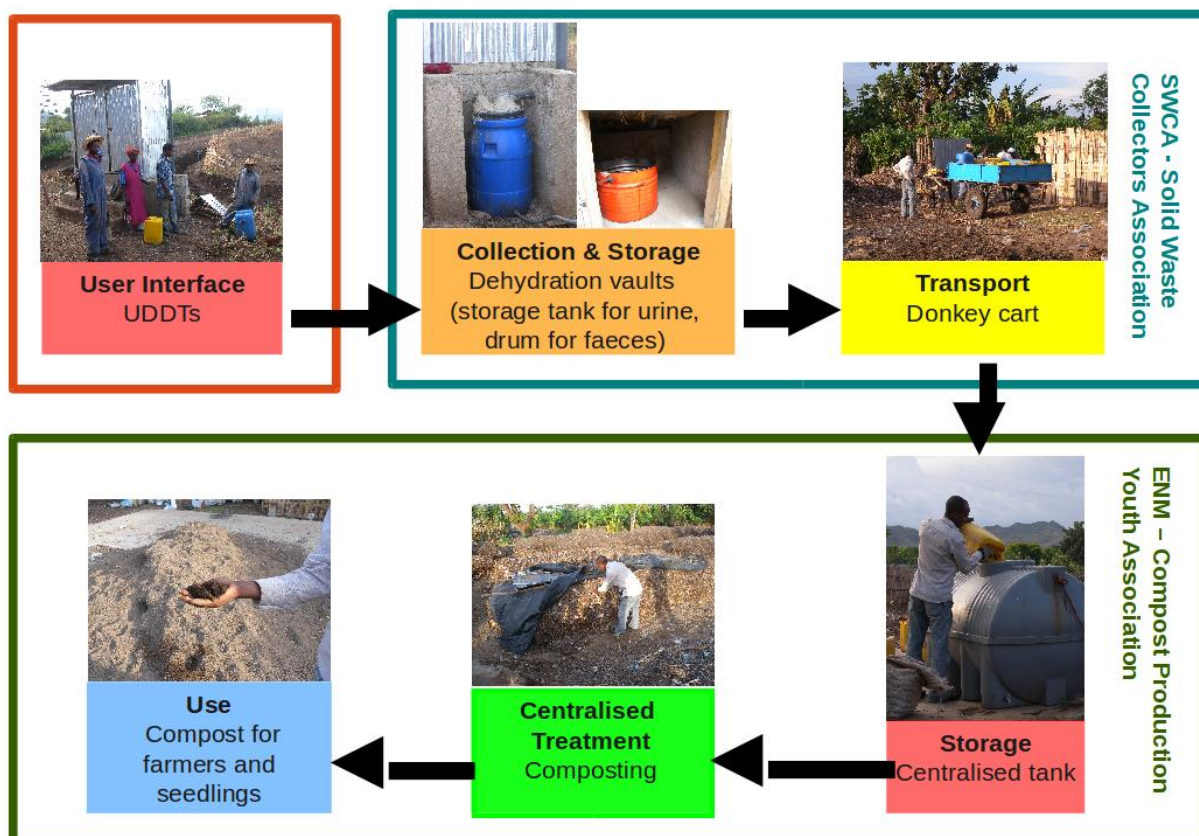


Figure 1 Sanitation supply chain for UDDTs in Arba Minch.

Scenario 2: No transportation and composting of urine and faeces.

Since 08/2012, SWCA has stopped the collection of faecal fractions in Secha, because ENM stopped composting for three main reasons: (i) a shortage of costumers who are buying compost, (ii) heavy rainfalls from May to July 2012 which made composting very difficult and (iii) internal organisational problems at ENM. Since then, there was no need for urine and faeces. Consequently owners of UDDTs are responsible by themselves for urine and faeces emptying. Urine is mainly soaked into the ground and faeces are buried into the soil. In cases of no collection and transport, owners still continue using UDDTs. They are continuously approaching the municipality for consultation about filled containers of urine and faeces. However, the demand for new UDDTs is currently low. Instead, fossa alterna is favored by new households who look at the challenges of dealing with UDDT contents. However, the municipality expects a paradigm shift, if the market for compost has developed. SWCA is willing to start immediately with collection of faeces and urine again, as soon as there is a need for the material. In the meantime the municipality is encouraging other solid waste collection associations to get into sanitation collection, in order to expand the service to the whole town and not only for the UDDTs situated in Secha.

Financial analysis

Detailed financial information was gathered over a period of 15 month (from 07/2011 to 09/2012) from the two SMEs. In the following the financial performance of SWCA and ENM are discussed separately, as both are independent enterprises.

Financial analysis of 'Wubet le Arba Minch' Solid Waste Collectors Association

The financial analysis of 'Wubet le Arba Minch' Solid Waste Collectors Association shows, that the solid waste collection service is not profitable if the total expenses (in average 21,300 ETB per month; ETB = Ethiopian Birr) are deducted from the total income (in average 5,900 ETB per month). This analysis, however, includes also expenditure covered by the CLARA project. Thus if only monthly expenditure paid by SWCA are deducted from the income, 'Wubet le Arba Minch' Solid Waste Collectors Association has a positive cash-flow in 14 out of 15 month.

SWCA has used the financial support from the CLARA project to prepare for the period after the project, i.e. from March 2014 onwards. SWCA is aware of their financial situation. They have used the donor money to develop a sustainable business by employing an office coordinator and an assistant. Their main activities, beside day-to-day administrative issues, are public relation activities and association development including business plan development.

Financial analysis of urine and faeces collection

The collection of urine and faeces is one of the services SWCA offers to their clients. From 12/2011 till 07/2012, 18 out of 27 UDDT owners in Secha made use of the service. But only in May, June and July 2012 the activity generated income. In the previous months the collection service was offered for free as promotion activity. However, SWCA received financial support from CLARA to start and develop the business of urine and faeces collection. During these three months SWCA earned in average 46 ETB from urine collection. That amounts to a service charge of 2 ETB per 20 litre jerry can in May and June as well as 4 ETB in July.

Table 1 shows various calculations for a theoretical income with urine and faeces collection. It is based on the current emptying schedule of every 3 month for faeces and every 2 month for 100 litre of urine respectively. As SWCA aims to charge 5 ETB for a 20 jerry can of urine and 20 ETB for a 50 kg barrel of faeces, the calculations are based on these figures.

For faeces collection, SWCA could earn in average per month 7 ETB and for urine collection 13 ETB per household. That amounts to an income of 126 ETB for faeces and 234 ETB of urine, if 18 UDDTs are emptied on a regular basis. Assuming that all 27 household with UDDTs in Secha make use of the toilet emptying service offered by SWCA, the income could increase to 189 ETB for faeces and 351 ETB for urine respectively. That is in total a monthly income of 360 ETB for 18 UDDTs and 540 ETB for 27 UDDTs.

Table 1: Theoretical income of urine and faeces collection.

	basics		per year / household		per month / household		income SWCA / month	
	emptying schedule	fee	amount	fee	amount	fee	18 UDDTs	27 UDDTs
FAECES	50 kg / 3 month	20 ETB / 50 kg	200 kg (= 4 barrel)	80 ETB	17 kg	7 ETB	126 ETB	189 ETB
URINE	100 l / 2 month	5 ETB / 20 l	600 l (= 30 jerry cans)	150 ETB	50 l	13 ETB	234 ETB	351 ETB

ETB: Ethiopian Birr; 1 EUR = 23.98 ETB (8 July 2013).

According to the recorded expenditure for September 2012, a labourer employed by SWCA earned 276 ETB per month, with an extra income paid by CLARA of 344 ETB. This means that already with the income of 360 ETB from 18 UDDTs nearly half of the personnel costs for a labourer are covered, if they have an average income of a solid waste collector which is about 500 ETB per month.

On a theoretical basis, urine and faeces collection is an extra income for SWCA of 360 ETB (18 UDDTs) and 540 ETB (27 UDDTs) for 3 and 4 days of work respectively. Additionally there is still potential for an optimisation of the service. The trip from Secha to Sikele is about 7 km one way and takes in one direction more than an hour with a donkey cart. If either the means of transport or the distance to the composting site can be reduced, the service can be even more profitable.

Financial analysis of 'Engan New Mayet' Compost Production Youth Association

The financial analysis of 'Engan New Mayet' Compost Production Youth Association shows that the composting business of ENM is currently a loss and heavily supported by the CLARA project. The average total expenditures per month are 23,521 ETB, compared to an average monthly income of about 6,000 ETB. In other words, ENM covers only 15% for their expenses from income generated by business activities. However, ENM receives currently intense support from the Arba Minch municipality in order to develop a sustainable composting business. As the municipality is aware of the solid waste problems in the town, they are interested in finding solutions. Enhancing composting is part of these solutions.

Business model development

The case study in Arba Minch proves what Sijbesma (2011) has stated, that the major difficulty is the financing of operational costs, rather than investment costs. For both SMEs the major share of the total expenditure are operational costs, with 91% for SWCA and 81% for ENM respectively in average per month. However, to cover the expenditure without any donor support is a prerequisite for a sustainable business. Currently they cover their expenditure with income from different sources:

Self-financing / Financing by fees

Table 2 shows that SWCA's main source of income are fees from solid waste collection (3,775 ETB from households and 4,520 ETB from commercial), fees from street cleaning (500 ETB) and urine and faeces collection (54 ETB). ENM generates income in three main branches: (i) Sale of seedlings, (ii) sale of plants and (iii) sale of compost. The branch sale of seedlings is with 44% the most profitable one, followed by sale of plants with 42% and sale of compost with 12%. Other income is negligible with only 2%.

Municipal or governmental subsidies or transfers

The municipality of Arba Minch has no regular subsidy program to support sanitation which is in line with the National Policy Direction. But the town municipality allot some amount of money to support sanitation activities. With ENM they signed a Memorandum of Understanding in order to expand composting in Arba Minch. The municipality provided land, fenced the area and provided drainage. SWCA is supported on an irregular basis for example to borrow them a tractor or to pay fuel costs. SWCA and Arba Minch municipality have a verbal agreement that the municipality will allocate budget to take over the responsibility to transport waste to the final disposal site after CLARA phases out. Generally there is a commitment from the municipality and the town administration in order to support sanitation programs in future. Within the frame of the SPA program, costs for toilet construction are already shared between SPA (50%), the municipality (40%) and the beneficiaries (10%) since 2012.

External donor funding

CLARA is a typical donor funded project. Support is provided for a specific topic (water and sanitation), a specific location (Arba Minch) and for a limited time period only. In contrary to many other externally supported projects, the objective of CLARA is not the financing of infrastructure. Investment costs are only covered to a very small extent. CLARA supports, among other issues, SWCA and ENM to defray operating costs in order to build up operational structures for a sustainable sanitation supply chain.

Business plan development

The business plans developed for SWCA and ENM cover a timeframe of two years from 09/2013 till 08/2015. The approach is based on the model of public-private-partnerships (PPP), in which the public and private sector cooperate in order to provide services to users. Both SMEs combine different services and link activities: SWCA combines solid waste collection with urine and faeces collection and street cleaning. ENM combines composting with plant and seedling production.

In the PPP model of 'Wubet le Arba Minch' solid waste collection association three different groups of stakeholders are involved:

- Households and institutions, who pay a reasonable fee for the solid waste collection.
- SWCA, who operates their business as a private enterprise. Thus they have to cover their operational expenditure as well as investment costs and
- Arba Minch municipality, who subsidises investments as well as operational costs.

Table 2 summarizes the average income over the research period and the planned income after the CLARA project starting with 03/2014.

Table 2: Average and planned income for SWCA.

	Average fee [ETB]		Number of costumers		TOTAL INCOME per month [ETB]	
	Research period	Starting March '14	Sept '12	Starting March '14	Research period	Starting March '14
Household solid waste collection	5	8	755	1,000	3,775	8,000
Commercial solid waste collection	40	70	113	113	4,520	7,910
Street cleaning	500	1,000	1	1	500	1,000
Emptying of 18 UDDTs	3	20	18	18	54	360
TOTAL					8,849	17,270
Municipal subsidy	--	1,500	--	1	--	1,500
TOTAL					8,849	18,770

ETB: Ethiopian Birr; 1 EUR = 23.98 ETB (8 July 2013).

By March 2014, SWCA aims to double their income from current about 8,850 ETB to 17,300 ETB plus a monthly subsidy from the municipality over 1,500 ETB. If it's possible to realise this ambitious goal, they shall be able to cover almost their average monthly expenditures of 21,300 ETB. Anyhow, SWCA are already planning to reduce their costs after the CLARA project. If the association is not able to afford the two employees that are currently fully paid by CLARA (an office coordinator and her assistant) they will not employ them any longer. This will reduce the costs already by more than 4,000 ETB monthly. Consequently, SWCA's business is able to run at a profit, if different services are combined, the municipality subsidises the activity and collection fees are increasing. Policy-makers could act on the collection fees and can support the diversification of the activities.

The PPP model of 'Engan New Mayet' Compost Production Youth Association also combines different branches. ENM currently generates income from two main products: (i) Sale of compost and (ii) Sale of seedlings and plants of ornamental and indigenous trees and flowers. The latter generates 86% of their income. However, ENM, with support from Arba Minch municipality, is currently strengthening the business of compost selling and offer additionally the service of landscape designing and gardening. From a financial point of view, the local municipality supports capital investments on the composting sites and also transports sorted non-compostable solid waste to the final dumping site. But ENM has to cover all operational costs.

CONCLUSIONS

- O&M services for on-site sanitation and solid waste collection in Arba Minch are ensured by small and micro enterprises, which are facing various difficulties to guarantee their balanced operation. Thus Arba Minch municipality has to take over the responsibility and has to strengthen organisations dealing with sanitation. Only if the private sector and the municipality are working hand in hand, the situation can improve in the long run.
- The acceptance of UDDTs depends u. a. on the availability of an O&M service. Many UDDT users prefer a collection service and are willing to pay for the service offered.
- The sanitation supply chain in Arba Minch is offered by two service providers, who are fully dependent from each other. If one of the activities stops operation, the whole supply chain is not functioning any more.
- Sanitation services offered by SMEs are able to run at a profit, if different services are combined, the municipality subsidises the activity and fees are increasing. Policy-makers could act on the collection fees and can support the diversification of the activities. For solid waste collectors, urine and faeces collection can be a profitable extra income as they have already the necessary infrastructure and extra investments are low. The compost producer's main difficulty is the development of a compost market, from which they are extremely dependent.
- Diversification of services and activities seems to be the solution to raise revenues and to reduce risks. That means for SWCA, that they still have income from solid waste collection if urine and faeces collection comes to a standstill. In the case of ENM it implies that the sale of seedlings and trees ensure income, if there is no or a limited market for compost.
- Sanitation marketing is key in order to increase the demand for sustainable sanitation systems among Arba Minch's population.

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Operation and maintenance strategies for a sustainable dry sanitation system in Arba Minch (Ethiopia)

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Abstract

It is a fact that operation and maintenance (O&M) of sanitation systems receives less attention compared to construction or is even completely neglected. Among the consequences are poor or non-functioning systems, damage to the environment and people's health. Examples are overloaded wastewater treatment plants with a poor purification quality, deterioration of infrastructure or dirty and poor maintained sanitation facilities on household level. However, the identification of the reasons behind provide a wide range of answers and range from deficiency of training and awareness raising, a lack of skilled labour, over high operating costs to excessive repair and replacement expenses. It is therefore indispensable to make tasks and responsibilities abundantly clear and to divide them among the actors/stakeholders e.g. between the municipality, Community-Based Organisations (CBOs), users and the private sector.

Considerable studies have been conducted on O&M of solid waste and urban services but very little information is available on the O&M requirements for sustainable sanitation systems. However, key considerations for the design of sustainable O&M services are summarized by Müllegger et al. (2012):

- The level of O&M is highly linked to ownership of a facility and the basic understanding of the technology and its functions.
- Every technology that is implemented in a sanitation chain requires proper O&M to function.
- Different technologies at different steps of the sanitation chain need different people and different responsibilities for O&M.
- Clear defined roles and accountabilities as well as appropriate support and training are essential for the management of O&M services.
- Institutional responsibilities as well as effective mechanisms for cost recovery are needed to ensure sustainable O&M.

But even if these facts are known, the realization in practice is lacking behind. Thus a two years study is currently conducted, which is part of the CLARA project (<http://clara.boku.ac.at/>). The specific objective is to develop a sustainable O&M strategy for a dry sanitation system in Arba Minch (Ethiopia).

Arba Minch is a small town in the South of Ethiopia with approximately 80,000 inhabitants. There is a wide range of problems associated with sanitation in Arba Minch. As the city is one of the fastest growing cities in the country, the problem is expected to grow even bigger with time. Most households use a shallow pit for excreta disposal, with a temporary superstructure made of local material. Pits are often emptied manually and there are no official sites for sludge disposal available. Gorges and jungle sites are potential open defecation areas and solid waste disposal sites.

Most households dispose grey water in their premises or outside of their compound. Solid wastes are poorly managed and are either dumped in gorges and open places, burnt or a small part is collected (Langergraber et al., 2010).

Two small and micro enterprises (SMEs) are involved in sanitation related activities to produce sanitation products (co-composting and transport of urine and faeces, respectively). 'Wubet le Arba Minch' Solid Waste Collectors Association's main activity is waste collection and road cleaning. In 2011 the organisation has extended their business by transporting urine and faeces from urine-diverting dry toilets to the composting site of „Engan New Mayet“. 'Engan New Mayet' Compost Production Youth Association are producing compost from faecal matter, urine, organic waste, agricultural waste and cow dung. They are growing young in-door and out-door ornamental trees and flowers for sale, cultivating vegetables for sale and are operating a cafeteria.



Figure 1: Urine transport to composting site (Arba Minch, Ethiopia).

Within the frame of the CLARA project the two SMEs financial performance was monitored for more than a year in order to get the micro enterprise view of the sanitation business. Thus in the full paper answers will be presented to the following questions:

- How can sanitation services be managed profitable and sustainable?
- How are supply chains for sanitation services organized?
- What is the role of the municipality in providing sanitation services?
- How is the economic situation of the service providers?
- What will be required for sustainable financing of operational costs and for replacement of material? What kind of model could deal with this?

Keywords

Dry sanitation, financing, operation and maintenance, sustainable urban sanitation service chains, UDDTs

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