sustainable
sanitation
alliance

Compilation of 25 case studies on sustainable sanitation projects from Africa

September 2012

Published by:
Sustainable Sanitation Alliance
c/o GIZ GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
email: info@susana.org
internet: www.susana.org

Place and date of publication:
Eschborn, September 2012

Design, compiling and editing:
Rahul Ingle (GIZ)

Responsible editor:
Dr. Elisabeth von Muench

Acknowledgement:
We thank all authors of these Fact sheets for their contributions

Contact:
Dr. Elisabeth von Muench, GIZ (ecosan@giz.de)
Rahul Ingle, GIZ (susana@giz.de)

Cover photos:

Left column:
1 Uganda, 2007 (I. Jurga)
2 Mali, 2009 (S. Hofstetter)

Right column:
3 Namibia, 2010 (S. Berdau)
4 Zimbabwe, 2009 (P. Morgan)

Preface

The Sustainable Sanitation Alliance (SuSanA) publishes case studies of sustainable sanitation projects from around the world to demonstrate the wide range of available technologies for sustainable sanitation systems. This case study book only comprises those project examples which are from **African countries**.

These case studies are useful for decision makers, planners, researchers, engineers and the interested public. We have compiled descriptions of well-running projects as well as of less successful projects so that we can learn from past mistakes.

The currently existing 25 case studies in Africa are compiled together in this book, and there are separate tables of contents for the following four categories: by country, technology, setting or by reuse type.

We invite you to contribute to this collection by making use of the case study template on the SuSanA website (www.susana.org/case-studies). We hope that those aspects and technologies which are not yet covered in these case studies will be described in future case studies (for example community-led total sanitation, small-bore sewer systems, hygiene education programmes etc.).

We thank all authors of these case studies for their contributions and their detailed answers during the reviewing process. If you spot any errors or omissions please e-mail us on info@susana.org (or susana@giz.de). The case studies of the other regions and the softcopy of this book are available on the SuSanA website (www.susana.org/case-studies).

Dr. Elisabeth von Münch
and the team of GIZ program
“Sustainable sanitation – ecosan”
(on behalf of the SuSanA secretariat)

Eschborn, 24 October 2012

partner of
sustainable sanitation alliance

Table of contents

[1] Before the dash: case study number, after the dash: page number within case study

Case study of sustainable sanitation projects

Greywater treatment in an oasis town Béni Abbès, Béchar, Algeria

Fig. 1: Project location

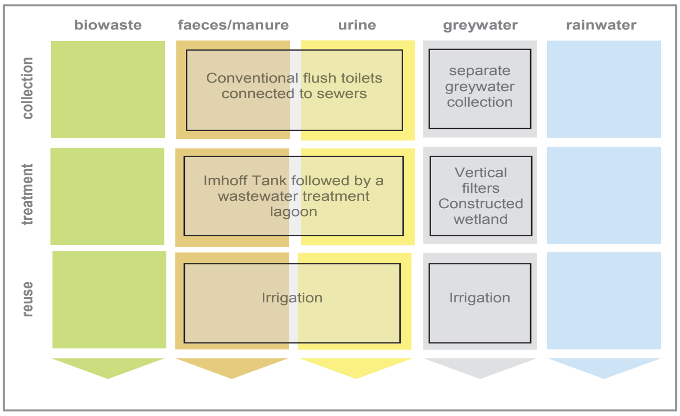


Fig. 2: Applied sanitation components of the overall project. (This case study focuses only on the greywater component.)

1 General data

Type of project:
The sanitation interventions took place within a larger GIZ Integrated Water Resource Management (IWRM) project for the efficient management of water resources in oases towns in Algeria. The sanitation component includes:

- The design of an black water collection, treatment and reuse system for the entire town
- The design and construction of appropriate on-site greywater treatment and reuse systems for domestic and institutional users.

This fact sheet presents only the greywater part of the wastewater concept.

Project period:
Start of construction: March 2011
End of construction: September 2011
Start of operation: March 2011
Project end: October 2011

Project scale:
Number of inhabitants covered: 2 private households, 2 public offices and a hotel
Size of treatment plant:
Greywater filters designed to treat a maximum of 150 l/day
Total investment: approx. 1,000 EUR

Address of project location:
Application and Diffusion of an Integrated Water Resources Management System in Oases Towns,
Béni Abbès

Planning institution:
AHT GROUP AG

Executing institution:
AHT GROUP AG

Supporting agency:
Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

2 Objective and motivation of the project

Water resources are limited in the oasis town of Béni Abbès (see Fig. 3). Efficient resource planning is complicated due the deficit of reliable data on demand, supply, and use of water. To improve the data collection, the GIZ introduced an IWRM project at the oasis in order to get a sufficiently account for all demands on the available water resources. IWRM is defined by the Global Water Partnership as "a process which promotes the co-ordinated development and management of water … in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".

The range of stakeholders in this project includes the Directorate for Water of Béchar Wilaya (Province) and its sub-division, the Directorate of Agricultural Services and its sub-division, the municipality and the farming and non-farming population of the oasis.

Fig. 3: The oasis town of Béni Abbès (source: AHT GROUP AG, 2008)

The main objective of the sanitation activities of this IWRM project is to support the elaboration of an overall strategy for the future management of all wastewater, ensuring the collection and treatment of the generated wastewater within the oasis and to maximise its reuse potential.

A central sewer exists for the collection of domestic wastewater which should be treated at an appropriate treatment plant. The effluent is reused for irrigation in accordance with national law. Slightly polluted greywater from households and public buildings should be collected and treated on-site and used for the irrigation of gardens and the interior courtyards of houses, thus reducing the consumption of drinking water for this purpose.

3 Location and conditions

The oasis town of Béni Abbès is located in the catchment basin of the Oued Saoura in the North-Western Sahara. In this area the average annual precipitation is generally below 100 mm and falls over a six month period of the year. In 2006 the town had a total population of 10,898 with 2,000 households.

Béni Abbès first settlement was around a 40 ha palm grove where traditional three tier agriculture was practiced and date palms, fruit trees and vegetables were cultivated. The main water source was the Sidi Othmane spring which had an average flow of around 25 l/s in recent years. This is now supplemented by three wells and a series of foggaras (groundwater collection systems) providing additional 10.5 l/s.

Until the mid-1960s, when the population was still only a few hundred inhabitants, agriculture was the largest consumer of water. However around this time a fundamental change took place in water use patterns as a result of a rapidly growing population and the completion of the asphalt road to the national road network. Domestic water use became the largest consumer of water and agricultural production decreased. The provision of drinking water has now the highest priority.

Today Béni Abbès has no significant industrial production and most employment is generated by 26 public establishments include primary, secondary and academic high schools, local administration of Ministries (Water resources, Agriculture), municipality, district council (Daira), mosques, fire service, hospitals, hotels and a slaughterhouse. The palm grove still plays a very important role in the life of the town, although no longer as a centre of agricultural production. Instead it serves to improve the quality of life in the oasis and provides a recreational area and refuge for the inhabitants from the extreme heat of the desert. The palm grove thus remains for the population an essential element of the life in the oasis.

4 Project history

Following the dramatic population increase in the last 50 years and the change in water demand from a primarily agricultural use to primarily domestic use, competition for the limited water resources has led to a conflict between the two sectors.

This conflict was compounded by poor and inefficient management of the water resources.

The main approach of the project focused on medium-term demand management within the different use sectors of drinking water and irrigation of the palm grove.

To improve resource use efficiency, efforts were put into improving wastewater treatment systems and the reuse of purified wastewater for irrigation. Improved water supply management practices were also promoted to introduce 24 hours supply, thus reducing losses and peak consumption.

In order to improve the water supply situation in the palm grove, irrigation management has been improved. This includes strengthening socio-cultural traditions, clarifying “water rights", i.e. sharing available water between land owners based on delivery over a fixed time period every four days. Farmers proposed the construction of retention basins, which are filled according to the “water right”, while irrigation is managed more efficiently according to plant water requirements.

5 Technologies applied

The greywater collection, treatment and reuse system was implemented as a pilot project. It was intended to test the technology at household / decentralised level and to raise awareness of the potential of the household greywater treatment and reuse.

Greywater is collected directly from the kitchen sinks and the wash hand basins in the households and flows to the single compartment sedimentation tank / grease trap, to separated solids and grease from the greywater. The liquids flow into an unplanted vertical-flow filter and will be treated physical, biological and chemical processes. After that the effluent flows through a pipe into the plants. The pilot implementation was based on a strict demand responsive approach. The first activity was to construct a first system in the office of the project as demonstration pilot. This filter was connected to the discharges of the kitchen sink and the handwashing facilities of both the male and female toilets and treated approximately 80 l per day. This served to sensitise project partners and other key actors to the possibility of treating and reusing greywater in home gardens.

The initial pilot system at the project office, used by the served to provide some valuable lessons for the construction of subsequent systems (see Fig. 4). Future users approached the project and demanded support in having their own on-site greywater system. Initial demands were made by private households, a local hotel, the offices of a local NGO and from a local sport centre.

Fig. 4: The first pilot greywater filter and reuse system installed at the project offices (source: AHT GROUP AG, 2011).

6 Design information

The greywater treatment and reuse systems used in the project were designed to collect, treat and reuse greywater coming from kitchen sinks and wash hand basins.

The greywater coming from the kitchen sinks is collected initially in a grease trap / sedimentation tank, allowing fat and larger solid material to be separated from the greywater before it flows into the filter media. Here the greywater is treated by a series of complex physical, chemical and biological processes before being collected at the base of the filter and piped directly to the roots of garden plants (see Fig. 5).

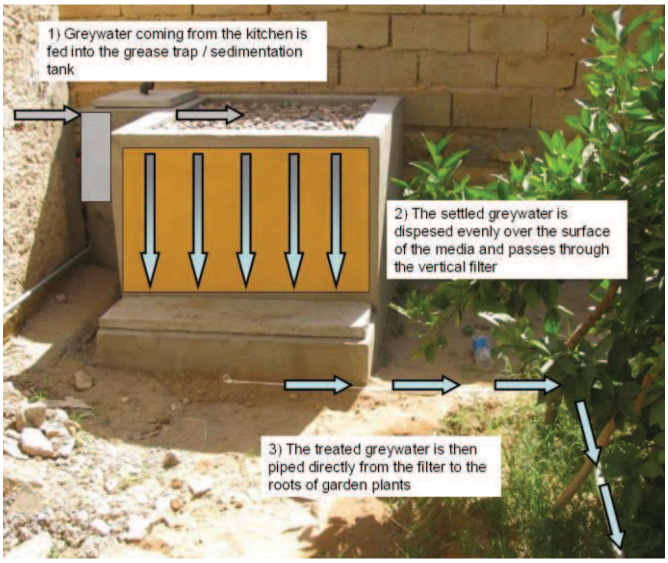


Fig. 5: Schematic of the greywater flow from the kitchen sinks, through the treatment system, to the garden plants.

The volume of greywater was estimated using the results of a survey carried out in households and institutional buildings in 2006 (see Table 1).

Table 1: Volumes of water used as a basis to estimate expected filter flows

Use	Volume (l/day)
Drinking and cooking	70 (summer) / 45 (winter)
Laundry (hand washed)	46
Personal hygiene	350 (summer) / 50 (winter)
Dishes	33

The estimated quality of the greywater was based on the data from experiences in Kenya and Germany as no specific data for the project area were available (see Table 2).

Table 2: Estimation of the quality of the greywater for the design of the filter

Source	Kenya * (mg BOD/l)	Germany ** (mg BOD/l)	BOD values used (mg BOD/l)
Kitchen	445	536–1,460	400
Laundary	449	48–472	400 (rinçage 200)
Shower	-	50–300	200
Simple hand washing basin	-	-	100

* Kraft (2009) ** Li et al. (2009)

The size of the grease tap and sedimentation tanks has been designed rather small due to the relatively low flows expected in all of the filters (generally around 80 l/day with a maximum estimated flow of 150 l/day for a filter to be installed in a hotel) with an average hydraulic retention time of over 10 hours. A BOD reduction of 20% was assumed for the grease trap. The tanks were built by a mason using cement blocks and finished with a high dosed smooth cement plastering. The grease tap/sedimentation tank and the filter have been constructed in one block. For the filter the general design parameters are shown in Table 3.

Table 3: General design parameters used for the filters

Design parameter	Value
Organic loading rate	25 g BOD/m²/day maximum (to prevent clogging)
Hydraulic loading rate	5 - 10 cm/day
Filter depth	> 0.8m
Filter material	Sand, coarse sand, pea gravel and gravel

The settled greywater is distributed across the filter media surface through a series of perforated pipes to ensure a relatively homogeneous distribution of water. If possible these pipes were placed on a layer of fine gravel to further disperse the greywater before entering the sand layer (see. Fig. 6).

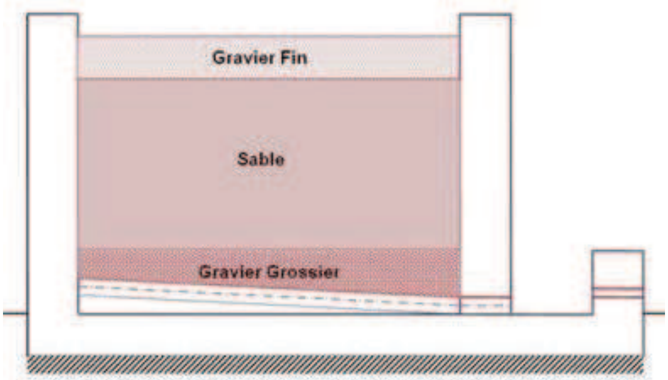


Fig. 6: Profile of the filter with the different layers (source: AHT, 2011)

This was carried out in order to reduce possible problems of plug flow and clogging once the filters were in operation. These pipes were then covered with a layer of coarse gravel.

Fig. 7: Settled greywater is distributed across the surface of the filter medium using a series of perforated pipes (source: AHT GROUP AG, 2011)

The filter media itself was made up of this initial layer of coarse gravel (10 - 20 cm thick), a sand layer (< 50 cm thick) and a bottom layer of gravel (10 cm thick) (see Fig. 7).

A priority in the design and construction of the filters was that all material should be available locally to keep the costs low and to demonstrate that local solutions are available for local problems. However sourcing a suitably porous sand proved to be a problem as the sand from the surrounding dunes proved too fine and required thorough sieving before a suitable grade was obtained.

7 Type and level of reuse

The irrigation of the gardens in the inner courtyards and in front of the houses consumes a significant amount of the total water consumption of a household. In general drinking water from the tap is used for this purpose. The treated greywater is a substitution of drinking water for the irrigation in the gardens.

The largest system is located at a household of 8 family members. The filter is connected to a storage tank that is necessary due the larger volume of treated greywater. The water is used for irrigation of the vegetable garden (see Fig 8).

Fig. 8: The grease trap /settlement basin, filter and storage tank for the irrigation of the vegetable garden and the house of Mr. Boussouri (garden visible in the background) (source: AHT GROUP AG, 2011).

8 Further project components

The project also aims to support the development of the design, construction and operation of an appropriate wastewater treatment plant where the treated wastewater will be used for irrigation to substitute the use of freshwater.. This component of the project is currently in the design phase and is awaiting further implementation by the local authorities.

In addition to the sanitation component, the project also had drinking water supply, irrigation and water resources management components and developed an information management system to facilitate water management. This system allows an easy consultation of all pertinent data for the project and was used as a tool to present key information in map form.

9 Costs and economics

The largest filter treating 150 l/day of greywater has been installed at a small hotel. The total construction costs were 195 EUR. Smaller filters for the treatment of approx. 80 l/day had average construction costs of 150 EUR.

The treatment and reuse systems were also intended to have a demonstrative function. They illustrate the possible ways in which closed loop water saving systems can be used in urban areas using available resources. They were installed either in areas where the public could see them or at the houses of influential members of the community. As such the project financed these awareness raising activities with the householders and responsible institutions accepting responsibility for the operation and maintenance.

10 Operation and maintenance

Whilst the unplanted vertical filters in some ways require less maintenance than a planted filter. A minimum amount of regular maintenance is necessary to ensure the correct operation of the system. The operators of the systems were therefore informed of a minimum number of checks and measures to be taken to maintain the system. These were:

- Regular emptying of the grease trap / sedimentation tank, with the period being determined through regular control of the tank;
- Visual control of the quality of the effluent;
- Regular control of the filter media to foresee and correct possible clogging caused either by plug flow or through general blocking of the media.

Households and institutions were charged with carrying out this maintenance themselves. The possible replacement of the filter media after an extended period of operation is possible by using locally available material available.

11 Practical experience and lessons learnt

The main lessons learnt regarding the operation and maintenance of the greywater filters were obtained from the small pilot filter installed in the project offices.

This filter was first installed using a bucket distribution system, a relatively small surface area, a filter depth of around 30cm and a layer of geomembrane below the sand layer.

Fig. 9: Excavation of the completely clogged filter media in the original (source: AHT GROUP AG, 2011).

After one year of operation the filter was leaking. Excavation of the filter material showed that the filter was entirely blocked and the coarse gravel layer at the bottom of the filter, below the geomembrane was completely dried (see Fig. 9).

From this observation and a review of the design capacity of the original filter following changes have been decided for new filters (See Fig. 10):

- The addition of a grease trap / sedimentation tank before the filter to remove problematic material;
- The use of a series of pipes to distribute the greywater more evenly over the filter surface;
- The use of a maximum design organic loading rate of 25 mg BOD/m²/day to minimise the risk of clogging;
- An increased filter depth to at least 0.8m whenever possible;
- The introduction of a regular maintenance programme to monitor filter operations (including visually checking the quality of the filtrate and the state of the filter media;
- Removal of the geomembrane in order to have a filter model that could be easily replicated by local masons using readily available material on the local market.

Fig. 10: The rebuilt greywater filter at the project offices in Béni Abbès (source: AHT GROUP AG, 2011).

12 Sustainability assessment and long-term impacts

A basic assessment (Table 4) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 4: Qualitative indication of the sustainability of the system. A cross in the respective column shows assessment of the relative sustainability of project ("+" means: strong point of project; "o" means: average strength for this aspect and "–" means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene		X			X			X	
• environmental and natural resources	X			X			X		
• technology and operation	X			X			X		
• finance and economics	X			X			X		
• socio-cultural and institutional		X			X		X		

Sustainability criteria for sanitation:

Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.

Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.

Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.

Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.

Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

The use of the on-site greywater treatment and reuse system in households and institutions in the oasis town of Béni Abbès results in the substitution of the use of precious and limited drinking water for garden watering purposes, through the use of treated purified greywater. This contributes to an improved integrated management of the available water resources and together with the implementation of the appropriate centralised wastewater treatment plant, would result in closing the wastewater loop for the town, dramatically increasing the efficiency of water use.

13 Available documents and references

- Hoffmann, H., Platzer, C. (2011): Technology review of constructed wetlands. Subsurface flow constructed wetlands for greywater and domestic wastewater treatment. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. Eschborn. Germany. URL: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=930
- Kraft, L. (2009): Characterisation of greywater from peri-urban areas in Nakuru, Kenya. Diploma thesis, University of Applied Sciences Weihenstefan. Germany. URL: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=949
- Li, F., Wichmann, K., and Otterpohl, R. (2009): Review of the technological approaches for grey water treatment and reuses. In: Science of the Total Environment. Volume 407/11, P. 3439-3449.
- Morel A., Diener S. (2006): Greywater Management in Low and Middle-Income Countries, Review of different treatment systems for households or neighbourhoods. Swiss Federal Institute of Aquatic Science and Technology (Eawag). Dübendorf, Switzerland.

14 Institutions, organisations and contact persons

AHT Group AG (executing/planning authority)
Dr. Anja Stache, Project Manager / Agricultural Engineer
AHT GROUP AG
Management & Engineering
D-45128 Essen, Huyssenallee 66 - 68, Germany
E-Mail: stache@aht-group.com

Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (supporting organisation)
Dr. Gabriele Kessel
Directrice Programme Lac Tchad
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
P.O. Box 123
N'Djamena, Tchad
E-Mail: gabriele.kessel@giz.de

Case study of SuSanA projects

Greywater treatment in an oasis town
Béni Abbès, Béchar, Algeria

SuSanA 2012

Authors: Patrick Bracken (AHT GROUP AG, bracken@aht-group.com)

Editing and reviewing: Dr. Jürgen Rambow (AHT GROUP AG, rambow@aht-group.com), Amel Sadooun, Philipp Feiereisen (GIZ, ecosan@giz.de)

This document is available from:
www.susana.org

Rural urine diversion dehydration toilets (after 6 years) Hanahai and Paje villages, Botswana

Fig. 1: Project location

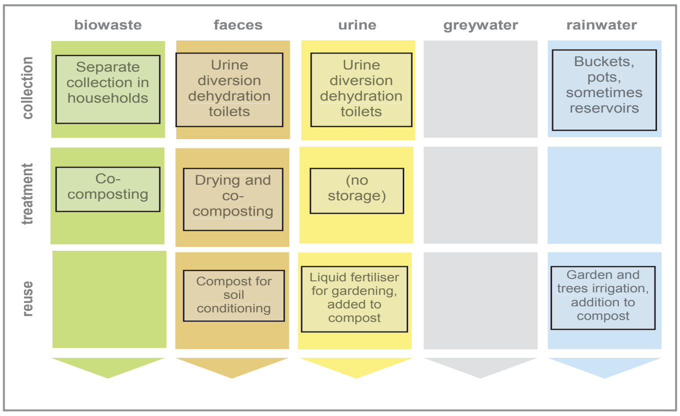


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Rural upgrading

Project period:
Start of construction: Aug 2002
Start of operation: Dec 2002 (of first toilets)

Project scale:
In total 42 UDD toilets (East Hanahai: 5 households, West Hanahai: 5 households, Paje: 11 households initially, expanded to 32 households)
Average household size in 2004 was 6 people, hence approx. 252 people reached

Address of project location:
East and West Hanahai (Ghanzi District)
Paje (Central District)

Planning institution:
International Union for Conservation of Nature (IUCN) in Botswana with support from German Development Service (Deutscher Entwicklungsdienst, DED; Cathrine Wirbelauer)
Permaculture Trust Botswana (PTB)
Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ) in Botswana and Germany

Executing institution:
International Union for Conservation of Nature (IUCN) – project coordination
Permaculture Trust Botswana (PTB) – implementing field component

Supporting agency:
German Federal Ministry for Economic Cooperation and Development (BMZ) via GTZ

This project description was first composed in 2005. In September 2009, Stefanie Lorenz from GTZ-Botswana made a follow-up visit to the initial 21 participating households to assess the ecosan systems. The case study has been reviewed in light of these findings.

2 Objective and motivation of the project

The overall goal of this ecosan project (which was a component of a larger program called CBNRM, see Section 4) was to develop, test and demonstrate a holistic/integrated approach to environmental management, sanitation and waste management at the household and community level in selected communities.

In the context of this project goal, ecological sanitation (ecosan) was defined as a cross-cutting concept having three main aims:

- improvement of health and sanitation within households and communities,
- reduction of groundwater pollution and better conservation of water resources,
- recycling of excreta as soil conditioner and fertiliser to improve land and agricultural productivity.

Fig. 3: Mrs. Goitsemang in Hanahai village says that her vegetables grow bigger since she applies urine and compost from the ecosan UDD toilet (source of all photos: S. Lorenz, Sept. 2009).

3 Location and conditions

Three communities were selected for the pilot project: **Paje Village**, in the Central District in eastern Botswana near the city of Serowe, and **East Hanahai and West Hanahai settlements** in the neighbouring Ghanzi District in western Botswana (near the city of Ghanzi). The village populations from a 2001 national census were 2,088 for Paje and 965 for East and West Hanahai together.

These two villages were chosen as they were close to two towns where the implementing partner, Permaculture Trust Botswana (PTB), had offices (the Serowe office of PTB was closed in the meantime).

Paje is situated along a main road and is close to Botswana's second largest village (a large semi-urban centre), Serowe. It is nestled between two hills and traversed by the Paje River. Livestock rearing and farming have traditionally been the main economic activities; however, lack of water due to unreliable rainfalls and inadequate water from boreholes has been a critical threat to livelihood. The river has also dried up and only carries limited water during the rainy season. Moreover, the village is affected by strong winds and water erosion, resulting in extensive degradation of the sand and loamy soils in the area.

East and West Hanahai are located 80 km from the town of Ghanzi and are new settlements established by the government in the late 1970s for tribes working and living on Afrikaaner farms around Ghanzi. In contrast to Paje, the people were originally hunters and gatherers, and they did not own any land or permanent structures. After settling, their way of life changed significantly; they were given livestock and agricultural seeds for their livelihood and not allowed to hunt without a license.

The relatively recent activities of livestock rearing and arable farming remain difficult to implement in the sandy soil and the extremely dry climate of the Kalahari Desert. The groundwater table is very deep, there is no permanent surface water, and households rely on reticulated water supply, mainly through public standpipes.

Fig. 4: Location of Paje Village (right arrow) and East and West Hanahai settlements (left arrow).

In all three villages, unemployment was a major concern and households have become very dependent on government assistance. In the Hanahai settlements in particular, it was reported that government welfare schemes were an integral part of the livelihood strategies of many households. In Botswana in general, the government is known for reliably providing food and medicine to those in need; however it also appears to lead to a low motivation of rural communities to maintain development projects in their area, even when they have requested such assistance themselves.

The settlement structure of the project communities was typical for the rural southern region of Africa: People live in unstructured agglomerations of compounds, connected by a complex system of unsealed roads and footpaths. Generally, yards are spacious, ranging from 1200 - 3000 m² with an external kitchen and a fenced areas for livestock (goats, sheep, donkeys etc.), and up to three generations can live together in the same compound. The ploughing fields and cattle posts are outside the village and many people move to their lands (normally between 2 and 10 hectares) during the wet season to plough and sow crops.

Although not common in Botswana, backyard gardens were found in Hanahai, where they had been introduced by Permaculture Trust Botswana to supplement livelihoods. Cow dung and chicken manure were typically used, without composting, to fertilise the vegetable plots. No gardening activities had been introduced in Paje.

The sanitation conditions varied between the two settlements. The government had promoted and subsidised pit latrines in the rural areas and many pit latrines were found in Paje Village. Alternatively, people there used the bushes and men often used trees and hedge fences for urinating purposes. It was found however, that concerns existed about groundwater pollution in Paje, and that in the past, boreholes had been closed because of groundwater pollution caused by pit latrines.

In East and West Hanahai, on the other hand, people generally did not have any toilets and hence were practising open defecation. All three communities were generally unaware of water toilets and not skeptic towards dry toilets. However, urine and especially faecal matter were considered dirty and to be forgotten as soon as possible. Superstitions and taboos also strongly supported this attitude.

The village institutions were important in carrying out any developmental activities in the three villages. The highest institution is the *Kgotla*, which is headed by the village chief and is responsible for administration and law and order, and it also serves as an arena for public debate. Next in importance is the Village Development Committee (VDC), which is considered the village parliament and coordinates most of the developments within the village.

4 Project history

The ecosan concept was a central component of the larger "*Community-Based Natural Resources Management (CBNRM) - Missing Link Project*", a pilot project in which research, planning and implementation of activities with households was carried out in two phases from June 2001 to December 2004[1]. The project was funded by GTZ (on behalf of the German Federal Ministry BMZ), coordinated by IUCN Botswana and implemented in the field by PTB (for abbreviations see box on page 1). PTB is a local NGO focused on disseminating improved stoves and improved gardening techniques and had already been working with the Hanahai communities in developmental activities since the late 1980s.

[1] A third phase for advocacy was planned but unfortunately never carried out.

The emphasis of the Missing Link Project was a “bottom-up” participatory approach in order to secure enduring commitment from participating families. Therefore, the processes were first presented to the village chief, the VDC, and to the community in meetings at the *Kgotla*, and project staff took on board the views of the communities on how the project should be implemented. A project evaluation in 2004, however, noted that more efforts were needed in involving district and municipal authorities. Developing the above linkages with the communities, community mobilisation, and awareness-raising were part of the preparatory steps in project implementation.

The pilot project was implemented with a set of selected households; however, other interested community members were involved during demonstrations and awareness-raising activities. The selection of the initial participating families (**5 in each of the Hanahais and 11 in Paje**) was mainly a community and individual household decision.

In 2004 it was estimated that the average household size is six people. During the evaluation tour in Sept 2009, Stefanie Lorenz asked most of the families how many people are actually using the toilet. The numbers varied from 5 up to 15 people (usually 3-5 adults, and up to 10 teenagers or children). In general it is mainly woman, children and old people living in the villages. The young adult Motswana are usually working in the City and only come home during their holidays.

In order to promote sustainability, the major requirement was that households must contribute to the cost of developing a urine diversion toilet (UDDT) system for their yards: project funds would be allocated for the purchase of the toilet pedestal and building of the structure up to the slab at the ground level; **households would be responsible for the expenses and the work for the super-structure**. With this in view, interested families registered for the project. The selection of the final participants was then done using a raffle system in the Hanahai communities and through a vote in the Paje community.

Construction of the UDDTs began in April 2002 and the first UDDTs were being used by December 2002.

During the course of project implementation, the number of households participating in the project increased to 32 in Paje Village; but not all of these new participants constructed a toilet. With each successive group, the level of input assistance to the families was reduced and more emphasis was placed on self-contribution. In contrast, in Hanahai, no additional households joined the project. The apparent reasons were that people could not afford a household toilet within their limited economic resources, and that the community had a relatively higher dependency attitude, expecting the same input support for all project activities as was given to the initially selected participants.

The project worked with the communities on ecosan and other project activities using training workshops, individual household visits and on-site demonstrations. The project notably focused on a ‘learning by seeing’ approach. For example, project staff and community representatives were taken on an ecosan study tour to South Africa in April 2002 to see working examples of UDDTs. The enthusiasm level rose considerably after the tour, and people began work on the toilets immediately.

The project evaluation in 2004 however noted that while the demonstration activities had been effective, one-off training events needed to be followed up so that households would be able to apply the knowledge and skills they had gained better. The communities in particular desired more training in urine application in the gardens, and Paje community wanted more training on garden management. This feedback was also noted during the follow-up visit in 2009, where people in Paje were asking for more training because they did not feel in the position to maintain a UDDT without training.

An important step taken in making the ecosan technology accessible was a training workshop on producing urine diverting concrete pedestals locally, so that the expensive plastic pedestals would not be needed. The training had an immediate effect in Paje, and it was reported that soon after the training, pedestals were being made and sold in the community. In Hanahai, local production did not catch on and the number of households adopting UDDTs did not increase.

There were some difficulties during project implementation. Notably, there were delays in making the super-structures of the toilets, mainly due to financial reasons and involvement of households in drought relief projects. Also, acceptance of the concept of using waste for composting purposes was a challenge. Fencing and proper protection of the backyard gardens was often neglected.

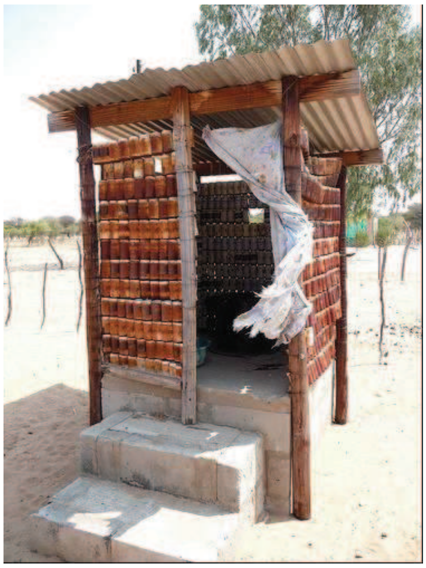


Fig. 5: Ecosan UDD toilet built out of beer cans in Hanahai. The most creative superstructure in the region!

In spite of the efforts made in ensuring ownership and sustainability during project implementation, the follow-up visit in September 2009 to the initial participating households showed that approx. half of the UDDTs had been abandoned. But the other half was still working well. Out of 21 UDDTs visited, 13 were still in use (6 out of 11 in Paje and 7 out of 10 in Hanahai). Encouragingly, however, **those UDDTs that were still in use (about 60%, 6-7 years after they were built) were being well maintained and worked properly**. Section 11 discusses reasons for abandonment of UDDTs at the three locations.

No assessment was done during the 2009 follow-up of the households that had joined the project in Paje at a later stage or of the households that had bought toilet pedestals from their own initiative, which would have been useful in gauging any demonstration effect more thoroughly.

5 Technologies applied

The communities were informed about three different types of “ecosan toilets”, namely urine diversion dehydration toilet (UDDT), Arborloo, and composting toilet. The households chose the UDDT to be the most feasible solution. An initial design was taken from a South African model and then adapted over the course of implementation. Essentially a single vault UDDT was used with a container inside of the faeces vault.

The urine was collected in a container situated within the vault or outside and was available for reuse. The system was complemented by a composting unit for processing and hygienising the faecal matter that was emptied out from the collection chamber. The faecal matter was composted together with other household organic waste and animal refuse. Urine was added regularly to the compost heap.

Greywater (used household wastewater) is often collected and applied directly to the trees etc. This practice was further supported by the project. The greywater was also used to keep the compost heaps moist.

Fig. 6: Collection chamber under a properly working ecosan UDD toilet (left: urine container, right: faeces bucket) in Paje.

Fig. 7: Left: UDD toilet working properly in West Hanahai. Right: This UDDT was well maintained, ash standing next to the toilet and composting unit filled (in Paje).

6 Design information

The first eight UDDTs were constructed according to a toilet design seen during a study visit of the project staff and community leaders in South Africa (in April 2002). The faeces collection chamber of that model was built half or totally below ground and it was approximately 1 – 1.5 m deep. Two-thirds of the sub-structure was covered with a concrete slab which supported the super-structure; one-third was covered by a removable slab which could be lifted for emptying the chamber from the outside.

This “below ground design” had some major drawbacks and is thus *no longer recommended*: some families had difficulty in moving the heavy slab, especially those without male support; the depth of the chamber was inconvenient even for routine maintenance; and the joints of the slab were often not water tight, and therefore rain entering from the outside increased the humidity of the faecal chamber and intensified odours.

In the Hanahai settlements, the design was changed upon requests and ideas from the households, and this design was then transferred to Paje using local builders. The final adapted model included a ground structure built entirely above ground with an access door at the back or at the side for better handling and maintenance and a ground and top slab made of concrete.

The urine diversion toilet pedestals, initially purchased as plastic pedestals from South Africa, were later locally produced from cement using a mould acquired from South Africa. The project organised a moulding workshop to train the toilet builders for the new structure. The cement pedestals were reworked with crack filler and painted with water resistant floor paint for hygienic and maintenance purposes (to minimise the risk of bacteria surviving on a rough surface). In comparison, a standard ceramic pedestal (without urine diversion) available in local shops was approximately 30% more expensive.

Households were responsible for constructing the super-structure and they used different materials, such as stone, wood, shade nets, even beer cans (see photo below).

During the visit in 2009, it was observed that the UDDTs with above ground chambers were working well. In two cases in East Hanahai, the below ground structure was still in use, but the removable concrete slab had been permanently removed to facilitate maintenance. UDDTs which were later abandoned included however both those with below ground structures and those built entirely above ground.

<u>Composting boxes</u>

The production and use of compost is culturally unknown in Botswana. It is also difficult to carry out composting successfully in the prevailing dry climate because the compost heap must be maintained with sufficient moisture. In Paje Village, brick-built composting boxes, as had been seen during the study tour in South Africa, were provided in order to set boundaries against children and animals during the composting process. The simple structure was approximately 1 m³ in size with openings for aeration. The faecal matter was mixed with earth, organic waste and chicken dung.

The evaluation visit in 2009 revealed that all households visited in Paje (i.e. the initial 11 households) were using these brick-built composters. It is not known why these composters were not introduced in the Hanahai settlements. There, households were using pits dug into the sand for composting and these pits were generally not protected from children and animals.

The recommended time to achieve good quality compost and hygienisation was 1-2 years. In the follow-up visit in 2009, it was seen that households that used compost were letting it mature for 3-4 years to be absolutely safe.

7 Type and level of reuse

On the one hand, gardening was a major motivation for families in all three communities to join the project; on the other hand, the inherent revulsion to any form of excreta posed challenges in harnessing its nutrient value for gardening. A break-through occurred in Paje Village after a demonstration of 16 vegetable trials in 2003. Each field trial comprised three comparative plots fertilised with (a) urine, (b) urine and compost or (c) nothing. Fertilisation with urine and compost achieved a 40–50% higher production than the unfertilised plots. The plants were stronger and more resistant against pests.

This “learning by seeing” motivated people to use their collected urine. Moreover, participating households that did not have a UDDT, also started collecting urine separately to reuse it. In the Hanahai settlements, PTB also promoted reuse activities.

By the time of project evaluation in 2004, it was reported that approx. 75% of all households visited were applying urine on their vegetable gardens and several households had planted trees on their compost pits or were reusing it. Importantly, 5 households in the Hanahai settlements and 4 households in Paje were selling surplus vegetables (though it was not reported how many of these were using urine/compost as fertiliser). The only problem then appeared to be a lower production of human fertiliser than was the potential from the toilets since children did not use the UDDTs and men often urinated outside, which reduced the impact on gardening.

During the visit in 2009, it was observed that **the situation had regressed in terms of reuse**. Half of the initial participants in Paje no longer had a garden; apparently no one in the three communities was selling surplus vegetables; and from the 13 households still using UDDTs, only 5 were applying urine (2 in Paje, 3 in the Hanahai settlements) and 4 were applying compost (2 in Paje, 2 in Hanahai) in their gardens.

This could be attributed to a need for further trainings and follow-up as expressed by the communities (see Section 4). Here it was noted that the support by PTB for gardens in Hanahai was much stronger than in Paje where the PTB was going through an institutional transition period and people complained about the lack of support.

Households that had been reusing excreta in Hanahai reported during the visit in 2009 that the vegetables were larger with the urine/compost applications, and this had also attracted interest from neighbours and other people. However, this interest had not translated into self-initiative. Here it was noted again that the amount of human fertiliser produced by one household was not enough for the backyard garden of that household. Surprisingly, in Paje, where the vegetable trials had been very successful with the participating households during the project implementation phase, the majority of villagers remained skeptical and still considered reuse of excreta a taboo.

Fig. 8: The garden of Gome Petros where the urine is used to fertilise the plants.

8 Further project components

The ecosan project was interlinked with other activities on small-scale rainwater harvesting, co-composting of faecal matter with household organic waste and animal manure, using compost and urine as fertiliser to increase yield from the backyard gardens, and using greywater for moisturising the compost heaps.

Since the existing method of rainwater harvesting simply consisted of collecting the roof runoff with pots and other such vessels, the construction of small rainwater harvesting systems, for example with a shaded, plastic sealed pit for the roof runoff, was introduced to interested households. These simple constructions were suitable since fly breeding did not occur and malaria did not exist in the area. Furthermore, water reticulation systems were designed to direct rainwater to the plants and reduce soil erosion.

9 Costs and economics

As this ecosan project was just one small component in a much larger program, the budget for this ecosan project is not known.

In 2003, a survey was done with participating and non-participating households in Paje to understand the willingness to pay for toilet services and existing prices of structures. Paje provides an example of a relatively central location close to a major village and along a main road. These prices are given in Table 1.

The cost of construction of the sanitation facilities was also calculated for the toilets built in Paje (in 2003). The ground structure was estimated at 705 BWP (141 EUR; see Table 2), the urine diversion toilet pedestal (painted concrete pedestal, made locally in Paje) at 73.5 BWP (15 EUR), and the composter at 310 BWP (62 EUR).

Table 1: Acceptable prices and market prices for sanitation related structures (prices converted from Botswana Pula, BWP; 1 BWP = approx. 0.2 EUR).

Item	Price (in EUR)
Acceptable price for use of public toilet	0.14
Average price of existing toilet	91
Acceptable toilet price at time of survey	**160**
Market price for pit latrine	300
Setswana house (20m²) relevant for super-structure	450
Brick house (15-25m²)	1360

Table 2: Cost of construction of the UDDT ground structure in 2003 (still to be added: UD pedestal and super-structure).

Item	Cost (in EUR)
Bricks, big (44*22.5*11)	18.2
Bricks, small	4.2
Cement (slabs, brickwork, plastering)	25
Riversand (wheelbarrow)	12
Plaster sand	4
Mashwire	10
Brickreinforce	5
Timber for frame (10% of total costs)	1.4
Timber for evacuation door	7.2
Joints, nails, screws etc.	6
Labour	48
Total	**141**

The cost of toilet ground structure plus urine diversion pedestal equals EUR 156 which is close to the quoted “acceptable” price of EUR 160 (but still excludes the super-structure). Therefore, the complete UDDT structure may not be within the economic means of the households. Enhanced sales from backyard gardening could theoretically off-set some of the expenses; however, this means of income was unfortunately not sustained.

10 Operation and maintenance

The participants were trained in the necessary operation and maintenance measures, which were as follows:

Faeces collection chamber: Faeces were collected in 50 L buckets or as heaps. It was recommended to add one cup from a mixture of ash and sand after every defecation to reduce the humidity of the faeces, flies and odour. A family of two adults and four children needed 2 - 3 months to fill a 50 L bucket, and this was then emptied onto the compost unit. Some families started using smaller 20 L buckets that needed to be emptied more often (once a month), but were lighter and thus easier to handle even by one person alone.

Urine collection: Urine was collected in a 20 L container placed either inside the chamber or outside next to it. Cooking oil containers, available almost anywhere in the country were used for this. One was filled by the “average family” mentioned above in about three weeks; however, the filling time depended on the habits of the users. Men and children often urinated in the bushes, around trees or on the hedge fences, and in some cases, overnight urine was collected separately and either emptied into the toilet or used directly on the compost, around the trees, and on the hedge fences.

Compost: Household organic matter, livestock dung if available, and faeces were co-composted together. Regular moisturisation of the compost heap with greywater and overnight urine was indispensable in the local climate and the project recommended a composting time of one to two years for hygienisation purposes.

Toilet structure: The pedestal had to be cleaned for hygienic reasons and fly and odour prevention, and during this process it was important that the collected excrements in the chamber beneath were not diluted by the cleaning water or substances. The urine pipe also had to be cleaned every 14 days with some hot water.

Follow-up in September 2009:
For the UDDTs still in use, the maintenance of the toilets was adequate in all cases. The toilets appeared to be clean and almost odourless. All households had a bowl of sand or ash standing next to the toilet. In most cases, a small 20 L bucket was being used for collecting the faeces, and plastic bags were used as gloves when emptying the buckets. Families reported that it took 1½ to 3 months to fill the bucket, depending on the number of people and the size of the bucket.

11 Practical experience and lessons learnt

The results of the ecosan project in Paje and East and West Hanahai Villages have been mixed. The project worked hard at developing a participatory grass-roots programme and at incorporating sustainability-oriented mechanisms such as community contribution and ownership. However, it also faced the difficult challenges of poverty, an ingrained dependency syndrome on external aid, and taboos on reuse of excreta.

During the project life, the 21 initially participating households from all three communities and many of the additional 21 households from Paje were active in establishing a UDDT toilet system with a composting mechanism and reusing at least the urine in backyard gardens. A follow-up of the initial 21 households in September 2009, however, showed that only 13 households were still using their UDDT and a third of these were reusing the excreta. Moreover, several households in Paje Village no longer had gardens, even though it had been one of the motivating factors for joining the project.

The reasons given (in Sept. 2009) for not using the UDDTs were as follows:
In Paje*:* the collection chamber was too deep for maintenance (bucket too heavy); the man responsible for maintenance of the toilet had left the household in 2007, and the women preferred the pit latrine which did not need any maintenance; the woman responsible for maintenance said she “felt like vomiting” when looking at the bucket; a blockage of the urine pipe that had not been repaired. One toilet had been destroyed because of border issues with a neighbour.

In West and East Hanahai*:* one family reported that the toilet was not used properly by people staying in the house while the family was outside on the farm (most likely used it as a pit latrine), and the other two families could not be asked for reasons because they were on the cattle post.

While the reasons for disuse of the UDDTs varied and also point towards lack of follow-up and maintenance issues, it can be said that the most important contributing factor was **need**. In Paje, 4 of the 5 households that no longer used the UDDT were using a pit latrine instead. One of these households converted the UDDT into a pit latrine - since the sub-structure was partly below ground - while the other three already had a pit latrine (i.e. there had been two toilets on the same plot). Moreover, the super-structure was dismantled and reused and hence presumably there was little loss of investment. Neighbours also often had pit latrines and were sceptic of the UDDTs.

In Hanahai, on the other hand, a UDDT was a better option than a no-toilet option, and neighbours also often used the UDDTs. They also desired such sanitation themselves, but, as before, they were looking for support with the construction of the ground structure and training.

Long-term follow-up after project implementation, continuous support for productive benefits from gardens, and the basic need for sanitation, played an important role for households to continue using UDDTs. A larger percentage of the initially selected households were still active in the Hanahai than in Paje and this could partly be attributed to the continuing support of PTB in encouraging people to build-up their gardens and using the UDDTs, whereas in Paje the support structure during the last few years had basically been non-existent.

Even though the participants of Paje were reported to be convinced about the benefits of reuse after visually seeing the results from vegetable trials with urine and compost fertiliser in 2003, it appears that further training and follow-up in garden maintenance and application of human fertiliser were needed for people to benefit from productive reuse and hence prefer a UDDT over a pit latrine.

In contrast to the awareness reported in Paje at the start of the project about groundwater pollution caused by pit latrines and the strong support of the village leadership for ecosan in protecting groundwater, the pollution risk did not seem to be a strong enough motivation for households to abandon pit latrines. Moreover, the taboos against excreta could not be overcome sufficiently, especially given an existing alternative sanitation option. Also, it appeared that the concrete urine-diverting pedestals were no longer being made locally in Paje.

In Paje, those families that already had pit latrines were not motivated to maintain a UDDT in the long-run. In all cases where two toilets were found on the same plot, the pit latrine was used and family members said that they either did not know how to handle the faeces and/or considered it to be 'yucky'. The parallel structures seem to account for an unwillingness to maintain the UDDT, in some cases because the decision to make a new toilet had not been taken by the woman who usually maintained the UDDT.

Fig. 9: UDDT (on the left) next to a pit latrine on the right (in Paje). The UDDT was never used since its installation in 2004 (as the main female of the household objects to having to empty the faeces container. The pre-existing pit latrine is used instead (when it is full, a new pit will be dug).

In Hanahai, the option to use a pit latrine often did not exist and people seemed to have less objections of handling the faeces. Neighbours were often using the toilets as well and (not trained) close relatives were in some cases taking care of the toilet while the family was on the cattle post.

During project life, an additional 21 households from Paje participated in some part of the project activities. No new households joined the project in the Hanahai settlements. However, after the end of the project, it appears that there has been no self-replication of UDDTs as a sanitation option. This lack of a demonstration effect can be attributed to the high cost of the toilets without sufficient benefits from productive reuse; the high dependency of people on external aid; and in Paje, because the wider society was not convinced of the usefulness of the toilets enough to overcome their taboos and fears of excreta handling and reuse.

In conclusion, it can be said that the UDDTs were successful where people were convinced of their benefits, where they had the need for sanitation, where they had been given financial support, and/or where they had been given long-term technical follow-up (for the toilets and for reuse activities).

12 Sustainability assessment and long-term impacts

A basic assessment (Table 1) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses). The qualitative assessment was done for the overall project (both project sites) and also took into account the abandoned and destroyed UDDTs.

The project can be considered sustainable in the health and hygiene and environmental parameters; however, these aspects did not seem to hold much value for the communities. The technology worked well and was easy to operate except for those households that preferred the "no-maintenance" scenario with the pit latrines. The project was not financially sustainable since people could not afford to adopt it or were not willing to pay for it. The sustainability indicator for socio-cultural and institutional aspects was also weak as shown by the reluctance towards handling and reuse of the excreta.

Table 4: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X		X		
• environmental and natural resources	X			X				X	
• technology and operation		X		X			X		
• finance and economics			X		X			X	
• socio-cultural and institutional		X				X			X

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, e.g. from fertilizer and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

Regarding long-term impacts the following statements apply:

1. The local NGO Permaculture Trust Botswana has gained experience with building and operating UDDTs.
2. Around 252 people (42 households) were directly reached by the project and benefited in one way or another.
3. About 60% of these 252 people still see a benefit 6-7 years after toilet construction to continue to use their UDDTs and a certain fraction of these still value the fertiliser properties of urine and compost.
4. This demonstration project has not led to copying of UDDTs in the region (to our knowledge) and was in that regard not successful.

13 Available documents and references

A set of **photos** from September 2009 is available here:
http://www.flickr.com/photos/gtzecosan/sets/72157622233387657/

- Hanke, T. (2004) Experiencing Ecological Sanitation in Paje, Botswana, Internship Report, 11.09-31.12.03. CBNRM Missing Link Project, IUCN Botswana. http://www2.gtz.de/Dokumente/oe44/ecosan/en-ecosan-experiencing-ecological-sanitation-paje-2004.pdf
- IUCN (2004) Final Evaluation of the CBNRM Missing Link Project. IUCN Botswana. http://www2.gtz.de/Dokumente/oe44/ecosan/en-evaluation-of-the-CBNRM-missing-link-project-2004.pdf
- IUCN and PTB (2003) CBNRM Missing Link Project. Phase 2 Project Report 1, 1st July 2002 – 31st Dec. 2002. IUCN Botswana. http://www2.gtz.de/Dokumente/oe44/ecosan/en-sanitation-waste-management-project-2002.pdf
- Wirbelauer, C. (2003) 'CBNRM-Missing Link: Piloting Ecological Sanitation in Botswana. Powerpoint presentation. IUCN. http://www2.gtz.de/dokumente/oe44/ecosan/cb/en-piloting-ecological-sanitation-botswana-2004.pdf

14 Institutions, organisations and contact persons

Note: IUCN office in Botswana no longer exists.

M. Gotaitamang, Permaculture Trust of Botswana (role: project implementation)
PO Box 31113, Serowe, Botswana
T: 4632428
E: permclt@botsnet.bw (currently not in use)

Margret Mpati, Permaculture Trust Botswana (role: project implementation)
PO Box 005, Ghanzi, Botswana
T: 6596138, M: 71883437
E: permaculture@mega.bw (currently not in use), magretmapati@yahoo.com

Case study of SuSanA projects

Rural urine diversion dehydration toilets (after 6 years) Hanahai and Paje villages, Botswana - draft

SuSanA 2010

Authors of original version from 2005: Christine Werner, Florian Klingel, Patrick Bracken, Jana Schlick (all GTZ at the time)

Revision in 2009: Stefanie Lorenz, Nadira Khawaja (both GTZ)

Editing and reviewing: Elisabeth von Muench (GTZ, ecosan@gtz.de)

This document is available from:
www.susana.org

Urban urine diversion dehydration toilets and reuse Ouagadougou, Burkina Faso - draft

Fig. 1: Project location

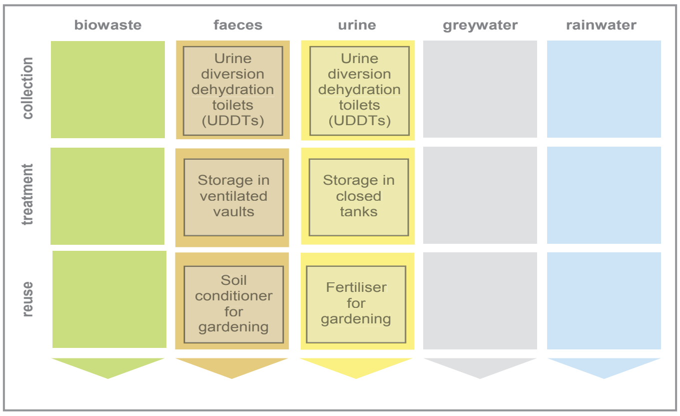


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Large urban pilot project

Project period:
EU project phase: June 2006 – December 2009 (the municipality is financially supporting the project from January 2010 onwards)
Start of planning: June 2006
Start of construction: December 2007
End of construction: Mai 2009
Start of operation of toilets and transport system: January 2008

Project scale:
- UDDTs built for 922 households and at 11 public places (such as prisons, community centres) – approx. 6,500 people (if 6.5 people per household toilet are assumed) and 500 users at the public places
- 800 gardeners/small farmers trained
- Total investment of 3-year project: EUR 1.497,120

Address of project location:
Districts within the city of Ouagadougou, Burkina Faso: Districts of Boulmiougou (sectors 17 and 19), of Nongremasson (sector 27), and of Bogodogo (sector 30),

Planning institution:
- Centre régional pour l'Approvisionnement en Eau Potable et l'Assainissement à faible coût (CREPA, Burkina Faso)
- German Technical Cooperation (GTZ, Germany)
- Office National de l'Eau et de l'Assainissement (ONEA, Burkina Faso)

Executing institution:
CREPA: a local NGO in Burkina Faso

Supporting agencies:
- European Union: EUR 1.11 million (under ACP-EU Water Facility Scheme)
- CREPA, Burkina Faso: EUR 207,120
- GTZ-Burkina Faso (Water Program, PEA (in French)): EUR 180,000 and GTZ headquarters (Ecosan Program) - on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ)

2 Objective and motivation of the project

The aim of the project was to achieve the following goals within a period of three years:

1. Facilitate access to sustainable, safe and affordable sanitation systems[1] for the residents of the disadvantaged and rapidly growing sectors of Ouagadougou, Burkina Faso.
2. Support 1,000 households in obtaining appropriate and affordable closed-loop sanitation.
3. Demonstrate novel excreta management systems that protect human health, contribute to food security, and enhance the protection of natural resources.
4. Promote small and medium sized businesses in the sanitation market.

The following five specific objectives were set out:
- Build 1,000 urine diversion dehydration toilets (UDDTs).
- Support the establishment of two "supply chains" (by establishing association) for the collection, transport and distribution of the raw and the treated excreta.
- Train 1,000 gardeners to use these products (ecosan fertilisers).
- Support 20 SMEs (small to medium size enterprises) to be involved in construction of public toilets as well as system operation.

Fig. 3: Outside and inside views of a single vault UDDT constructed at town halls in Ouagadougou (with urine diversion seat) (source: CREPA, 2008).

[1] Here, the term "sanitation systems" only refers to excreta management (and hand washing); other components of sanitation (greywater, solid waste, drainage) were not part of this project.

- Train 100 artisans (masons etc.) to provide the necessary infrastructure, in particular the construction of the toilets.

3 Location and conditions

The capital city of the landlocked West African nation Burkina Faso, Ouagadougou, and its peri-urban sectors are the project location. The city is administratively divided into five districts: Baskuy, Bogodogo, Boulmiougou, Nongremasson, and Signoghin. Each of these districts is administered by a council led by an elected mayor.

Until recently, sanitation had a rather low priority for development in Burkina Faso. In Ouagadougou, only 19% (according the baseline study performed within the project in 2007) of the population of a total of 1.4 million people had access to improved sanitation (according to MDG definition) in 2006 (such as septic tanks, VIP latrines, pour flush latrines, sewerage, etc.). With an annual population growth rate of around 5% it is difficult to maintain pace with growth – particularly in low income peri-urban areas of the city.

The implementation of the project addresses **four sectors** (of a total of 30 sectors) within the districts of Boulmiougou (sector 17 and 19), Nongremasson (sector 27), and Bogodogo (sector 30).

In order to achieve the project objectives, the project partners GTZ, CREPA and ONEA identified three major fields of activity.

1. Firstly, ecological sanitation (ecosan) systems were developed with the users of these systems, responding to their needs and the local context.
2. Secondly, lobbying and advocacy work were carried out at municipal and governmental level in order to create an enabling environment for ecosan and ensure its inclusion in legislation and future strategic plans. This second field of activity also served to create the conditions for the third field.
3. To support and promote the involvement of the local private sector in furnishing the infrastructure and logistical services required by the system.

What about the identification of the location as a first step? Who could get a UDDT? Everybody or only selected households?

In Burkina Faso, the under-five child mortality rate is currently **169 children per 1000**, which is very high but at least there is currently a downward trend towards fewer child deaths.[2]

[2] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

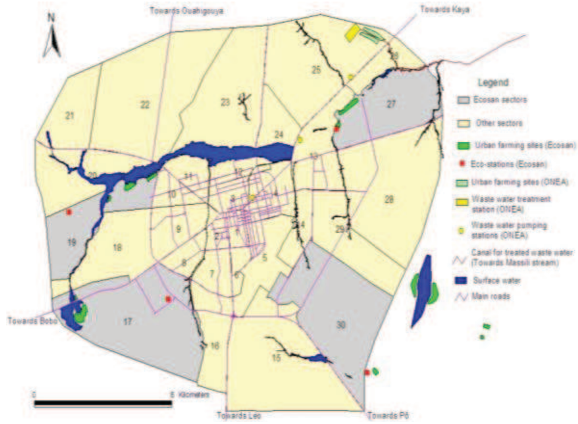


Fig. 4: UDDTs are located in four sectors (here in grey) out of the 30 sectors in Ouagadougou city map (total diameter of the city is approx. 18 km) (source: CREPA, 2008).

4 Project history

In 2005, the German Technical Cooperation (GTZ), the West African Centre for Low Cost Water Supply and Sanitation (CREPA), and the National Office for Water Supply and Sanitation (ONEA) developed a project proposal for a 3-year project entitled "Ecological sanitation in peripheral neighbourhoods of Ouagadougou" (in French: "Projet d'assainissement écologique dans les quartiers périphériques de Ouagadougou"). The project, which was approved in early 2006 was mainly financed by the ACP-EU[3] Water Facility (74% out of the total of EUR 1.48 million), and co-financed by GTZ-Burkina Faso (12%), and CREPA (14%). The contribution of ONEA was the mobilisation of skilled staff.

The project (commonly known by the French name ECOSAN_UE) began in June 2006 and was initially planned to last until June 2009. The project was however carried on until December 2009, since a cost-neutral extension was granted.

In the first year, there was an intensive dialogue period with various stakeholders from municipal authorities, households and the local private sector, in order to assess needs and establish the framework within which the system was developed. The baseline study as well as a strategic ecosan plan including technical, logistical and organisational proposals were made and validated with the various stakeholders, before any work began to put the system in place.

Masons were trained to build three different urine diversion dehydration toilet (UDDT) types.

Gardeners and farmers were consulted and trained on the application of treated urine on their crops in the beginning of the project. When the project started to be operational, the use of treated faeces got in vogue among farmers since they thought it would be easier to use and apply it compared to urine. Households were consulted on their preferences, and community-based organisations were supported in setting up collection and transport businesses (associations).

[3] ACP-EU stands for Africa, the Caribbean, the Pacific and the European Union. This project was funded under the first call for proposals (category C for "civil society initiatives") which took place in 2005 (http://ec.europa.eu/europeaid/where/acp/regional-cooperation/water/index_en.htm)

The construction activities started in December 2007 and one year later, by December 2008, about 500 private UDDTs and 11 UDDTs at public places (in and around communal structures to raise awareness) had been built. Also, gardeners had harvested their second season of crops treated with ecosan fertilizer (sanitised urine and faeces).

The public UDDTs were installed at the following places: three at the central prison of Ouagadougou (MACO), one at the park Bangrweogo, two at each Town Hall (4 in total) and one at the zoo.

The prisoners at the MACO prison are in charge of the management of the whole system: O&M of the toilets, treatment of the collected urine and faeces, and agricultural reuse of the ecosan by-products in their own fields in the prison.
Many households were indeed willing to have a UDDT installed at their house, but they could not afford one despite the existing subsidies (see chapter 9 for details). Through increasing the subsidies, it was possible to build more than 400 double vault UDDTs within 6 months. However, overall numbers on how many households wanted a UDDT and how many got one (by help of subsidies) in the end are not available.

By June 2009, 922 homes were using UDDTs (867 double vault UDDTs, 18 single vault UDDTs and 37 box-type UDDTs). So far, 107 artisans have been trained to build the three different toilet types and some 800 gardeners and small-scale farmers on the application of treated faeces and urine on their crops.

The main challenge at present is to ensure further development of the project's main achievements (such as system management in place) and activities through local authorities. The municipality of Ouagadougou has now allocated EUR 10,670 (CFA 7 million) of its budget in 2010 to keep the ecosan system functioning (equals about EUR 10.64 per UDDT if it is assumed that 6,500 users benefit from the UDDTs).

The average household size is 6.5 people. The number of persons using a UDDT is varying from 4 to 25 persons depending of households. In polygamous households, the head of household who is occupying the main house, as well as his wives and children living in additional houses on the same compound. They all share the UDDT and are considered as one household.

5 Technologies applied

The project team gave households the choice between double vault and single vault UDDTs. However, after a first assessment, it was decided to stop building single vault UDDTs, because of difficulties related to their management (handling of faeces). Double vault UDDTs made of banco (adobe) bricks were also tested but soon removed as a technical option due to problems during the rainy period (collapse).

Building the vault with local material was an attempt to reduce costs, however this failed since the structures were not strong enough (despite vaults being made of a double layer of adobe bricks).

The physical infrastructure of the ecosan system consists of:
1. UDDTs at household level and at public places in four sectors of Ouagadougou.
2. Four treatment sites (called eco-stations) for urine and faeces in the same four sectors (each run by a separate association) (see Fig. 8).
3. Collection, transport and delivery of urine, dried faeces, sanitised urine and of sanitised dried faeces.
4. Peri-urban gardens/fields were sanitised urine and faeces are used.

Fig. 5: The ecosan system as implemented within the project (source: CREPA, 2008).

User interface and collection of urine and faeces

The user interface is a squatting pan with a small hole for urine collection (which flows into a yellow 20 L jerrycan for storage) and a hole for defecation. There is also a designated area for anal washing in the toilet cabin. The anal wash-water is simply infiltrated in a gravel bed (per toilet use, about 0.5 L of anal wash-water is used every time).

Three types of urine diversion dehydration toilets (UDDTs) were initially used for the collection of faeces and urine: double-vault toilets, single-vault toilets and "box toilets" (for informal areas)[4]. One cup of ash is used as added material to cover the faeces after each defecation event.

Once the first of two vaults of the UDDT is full, it should be closed for a while (approximately 6-12 months), while the second vault is used. The faeces in the first vault remain in the vault for at least six months for sanitisation by drying/storage. The vaults are then emptied by the collection service workers and brought to an eco-station for a further drying/storage period of two months and for final packaging (see additional photos (link to flickr in section 13).

For cultural reasons and reasons of convenience when emptying the UDDTS, most of them are built outside. There are however also others in houses, requiring much more delicate maintenance (section13).

[4]There are areas where houses are spontaneously and illegally installed. Thus, there are no appropriate facilities/infrastructures.

Fig. 6: UDDT inside a house (inside, backside view and waterless) (source: A. Fall, 2010).

A low cost variant of the single vault toilet has been the so-called "box toilet", which is a urine diversion box made out of ferrocement (reinforced concrete) and a superstructure made up of local material. In some cases, the entrance was build with an angle and thus no door was needed.

Alongside the public UDDTs, urinals (made from local material) were also installed.

For the transport to the eco-stations, urine is collected in 20 L yellow jerrycans, and faeces are transported in plastic bags.

Fig. 7: Outside and inside views of a double vault UDDT with urine diversion squatting pans and anal wash area (dark circle in the middle). Urine jerrycans are stored under the stairs (left picture) (source: CREPA, 2008).

Treatment of urine and faeces

A central point of the urban ecosan system is the treatment site, also called eco-station, which connects the households (producers of ecosan fertilisers) with the gardeners/small-scale farmers (users of ecosan fertiliser). Two of the five eco-stations are built near the sites of market-gardening[5], another at the central prison and two near the collection points of municipal waste transported from these points to the landfills outside the town.

In total, five eco-stations were built. The eco-stations are equipped with the sanitising equipment required (plastic tanks for urine and storage pits for faeces) and accompanying infrastructure such as a hangar for the working material, space for nutrition and maintenance of the donkeys which pull trolleys of urine jerrycans and a storage room for the finished fertiliser products.

The number of plastic urine tanks with 1 m³ at each eco-station varies from 6 (in small sectors such as 19 and 27) to 12 (large sectors like 17 and 30).

For sanitisation reasons, urine is transferred to the eco-stations and **stored for one month** in the closed 1 m^3 plastic tanks. In contrast, faeces from double vault UDDTs are stored and kept dry in chambers (total volume: 6 m^3) **for two months**[6]. Faeces from single vault or box UDDTs are regularly collected and stored in separate 6 m^3 chambers for a period of 6 to 8 months. No composting takes place.

Data to check for cross contamination of urine with faeces has not been collected.

Fig. 8: Eco-station with four 1 m^3 plastic tanks for urine sanitisation (by storage over a period of one month) in sector 27 (source: A. Fall, 2009).

6 Design information

Double vault UDDTs were designed for households with 6 to 7 members and the storage time for the faeces is about 6 to 8 months. However, two vaults of this size can normally cater even up to 15 persons. The vaults have sizes of three blocks (20 cm each) plus mortar between blocks. So, they have a total height of 65 cm, a width of 145 cm a length of 130 cm and a volume of 1,220 L.

To save costs, the urine diversion squatting pans (for double and single vault UDDTs) and pedestals (of box UDDTs) are made of concrete which is easy to use and to maintain. Both pans and pedestals were purchased through local manufacturers who were trained by CREPA within the project.

The single vault UDDTs and the box toilets have a plastic bin with a volume of 50 L. Recycled or plastic bags ("rice bags") are placed in the container to collect faeces. Once the bags are full, they are stored in former/empty oil barrels, which are painted black, next to the toilet or in another safe place. Full bags are collected twice a month and transported to the eco-stations for further storage of six months and packaging.

Each household was given at least three yellow 20-L jerrycans for urine collection. Full jerrycans (often two or three depending of the size of household) are collected by the eco-

[5] The products of the gardening (vegetables, fruits, etc.) are also sold on-site.

[6] The WHO Guidelines for the safe use of excreta, greywater and wastewater in agriculture (from 2006) should be consulted for further details on the required storage times: http://www.who.int/water_sanitation_health/wastewater/gsuww/en/index.html.

station workers once a month and transported to the treatment site[7].

Every full 20-L jerrycan collected is replaced by an empty one. The storage space for the urine storage containers is under the stairs of the toilet and is thus easily accessible for collectors and household members (as UDDTs are built separately from the houses). The urine pipes have a sufficient slope to completely drain the collected urine into the jerrycans. Thus, urine odour is kept at a minimum.

All UDDTs were built entirely above ground to facilitate the air circulation in the vaults/buckets, thus accelerating the drying process. The toilet buildings have a small staircase (2 to 3 steps). For physically impaired people, the staircases are installed with a ramp or an iron bar to facilitate access to the toilet.

The toilet superstructure is made of different materials. The wall material is chosen by the household and depends on availability and affordability. Mud or cement bricks have been used for the walls. Galvanised steel sheets were used for the roof and standardised metal doors were provided by the project instead of the use of straw mats, which are cheap but whose degradation is quick. A metal door seems to be quite sustainable but requires a technical implementation and good paint layer to be weather resistant.

Ventilation is provided through ventilation pipes at the back of the toilet building. The vent pipe is made of PVC and has a diameter of 110 mm. Only one vent pipe serves two vaults and is at least 0.3 m longer and thus higher than the roof. The openings are covered with fly screens to prevent insect access.

To facilitate the collection in the households, the sectors are divided into smaller areas. The biggest sectors (17 and 30) are divided in 12 areas and the small ones (19 and 27) are divided in 6 areas. Each team of collectors has to visit all latrines in 6 areas within 2 weeks. Unfortunately, there are long distance between the UDDTs and also between eco-stations and UDDTs. Hence the collectors may have to cover distances of up to 12 km (the daily work time is estimated to 5-6 hours).

In total, there are four associations operating with approx. 28 people, 10 donkeys and 10 donkey carts. In the small sectors (19 and 27), each association works with 2 donkeys, 2 donkey carts and 6 workers, while the numbers in the biggest sectors (17 and 30) are 3, 3 and 8 respectively. At the prison, the prisoners are involved in the functioning and management of the eco-station.

7 Type and level of reuse

The project has benefited from the extensive experience of CREPA in the field of safe reuse of ecosan products (sanitised urine and dried faeces) in Burkina Faso and other countries in West Africa.

At the beginning of the project, the technical team and facilitators informed the households and farmers about the benefits of using ecosan products for crop production. The information campaigns during project implementation included training sessions on the safe use of dried faeces and urine.

<u>To increase acceptance</u> among the users (gardeners, farmers and consumers), it was decided to label the ecosan products as follows: Sanitised urine was sold in green 20-L cans labelled "**birg-koom**" in the local language (which means liquid fertiliser), while sanitised dried faeces are sold in bags labelled "**birg-koenga**" (meaning solid fertiliser).

One important aspect of the project was to ensure the quality and also the safety of the ecosan products sold to the farmers. The gardeners and small-scale farmers were specifically trained to use the treated urine and faeces on different vegetables (such as tomato, cabbage, cucumber, zucchini, carrot, salad, aubergine, strawberry).

Moreover, samples of sanitised urine and dried faeces have been taken and analysed by the National Water Laboratory (Laboratoire National des Eaux) for N, P and K values, and for pathogens such as E. coli. First results have shown that sanitised urine is safe (without pathogens) and has no negative impact on the environment and the health when used as fertiliser (see Makaya (2009) in Section 13).

However, when considering the meagre budget allocated to the project and the fact that municipalities are managing the project now, products are not really analysed. Probably it will be more an appropriate subject for MSc and PhD students to work on those topics. For instance what are the results for the faeces?

Given the fact that faeces take more time to be collected and then sanitised, the focus has been placed on urine which is the bulk of the excreta. Urine is collected and available within a day, and it had already been reused by farmers during the EU project time. However, urine reuse is still something very strange for the people and some authorities, thus it will be important to show that it is natural and harmless.

Analysis of the crop fertilised by sanitised urine and dried faeces is conducted within the EU-financed project ecosan_UE2 which is still ongoing.

Fig. 9: The workers of the associations deliver ecosan products (sanitised urine fertiliser in green jerrycans) by donkey carts to gardeners and sometimes show them how to use the product (source: CREPA, 2009).

[7] Note: A household of 6.5 people and urine production of 0.5 L/cap/d could produce about 48 L of urine in a two week period (the three jerrycans give a volume of only 60 L). But, not all "expected" urine is collected at home; since most of household members urinate by using toilets at their work places / schools or are on their fields during the day.

Fig. 10: A group of gardeners in Ouagadougou who use stored urine, called birg-koom (source: A. Fall, 2009).

Having witnessed the crop yields using sanitised urine and dried faeces, gardeners and small-scale farmers are now willing to **pay for these novel fertilisers** (for prices see Section 9).

Birg-koom (sanitised urine) is promoted as a fast acting, nitrogen rich fertiliser to be used during the growth phase of the plant, whereas birg-koenga (sanitised faeces) is promoted as a soil conditioner (base fertiliser).

Due to a low filling rate of the UDDT vaults and a longer storage time for treatment, not much faeces have been collected und used as fertilisers yet. Hence, the reuse activities have focused more on the application of sanitised urine.

8 Further project components

Throughout the project, a strategy of close cooperation with communal authorities, community-based organisations in peri-urban areas, and the local private sector was adopted. This strategy brought about positive results and a high degree of engagement from all actors involved. The project has intensively focused on the involvement of these actors, in order to increase their capacities to engage in a programme of sustainable sanitation systems aiming at ensuring that activities will be integrated into ongoing work when the initial project ended.

To ensure that the sanitation system meets the needs and expectations of all actors, the project has adopted a participatory and multidisciplinary approach with an appropriate legislative and regulatory framework (see document of capitalisation in section 13). The users (and farmers) are the key stakeholders in system design and operation.

The project put a strong focus on active local stakeholder participation during the planning and implementation stages. It started with information campaigns on health, hygiene and sanitation, which included discussions of the existing situation.

The municipal representatives as well as representatives from different community groups were involved in the design of the baseline study and the strategic ecosan plan. What do you mean by baseline study and how did the involvement of locals look like? Moreover, they were accompanying the project in planning, implementation and evaluation through the guiding committees (in French: comités directeurs) that were formed in each sector. The households were invited for validation of the baseline study results and the strategic plan.

Training sessions at all levels, particularly on maintaining the UDDTs and on practicing a safe reuse also constituted further important aspects of the project.

Monitoring activities throughout the entire project phase were an integral part of the project cycle. This allowed improving the design, mitigating construction errors, ensuring that the households maintained their new toilet facilities properly, and to encouraging safe reuse practices.

Further project components are:

- Research on agricultural reuse, health and socioeconomic aspects of ecosan, as part of the large research program on ecosan being carried out by CREPA and financed by SIDA.
- Capacity building on ecosan for the government, civil society and private sector.
- Policy advocacy for decision makers such as assistance in drafting an executive order for the establishment of a technical working group on sustainable sanitation at the national level, including all national key stakeholders in the following sectors: water and sanitation, environment, health, agriculture, research and education, etc. The new Direction Générale de l'Assainissement, des Eaux Usées et des Excréta (DGAEUE) was designated to be the national ecosan coordinator.
- Promotion of ecosan through diverse media (television, radio, internet, newsletter, etc.) and at national and international events (lecture, trainings courses, etc.).

9 Costs and economics

The capital costs for four types of UDDTs are shown in Table 1 below, depending of the quality of material use for the construction. Attempts were made to reduce the costs through a modified design. However, especially for the single vault UDDT, costs could only be reduced by about 16% by choosing cheaper materials for the superstructure.

Table 1: Prices of the different UDDT types, and contribution of the ECOSAN_UE project and beneficiaries (includes all materials and labour).

Toilet types	**Value in EUR**		
	Subsidy from the project	Contribution of the beneficiary	Total cost of the toilet
1.1. Double vault with superstructure (in cement)	168 (61%)	108	276
1.2. Double vault with superstructure (in mud)	168 (74%)	60	228
2. Single vault in cement	158 (64%)	90	248
3. Box with mud superstructure	125 (84%)	24	149

A cost breakdown for one UDDT with material and labour costs is not available. For a comparison of all costs with the costs of the ONEA latrines, particularly the VIPs, see section 13 the study for financial and economic analysis of ecological sanitation in Sub-Saharan Africa done by WSP (2009).

The households were involved in the construction process of the toilets by providing building material and assistance for the construction workers.

The construction costs were so high that many low-income households could not build UDDTs without external funding. Despite the subsidy given to each household, only 500 UDDTs were installed up to December 2008, six months before the project was due to end.

To boost the number of UDDTs built, the project team decided in December 2008 to give an additional subsidy of about EUR 38 per household (through a total contribution of EUR 15,000 by the Regional Ecosan Programme of CREPA). With this subsidy additional 400 UDDTs were built.

This subsidy was in form of material needed for the construction of the UDDTs, and included the salary of the mason. Therefore, for the last 400 UDDTs constructed between December 2008 and June 2009, the households contributed around 10 % (for toilets with walls in mud) or 25 % (for toilets with walls in cement) of the construction costs through material for the super-structure and unskilled labour.

Regarding the management of the system chain, about 12 SMEs/CBOs (small to medium enterprises / community-based organisations) were identified, trained and involved in the project implementation. For the operation (collection, transport, treatment, management and delivery, etc.), eight out of twelve were selected: this means 2 associations per sector. In order to decrease the management cost, the two have been asked to form one association in each sector (one SME per eco-station; these are called “associations”). The monthly income for each association is made up of a fixed sum (being in essence a subsidy component financed from the EU project) and a variable sum. The fixed sum was EUR 300 for each association in the sectors 17 and 30 (which are larger in terms of area), and EUR 230 for each association in the sectors 19 and 27. It is planned that the Municipality of Ouagadougou takes over this fixed amount after the EU project ends.

The variable income for the associations includes:

- The monthly collection of about EUR 0.5 (300 FCFA) per UDDT (the amount depends of the number households that are able to pay[8]) – in theory this should amount to EUR 461 per month as there are 922 households with a UDDT,
- The income from selling the ecosan fertilisers i.e. sanitised urine and dried faeces to gardeners and small farmers. The birg-koom fertiliser (sanitised urine) is sold for **EUR 0.15 for a 20-L jerrycan** (equals 100 F CFA) or **EUR 7.5 per m^3**. The price for birg-koenga fertiliser (sanitised faeces) would be EUR 3.86 for the 50 kg-bag (2500 F CFA)[9] although less of this fertiliser has been sold so far.

The fixed price for ecosan fertilisers is the result of a workshop in March 2009. This workshop brought together all actors involved in the management and use of ecosan fertilisers, such as gardeners of old and new sites[10], vendors and developers of chemical fertilisers, associations responsible for the delivery of ecosan fertilisers, farmers, private individuals and municipal representatives.

The monthly expenditure of the association consists primarily of salaries, food for the donkeys, maintenance work at the eco-stations, as well as transport and communication (calling) expenses for the responsible. The exact monthly expenditure varies from EUR 200 to 220.

In theory, it would be possible for the associations to cover the operational costs of the ecosan system with these income streams. In practice, however, the demand for ecosan fertilisers is not always sufficient and unfortunately many households (80%) do not accept to pay the collection fee.

The urine sale would therefore generate EUR 8,640 per year for the 5,993 people covered in the project (or EUR 1.45 per person per year), not counting the UDDTs at public places (assuming collection of 0.5 L urine per person per day). If this approach was up scaled to cover the entire population of 1.4 million people, it would mean that the urine has a value of EUR 2 million per year for the city of Ouagadougou.

10 Operation and maintenance

At the household level, operation and maintenance include keeping the toilets clean, covering the faeces after defecation with ash, and monitoring the urine and faeces levels in the collection jerrycans and vaults. These tasks are mostly done by the women and girls of the household (the covering of faeces with ash is done by each user himself).

A common social practise in Ouagadougou is that people use water for anal washing however some of them may use toilet paper instead.

For UDDTs at public places or institutions, the facilities are maintained by a staff member. In the Ouagadougou prison, prisoners are in charge of this work.

Short monitoring visits to observe the proper use and operation of UDDTs were usually conducted two weeks after the users began to use the UDDTs. A more comprehensive monitoring was conducted after several months of operation. This included technical aspects (maintenance, functionality) as well as the general perception of the users, their satisfaction with the ecosan system and reuse practices. Does this continue now that the project is over? Does City hall take care of that?

The results of these monitoring activities showed that the vast majority of users were motivated and able to operate and maintain their UDDTs properly. However, in some cases additional instructions were necessary.

At the treatment sites (eco-stations), the faeces are left in drying chambers depending on the arrival date on site or the commissioning drying date, followed by sorting, made to remove non-degradable particle from the product in the chambers from time to time to enhance the drying process.

The use of ash as an additional material favours the climate conditions for better dehydration. Faeces that have spent already six months in the pit (after it was full) are very often already well dried. This second period of hygienisation is made to ensure “security” for the users.

[8] On average about 50% of the household do not pay the monthly collection fee.

[9] If 922 households with 6.5 members deliver half their daily urine production (say half of 1L/cap/d), this would be about 96 m^3 urine collected in the system per month. Hence, this would result in an income of EUR 720 per month for the sold urine fertiliser.

[10] For a larger promotion of the ecosan fertiliser, new gardening areas were identified, in addition to the four first (old) ones. Gardener/small farmer from these new areas were also trained and involved in the project

All other tasks in the treatment sites (such as cleaning, emptying yellow urine jerrycans and putting the content into the large plastic tanks, emptying the large plastic tanks into the green urine jerrycans, taking care of material and donkeys, etc.) are done by the staff of the association in charge of the site.

In the institutional arrangement, the ECOSAN_UE project sponsors the equipment of the beneficiary (household, farmers and associations). It also built and equipped eco-stations in each sector of the project. It signed management contract with the local associations and followed their activities. But since last year, the project is in charge of the municipality. The municipality have the needed funds for managing of the eco-stations and the replacement of equipments and took over.

These associations were trained to fulfil their duties which are:

- Collect the filled jerrycans and the sacks of faeces that come from single vault UDDTs.
- Replace the number of full jerrycans collected by empty ones at the households.
- Empty the filled vaults of double vault UDDTs.
- Transport the excreta to the eco-stations.
- Supervise excreta hygienisation at the eco-stations.
- Ensure handling of excreta in the eco-stations and delivering of the end products to the farmers if needed.
- Administer the excreta collection fees from the household and the money for sale of ecosan fertiliser

11 Practical experience and lessons learnt

All project target groups say that the UDDTs are very useful (household members who have changed from traditional pit latrines and gardeners who now have an affordable natural fertiliser).

But most of the UDDT users said that the anal washing area was inconvenient to use, since firstly there is too little space available, secondly it is very shallow and thirdly it is located too close to the wall.

The cleaning of the toilet bowl or squatting pan is a big concern especially when there are many users who do not know how to use it properly (such as when some of the faeces remain on the sides of the bowl after defecation).

There have also been problems with blocked urine pipes when ash is added to the urine part of the squatting pan by mistake.

At public places, apart from the prison, the project has faced great difficulties in the use and maintenance of the UDDTs. This is mainly due to the fact that the people responsible of these places have never created the required condition which was agreed upon before construction (ensure compliance of guideline of UDDTs use).

At the level of the different town halls, the gardeners were trained to take care of the toilet and use the end product in the gardens. In the park (Parc Bangrweogo), it was therefore expected that a private service takes money from the toilet users, and ensures the O&M activities. But none of these stakeholders fulfilled their commitment despite the multiple calls from the project team and the effort to sensitise users with pictures on how to use the toilet. As a solution, the toilets at the zoo and the park were simply closed. People in charge of the town hall decided to limit the access to the UDDTs for their employees only by using keys. As result, these toilets are not used any more. Hence, a successful use of public toilets is strongly linked to an appropriate cleaning and management system. How much did the public UDDTs cost per block?

Further problems and challenges with the ecosan system include:

- Difficulties to reach the households due to the bad quality of roads in the sectors especially during the rainy season.
- Misuse of latrines (lack of ash, insertion of water in the faeces vault, etc) particularly in the rented properties (and particularly for single vault UDDTs) most often when many families live in the same compound and sharing a UDDT; generally they don't take good care of the toilet.
- Collection of faeces sacks from single vault UDDTs in the donkey carts without intermediate storage at household (household members do not want to handle the faeces sacks even if they are filled and rather wait for the collectors to remove the sack and place it in the cart directly).
- Leakage of plastic 1 m^3 urine tanks (“polytanks”), during the storage: between the tank and the emptying pipe at the base. (see pictures on flickr)
- Low storage capacities of eco-stations, especially because demand for urine by farmer is still low. Thus, urine remains a long time at the eco-station after being sanitised.
- Low level of demand of ecosan fertiliser by the farmers in certain sectors and high level in others: the long distance between the eco-stations to balance the demands is a challenge.
- Difficulties in the delivering of products to remote areas due to a lack of transportation (demand in remote areas and surrounding village is great, but due to difficulties in transportation, products are very expensive to the farmer as end consumer).
- Irregular payment of workers leads sometimes to the non-collection of products from households; which oblige sometimes households to empty the filled jerrycans in nature because of lack of empty jerrycans to use.
- Impossible to cover the operating costs of the ecosan system without external support (the municipality has been supporting the associations since 2010). It is expected that this kind of support will move progressively from old sectors to new ones. That means also that the actual associations should find strategies to become self-functioning in the future by promoting their products.
- How to ensure the renewal of the equipment (for example will the UDDTs that were destroyed in the floods of September 2009 be re-built?)
- How to make the associations more financially independent?
- How to ensure the renewal of antiquated equipment in eco-station due to the inability of the eco-stations to be managed themselves and limited means offered by the municipality?
- How to motivate the farmers to use constantly birg-koom (urine fertiliser)? They consider urine (liquid fertiliser) as more difficult as the application of mineral fertilisers (powder). Additionally, the storage of urine requires more space.
- There are many differences in the management capacities of what existed for the three town city districts.
- Non involvement of institutions taking part in the process of durability along all 36 months: Technical and financial difficulties of what existed and the spread of the system to be considered.

- The full support of the project brought the issue of sustainability.
- Project view: reluctance of households to pay for latrine maintenance and excreta collection.

On the other hand, success factors of the project were:

- Successful accounting for the socio-cultural realities during the technologies conception: inventory and inspection of rented property,
- Production of a strategic witness plan,
- Acceptance of the approach by the town city districts, households, SME and market gardeners thanks to tremendous sensitisation and subsidy,
- Communicational and promotional activities,
- Development of the capacities of stakeholders,
- Creation of a Geographical Information System with a link to that of ONEA (National Office/Agency for water and sanitation) showing the location of the UDDTs,
- Appropriation of the approach by the Government: Working plan of the National strategy for sanitation,
- Ownership of the project by people of concerned sectors: They have well understood the importance of the project for their health. This translates into strong demand for UDDTs even though the project has been stopped,
- With the introduction of UDDTs, behavioural changes compared to poor management practices of excreta are clearly visible. Unlike the misuse of latrines in beginnings of the project, there is noticed a proper use of latrine by households who rejoice of the benefits,
- Strong opportunity of technical durability and beginning of the financial one,
- Production of important documents on the strategic implementation of ecosan.

Overall, the results have been encouraging at both household and farming level. The municipal authorities have embraced the concept. At ministerial level, the Minister for Agriculture has spoken out in favour of the approach, and the double benefit it is bringing in sanitation and agriculture, noting its compatibility with the national operational strategy for food security, which aims to reduce the number of people suffering from malnutrition in Burkina Faso by 50%.

The transfer of responsibility of the project to the local authorities is ongoing. ONEA is planning to integrate the UDDT in their portfolio of latrines in the four concerned sectors. The “ECOSAN-action team” of Ouagadougou municipality created to follow up on the collection chain, and support for the associations has been established since the beginning of 2010.

Since the end of the EU project (from January 2010 onwards), the municipality supports the associations until they become self-functioning. This will be effective when ONEA will continue the building in the four sectors in future years to increase the number of toilets built but also to sell more products to the farmers and collect more fee from household level. The associations sometimes receive a helping hand from CREPA in finding customers and for transportation. The government has also implemented an advertising spot on the national television to raise awareness among people for the use of ecosan products.

The use of UDDTs is seen as having the potential to make an important contribution to reaching several of the Millennium Development Goals at national level, including those outlined in the National Programme for Water Supply and Sanitation and the Strategic Framework for Poverty Reduction.

The main donor of the project, the EU, has also expressed its satisfaction and is now financing a second large-scale ecosan project using a similar approach which is aimed at farming families in the rural province of Kouritenga via a fund earmarked for improving food security through improved soil fertility (through the Food Facility ACP-EU).

How did the UDDTs resist the floods in Ouagadougou in Sept 2009?

On 1st September 2009 there was unusual and wide spread flooding in Ouagadougou. UDDTs had an advantage over pit latrines during flood events because they were being more durable and could still *contain* the excreta (depending on the severity of the flood).

According to Chiaka Coulibaly, the experience here was that none of the UDDTs built with concrete blocks collapsed after the flooding. For those UDDTs whose vaults were built with local material (mud, clay or adobe blocks) they collapsed when the water has reached the level of the vault. In total, 20 out of 932 UDDTs collapsed. In some areas only ecosan toilets remained after flooding.

In addition, from the 20 UDDTs which collapsed, most of them were located in depressions areas, where all household had been forced to leave the place.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 1) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 2: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	O	-
• health and hygiene	X			X		X	X		X
• environmental and natural resources	X			X			X		
• technology and operation		X		X		X		X	
• finance and economics		X	X		X	X		X	
• socio-cultural and institutional	X			X			X		

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, e.g. from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

With regards to long-term impacts of the project, the main impacts of the project are:

1. After the floods, around 912 households (or about 5930 people) still have UDDTs, thus increasing the number of families with access to improved sanitation facilities, and preventing pollution from poor excreta management.
2. The UDDTs should improve public health (such as reduced rate of diarrhoea incidences in children). It is planned to assess this during the final evaluation of the project in 2010 (was this done? Results?) (baseline was carried out in the beginning of the project).
3. Many urban farmers in Ouagadougou now recognise sanitised urine and dried faeces to be efficient fertilisers. The local ecosan champions among the urban farmers will be crucial for the uptake among others. The ecosan fertilisers have a market potential, but their competitiveness is also a function of chemical fertiliser prices. If artificial fertiliser prices increase in the future, the demand for ecosan fertilisers would also increase.
4. The project has helped to put sanitation in general and ecosan in particular higher on the political agenda. In the Implementing Plan of the National Sanitation Policy, UDDTs are now recognised as appropriate among other sanitation technical options. It is also planned to integrate UDDTs in the development of the next “Plans Stratégiques d’Assainissement” (Sanitation Strategic Plans) for small and medium cities in Burkina Faso.
5. The project’s infrastructure serves now as a research and teaching facility.

13 Available documents and references

- Bracken, P, von Muench, E., Panesar, A. R. (2009) Tackling the urban waste and food crises simultaneously and sustainably – examples from the Philippines and Burkina Faso, 34th WEDC conference, Addis Ababa, Ethiopia. http://www2.gtz.de/Dokumente/oe44/ecosan/en-tackling-the-urban-waste-and-food-crises-simultaneously-and-sustainably-2009.pdf
- WSP (2009) Study for financial and economic analysis of ecological sanitation in Sub-Saharan Africa, Water and Sanitation Program – Africa, The World Bank, USA. http://www.wsp.org/UserFiles/file/Ecosan_Report.pdf
- Fall, A. (2009) Report of main achievements and success/failure factors of the project (in French) - Document de capitalisation des acquis et leçons apprises du projet Ecosan_UE1. Consultancy report for GTZ. http://www2.gtz.de/Dokumente/oe44/ecosan/fr-des-activites-du-projet-EcoSan-EU-2009.pdf
- Campaoré, O. A., Dioma, S. K., Fall, A. (2009) Mid-term assessment of ecological sanitation in peri-urban areas of Ouagadougou (in French) - Evaluation à mi-parcours du projet d’assainissement écologique dans les quartiers périphériques de la ville de Ouagadougou, consultancy report for GTZ. http://www2.gtz.de/Dokumente/oe44/ecosan/fr-evaluation-du-projet-assainissement-ecologique-2009.pdf
- Coulibaly, C. (2009) Management of ecosan system in urban areas: "ecosan_ue project case study" in four sectors of Ouagadougou, Burkina Faso, paper at the Sanitation and Hygiene symposium in Accra, Ghana, 3-5 Nov 2009. http://www.irc.nl/page/50790
- Makaya, J. (2009) Control of the physico-chemical and microbiological agricultural fertiliser based on sanitzed urine: assessment of health impacts (Contrôle des paramètres physico-chimiques et microbiologiques du fertilisant agricole à base des urines hygiénisées : évaluation d’impacts sanitaires), Consultancy report for CREPA (Makaya’s MSc thesis). http://www2.gtz.de/Dokumente/oe44/ecosan/fr-évaluation-d'impacts-sanitraires-in-ouagadougou-2009.pdf.
- Kameni, A. (2010) Comparative study of strategies for implementation of ecosan concept in various contexts (Etude comparé des stratégies de mise en œuvre du concept ecosan dans divers contextes), MSc thesis, Ouagadougou, Burkina Faso. http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=965
- Unknown. Project for the improvement of the agricultural fertility by usage of hygenised human excreta as fertiliser in 30 villages in Kourittenga (Projet d’amélioration de la productivité agricole par l’utilisation des excréta humains hygiénisés comme fertilisants dans 30 villages du Kourittenga.), Burkina Faso. http://www.susana.org/images/documents/nl32/gtz-ecosan-nl-32-ecosan-ue2.pdf

Additional photos (2008 and 2009):

- http://www.flickr.com/photos/gtzecosan/sets/72157613296193005/
- http://www.flickr.com/photos/gtzecosan/sets/72157625719409533/
- http://www.flickr.com/photos/gtzecosan/sets/72157623223068890/
- http://www.flickr.com/photos/gtzecosan/sets/72157625643299691/
- http://www.flickr.com/photos/gtzecosan/sets/72157625642803125/
- http://www.flickr.com/photos/gtzecosan/sets/72157625696108825/

Video clips

- On YouTube[11] about UDDTs in prison: http://www.youtube.com/watch?v=1F-MgqrDs8g
- On YouTube[12] about reuse demonstrations: http://www.youtube.com/watch?v=Bc8NKaPrni4

14 Institutions, organisations and contact persons

Municipality of Ouagadougou (role: Project owner)
Dramane Compaoré, 2e Adjoint au Maire de la Commune
01 BP 85 Ouagadougou 01, Burkina Faso
Tél: (00226) 50 30 68 17/18 or (00226) 50 31 60 10
Fax: (00226) 50 31 83 87
E-mail: ecrireaumaire@yahoo.fr
www.mairie-ouaga.bf/

CREPA (role: Planning, co-financing and project management)
Anselme Vodounhessi (until June 2009) and Chiaka Coulibaly (since July 2009), Project Coordinator
CREPA Siège
03 BP 7112, Ouagadougou 03, Burkina Faso
Tel.: +226 50 48 49 43
E-mail: ansvodhess@yahoo.fr, coulchi@yahoo.fr and ecosan_ue@reseaucrepa.org
http://www.reseaucrepa.org/

GIZ (former GTZ) (role: Planning, co-financing and technical support)
GIZ Burkina Faso, Water Program for Small and Medium Towns (Programme Eau et Assainissement petites et moyennes villes, PEA)
Contact: Olivier Stoupy ¸(e-mail : Olivier.Stoupy@giz.de)
GIZ / Coopération Internationale Allemande au Burkina Faso
B.P. 1485
Ouagadougou, Burkina Faso
Tel: +226 50 30 09 64
http://www.giz.de/en/weltweit/afrika/578.htm

ONEA (role: Planning, co-financing and technical support)
Contact: Félix Zabsonré, Directeur de l'Assainissement (DASS)
Office National de l'Eau et de l'Assainissement (ONEA)
Direction Régionale de Ouagadougou (DRO)
01 BP 170, Ouagadougou 01, Burkina Faso
Tel.: +226 50 43 19 00 to 08
E-mail: dass.onea@fasonet.bf
http://www.oneabf.com/

DGAEUE (role: National ecosan coordinator)[13]
Contact: Mrs. Marie Denis Sondo (General Director / Directrice Générale)
Direction Générale de l'Assainissement, des Eaux Usées et des Excréta (sanitation, wastewater and excreta)

List of associations involved in the management of eco-stations:

- **YNEFE** for sector 17
  Resp.: Mrs Baya Zenabou - Tel.: +226 70267333
- **POUPELM NOOMA** for sector 19
  Resp.: M Kaboré Amadou - Tél: +226 70271545
- **ACONA-Z** for sector 27
  Resp.: M Kerre S Pierre - Tél: +226 70231610
- **RATAMANEGRE** for sector 30
  Resp.: Mrs Ouédraogo Haoua – Tel.: +226 70438082

Case study of SuSanA projects

Urban urine diversion dehydration toilets and reuse, Ouagadougou, Burkina Faso

SuSanA 2011

Authors: Abdoulaye Fall (Consultant for GTZ; vieuxfall@yahoo.com), Chiaka Coulibaly (CREPA, coulchi@yahoo.fr)

Editing and reviewing:

Patrick Bracken (consultant; pocb123@yahoo.com), Elisabeth v. Muench (GIZ; ecosan@giz.de), Joelle Kameni (2ie; kam29audrey@gmail.com)

This document is available from:
www.susana.org

[11] Three UDDTs are installed at the prison (MACO) of the city of Ouagadougou, Burkina Faso. The prisoners are in charge of the management of the whole system: O&M of the toilets, treatment of the urine and faeces collected, and agricultural reuse of the EcoSan by-products in their own fields in the prison.
[12] Results from field experiments in Koupéla (Burkina Faso) on the use of ecosan by-products as fertiliser (urine and/or dried faeces) for the production of maize.
[13] DGAEUE is the most important institution (political instrument) in charge of sanitation in the country, whereas ONEA is the national implementation agency for urban sanitation. DGAEUE falls directly under the Ministry of Agriculture, Water and Fisheries Resources.

Case study of sustainable sanitation projects

Household pit latrines with urine diversion Farchana refugee camp, Chad - draft

Fig. 1: Project location

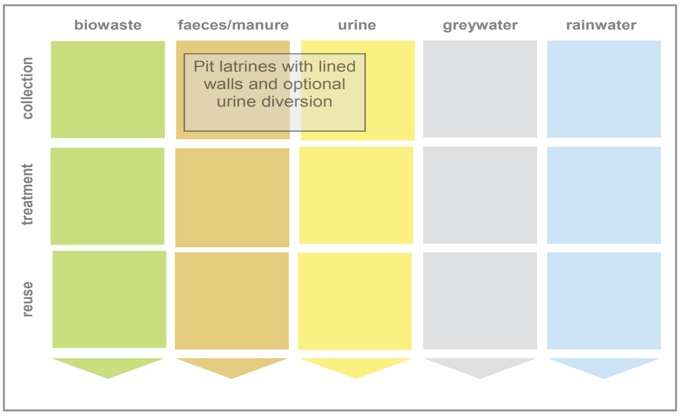


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Sanitation for a refugee camp
Family based sanitation, between a pilot scale and a full-scale project

Project period:
Camp established in 2003
Start of planning: 2008
Start of construction: November 2008, 5 years after the refugees arrived
Start of operation:
End of project:

Project scale:
Number of inhabitants covered: about 500 in Farchana (102 pit latrines with lined walls: 80 single pits and 22 double pits; 5 people per household)
Total investment: EUR 36,000

Address of project location:
Farchana Refugee Camp, more precise location: province, region?, Eastern Chad

Planning institution:
SECADEV - a Chadian NGO ('Caritas Chad' - known nationally as SECADEV: Secours Catholique Développement)

Executing institution:
SECADEV (a Chadian NGO)

Supporting agency:
CARITAS, from which country?

2 Objective and motivation of the project

Family pit latrines with lined walls that can easily be emptied have been implemented in the Farchana refugee camp in Chad to address a number of problems. The primary goal has been to find a sustainable solution for sanitation that can be adapted in a protracted crisis context.

Generally, there is a lack of space in the refugee camp to build new pit latrines. In addition, several hundred pit latrines have collapsed in the sandy soil. Therefore, the primary reason to implement the new family latrines is their extended lifespan rather than the ability to make use of by-products.

The most innovative aspect of this latrine project is that it is adopted in a Chadian refugee camp for Sudanese refugees. In addition, it is an opportunity to raise awareness among humanitarian agencies for different existing forms of sustainable sanitation.

3 Location and conditions

Approximately 260,000 Sudanese refugees have fled to Eastern Chad since 2003, in order to escape the socio-political conflict in Darfur, Sudan. Since 2005 ethnic conflicts within Chad and intrusions by Sudanese armed groups have caused a large number of Chadian internally displaced people (IDPs). There are 170,000 people living in IDP sites in 2009.

Fig. 3: Farchana refugee camp in Chad (source: J. Patinet, (2009), Groupe URD).

From 2007 onwards, displaced communities have begun to return to their villages of origin such as Koukou, Kerfi, Am Timan, etc.

The current situation in Eastern Chad is characterised by the following factors:

- **Permanent instability and insecurity**. Chadian rebel groups which are based in Sudan make regular forays into Eastern Chad. Their objective is to destabilise Idriss Déby Itno's regime by attacking the capital of Chad, N'Djamena. There is an increase in lawlessness in zones with crisis-affected communities. Both, humanitarian aid workers and the local population are affected by the resulting insecurity. Vehicles have been held up, humanitarian bases have been attacked and violence has been directed at civilians.

- **The existence of several different types of issues,** present at the same time in Chad, require different types of humanitarian response. Care and maintenance operations are necessary for refugees and certain IDP sites, despite their increasing self-reliance. Rehabilitation and development activities are needed for returnees and local populations. Finally, new emergency situations call for a better emergency response.

- **Difficulty of coordination** of humanitarian action. There are currently two systems in place that coordinate humanitarian actions in Eastern Chad. One is the UNHCR (United Nations High Commissioner for Refugees) whose operations mainly address refugees. The other one is the UNOCHA (United Nations Office for the Coordination of Humanitarian Affairs), mainly responsible for operations involving IDPs and returnees. Its operations are based on clusters with several levels of coordination (N'Djamena, Abéché, Goz Beida, etc.). Yet, coordination between developmental and humanitarian agencies is limited. The existence of two systems increases the number of necessary meetings for similar topics, which is problematic, given the limitation of human resources.

- **Initiatives to promote self-reliance** involve varying levels of difficulty, depending on the status of population group (e.g. refugees, IDPs, returnees, local people). Many of the humanitarian agencies that work in Eastern Chad agree that there is a need to promote self-reliance among the affected peoples. However, depending on the sector and the "type" of population, the objectives and the means needed to reach them (in relation to land available for cultivation and social, economic, climatic and legal conditions) are not always very clearly defined and communicated.

- **Unsustainable water and sanitation systems** are often set up by humanitarian agencies. Poor excreta management systems like common pit latrines, which lead to a lack of space in the long run, is one obvious example. It is also important to realise that the "host communities" in villages around the camps and also in towns do not have access to sanitation either.

Humanitarian agencies are therefore confronted with a complex, protracted crisis: certain camps have been in place for more than five years. Due to the nature of the crisis, it is very likely that they will be existent for several more years.

This case study focuses on the Farchana refugee camp. There are 21,153 refugees (approx. 5,650 households) in an area of 1.72 sqm, which means a density of 11,849 habitants/square kilometre (source: OCHA, registered refugees camp population, May 2009).

The climate where the camp is located is very dry, with an annual rainfall of about 500 millimetres. The level of poverty of the refugees is unfortunately not well known among the humanitarian actors and should therefore be assessed, in order to better understand in how far people could financially contribute to the facilities provided.

Regarding the legal framework, the Chadian "Schéma Directeur de l'Eau et de l'Assainissement,"[1] which was written before the crisis, rather neglects sanitation issues.

Regarding the camps, the 'Plan Stratégique pour l'approvisionnement en eau et l'assainissement au Tchad 2008 – 2010' (PSEA Tchad 2010) by UNHCR aims to facilitate the transition phase in between emergency aid and the implementation of durable (sustainable) solutions.

The international humanitarian standard suggests that there should at least be one latrine per 20 persons in an emergency situation. After more than 6 years, the strategy currently applied in Eastern Chad camps is one latrine per family (with 5 people per household on average). However, this coverage is very difficult to keep up, as there is not enough space to build new latrines and existing ones get full or collapse.

In Chad the under-five child mortality rate is currently still very high at **209** per 1000 children[2]. By comparison, in 1990 the figure was 201 per 1000 children. Hence, one can see a slight upward trend unfortunately, whereas most other developing countries have had a clear reduction since 1990.

4 Project history

Please provide information on the project history – "milestones". Why was this project initiated? Who did what, why, and when?
How did Groupe URD get involved? And who is managing the overall camp?

5 Technologies applied

Faced with limited space to dig pit latrines in some parts of the camps and the collapse of latrines in sandy areas, SECADEV has been testing its own form of ecological toilet - family latrines that can be emptied. This type of toilet saves space because the pits can be emptied when full and there is no need to dig again.

The **first technical solution** that was chosen in 2008 was a simple deep pit (2 to 3 metres). The side walls are built with terracotta bricks, without a bottom so that it can be cleaned out manually (using shovels and carts). About 80 latrines of this type were built in the Farchana refugee camp. This

[1] National Plan for water and sanitation
[2] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

system, with an in-ground pit (without a base slab) assumes a sufficiently low groundwater table.

The **second technical solution** that has been set up in 2009 has two pits, which should be used alternately (following Groupe URD's advice). This improvement aims to avoid the handling of un-sanitised (fresh) excreta, since the filled-up latrine can be closed for several months before being emptied. In the meantime the other one can be used.

About 22 of these double pit latrines have been built in Farchana. Users can separate urine and faeces so that the faeces can dry easily; however there is no specific concrete system facilitating the separation. But Figure 5 indicates exactly this or not? Hence, some families do the liquid diversion because they found that there are less flies and odour when faecal matter is dry. However, others do not do it.

There are a few conditions that favour the implementation of the double pit latrines. The refugees are familiar with soil restoration techniques (e.g. composting, excreta reuse in crop production), since these have already been used in Sudan. In addition, some of the Sudanese refugees already separated liquids from faecal matter (those who already had access to a latrine before arriving in the camp).

Advantages of the double pit latrine:

- Since the groundwater is about 30 meters deep, there is no threat of pollution from the latrine.
- Possibility to reuse by-products/create income generating activities.
- Very long system lifetime and low recurring costs.
- Easy to empty, it can be done by the family.
- Solution that saves space and is therefore adapted to densely populated zones. The work is continuous (the pit is repeatedly emptied), so it is not necessary to dig new pits.

Disadvantages of the double pit latrine:
For the construction of the latrines, kiln-fired bricks are needed. This is unsustainable in the way that firewood is needed which can lead to deforestation.

6 Design information

The pit (1.4 x 1.4 x 2 to 3 metres deep) is reinforced from top to bottom with kiln-fired bricks[3], joined with cement. It will be relevant to assess if the faeces dry out properly despite the 3-metres depth. This sanitation system is built with materials that are more durable and costly than the refugees' shelters.

The small concrete slabs with the drop hole have handles so they can easily be moved aside to allow for emptying. Hence, the pits can be emptied manually (using shovels and carts) so that the contents can be reused in agriculture.

The majority of the liquids (urine and anal-washing water) should flow separately over the slightly inclined slab and drain away to the outside (see Fig 5). But in fact, liquid diversion is done only if the user decides for it: liquids can easily enter the pit.

While the latrine also serves as shower, the bathing waste water drains out in the same way. SECADEV decided to encourage the practice of separating liquids at the source. Thereby, the pit is being reserved specifically for faeces, as it was already a relatively common practice among some of the Sudanese refugees.

The possibility to reuse the latrine by-products in order to restore the soils' agronomic potential is a technique known to the refugees, and previously practiced by some facilitators of the Farchana in Sudan. In the first case (single pit), before reuse, the faeces must undergo a second treatment through composting in pre-designated areas for this use, because faecal matter is fresh when being emptied.

For the first emptying, anticipated to happen after two or three years, SECADEV is currently reflecting on the different technical options.

Fig. 4: Superstructure of a double pit latrine. Is this the material usually used for the superstructure? Fig. 7 indicates a much simpler version. Do the pit latrines not have a roof? Why? What about privacy or similar issues? (Source: J. Patinet (2009) Groupe URD).

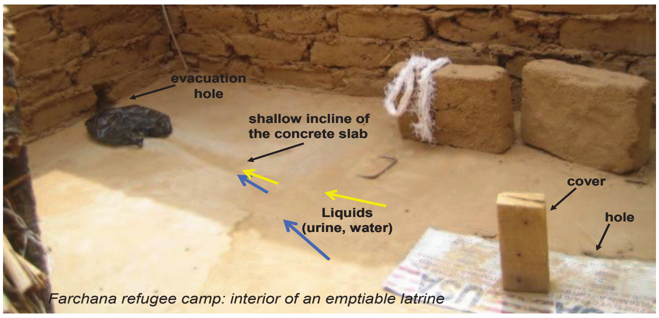


Fig. 5: Single pit family latrine (source: J. Patinet (2009) Groupe URD). Where is the faeces drop hole?

---

[3] Earth bricks fired in a kiln.

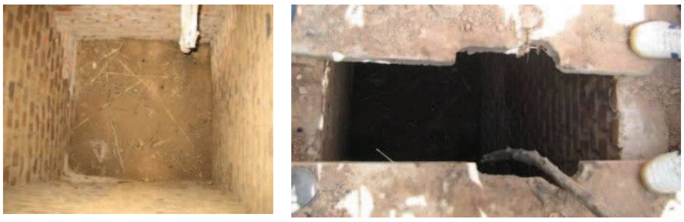


Fig. 6: Both pictures show the single pit family latrine that can be emptied. Left side: this shows the interior of a pit with lined walls. Right side: the pit is shown with opened slab which indicates how the pits can be opened and emptied (source: J. Patinet (2009) Groupe URD).

7 Type and level of reuse

The main objective of the project was to implement a sanitation system that provides a permanent and sustainable infrastructure, and which preserves space at the same time, since refugees only have very little access to agricultural land.

As in the entire Sahel zone, the soil in Chad is poor or degraded. Agricultural land that surrounds the *wadis*[4] is over-exploited. There is very little vegetation. Moreover, insufficient rainfall and poor soil mineralisation, caused by two highly contrasting alternating seasons, leave the area unfertile. The scare vegetation causes weak soil equilibrium. In general, erosion is very strong.

The refugees have very little, if any, access to agricultural land. Therefore, most manure of small ruminants is not used by the refuges for agricultural purposes, despite the fact that animal manure as well as human excreta after treatment could help to restore soil fertility.

Fig. 7: Double pit family latrine that can be emptied (source: Mahamat Absakine (2010) Groupe URD).

Fig. 8: The slabs of the pit latrines, drop hole is at the bottom right in the shaded part of the photo (source: Mahamat Absakine (2010) Groupe URD). When the document is printed black and white, the drop hole is not visible. Use better photo?

The first emptying of the latrine is about to take place in several years time (when roughly?). SECADEV plans to reuse the by-products, but is currently not sure how to do it. Certain aspects relating to the reuse of by-products still need to be clarified. One possibility for the reuse is the reforestation site (15 ha) managed by SECADEV's environment team, located a few kilometres from the camp.

8 Further project components

Responding to the classical WASH camp management, SECADEV provides hygiene promotion through training, sanitation and hygiene committees and hygiene promoters. But "soft" activities (like training, awareness raising campaigns, capacity buildings) are absolutely not sufficient. For example no educative workshops on the reuse of urine and faecal matter in agriculture were conducted.

9 Costs and economics

Each family's contribution to the latrines is less than 10% of the total cost. However, they are responsible for building the superstructure and giving meals to the workers. For the traditional latrines, the refugees are normally required to dig their own pit. However, for this new type of latrine, this work is done by NGOs themselves, since it needs to be done very accurately, as the inside of the pit need to be lined with bricks. In this case, the cost is hence almost entirely covered by the operating NGO.

The construction costs (including labour costs?) for three different types of latrines that are present in the Farchana camp are listed in the following (one family consists of 4 household members on average (but we said 5 on page 1??)):

- Traditional family latrine: 98,000-120,000 FCFA = 150-180 EUR
- "Reusable" family single pit latrine (built under this project): 207,000 FCFA = 315 EUR
- "Reusable" family double pit latrine (built under this project): 325,000 FCFA = 495 EUR

[4] Wadis : Arabic term traditionally referring to a dry riverbed that contains water only during times of heavy rain

The total construction costs were EUR 36,000.

Is it possible to provide a detailed cost break down? What is the difference in costs if the superstructure is made from bricks compared to a simple wooden structure?

The difference between a traditional family latrine and the "reusable" family single pit latrine built under this project:
A traditional family latrine looks like what 'humanitarian actors' call a single pit latrine. But there is a big difference between the traditional family latrine and the family single pit latrine: the family single pit is a latrine that can be emptied and which is reinforced with fired-bricks and cement (that allows the emptying and explains the higher costs). The traditional family latrine is a simple pit which is less deep than the "reusable" latrines (the former cannot be emptied, except in very hard soil).

10 Operation and maintenance

The first emptying of the latrines is due to take place in several years time. The NGO which is responsible for operation and maintenance (SECADEV) has not yet determined which management model it will use. Information on this will follow.

11 Practical experience and lessons learnt

The first lesson learnt is the importance of 'software' activities such as trainings, participatory workshops, general awareness creation, etc. (which were not sufficient) and also the risk of constructing hundreds of latrines without running a small-scale pilot project before. For example, some refugees were using both pits of the double pit latrine at the same time.

Certain technical issues still need to be clarified such as the management of by-products. Hence, it is essential to give importance to awareness-raising, social organisation and capacity building activities as well as to infrastructure building activities. Whether or not affected people participate successfully is depending on the quality of the dialogue and interaction that will take place with the humanitarian agency.

The main encountered obstacles of the project were:

- A violent and unstable context hinders investment into sustainable solutions and thus forces NGOs to manage projects from distant places or to interrupt them; in this context, monitoring and implementing a real "software" part in the projects is highly challenging.
- Difficulty for refugees to gain access to land.
- Costs are also an obstacle, but this could be overcome by experimenting with different materials to reduce the costs (for example using sundried soil, etc.). Costs could also be reduced if donors make a commitment to support these systems.

Further technical variations to be tested:

- Adding ashes (or dry soil if ashes are not available).
- Reusing the diverted liquids (urine and greywater) for water plants, for example.
- Testing pits which are less deep. So far it is not clear if the faeces dry out properly despite the 3-metres depth.
- Testing pits constructed with sun-dried blocks. This technique requires a double coating over the pit lining (sun-dried blocks). The first layer uses a mix of cement (or lime, if available) and soil, while the second uses a classic coating of cement (or lime) plus sand. The technique reduces costs considerably, since no kiln-fired bricks are needed. In addition, the technique also preserves timber resources, since no kiln is used. The use of soil for the construction of the lower parts of ecological latrines is well known in South America.
- A further project in Aguié (Niger) is also interesting in this respect, because the pits of the latrines are constructed with sun-dried bricks (two rows of bricks) with cement finishing coatings on the interior and exterior.
- Testing other ecological composting latrines. For these types of latrines the faeces are treated through the process of composting (not through dehydration). The composting latrines are sometimes below-ground pits (1 – 1.5 metres deep) (Arborloo / Fossa alterna).

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects represent weaknesses.

Table 1: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse[a]		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X				
• environmental and natural resources		X			X				
• technology and operation	X			X					
• finance and economics			X		X				
• socio-cultural and institutional	X			X					

[a] Not carried out yet

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

What have been the impacts of this project (compared to the objectives of the entire project)?
E.g. Success in raising awareness amongst humanitarian workers for sanitation issues and sustainable solutions?

13 Available documents and references

- Groupe URD (n.d.) Programme to support collective learning and improve the quality of the humanitarian response in Eastern Chad, http://www.urd.org/IMG/pdf/URD_Chad.pdf
- Groupe URD (2009) Urine diverting dehydration latrines in Eastern Chad, technical brief : an alternative to the pit latrine, http://www.urd.org/IMG/pdf/URD_-_Urine_diverting_dehydration_latrine.pdf
- OCHA (2009) Chad – mid-year review – consolidated appeal, United Nations, http://ochadms.unog.ch/quickplace/cap/main.nsf/h_Index/MYR_2009_Chad/$FILE/MYR_2009_Chad.doc?OpenElement
- OCHA (2009) Registered refugees camp population, http://ochaonline.un.org/OchaLinkClick.aspx?link=ocha&docId=1112458)
- Patinet, J. (2009) Sanitation in refugee and IDP camps and sites (as well as possible areas of return) in Chad: current and future challenges (Groupe URD), Session3: Implementing ecological sanitation in emergencies, 3rd Dry Toilet International Conference, Finland, http://www.huussi.net/tapahtumat/DT2009/pdf/Julie_Patinet.pdf
- Patinet, J., Mahamat Absakine, M. (2010) ETUDE d'opportunité pour l'assainissement écologique a l'est du Tchad (Opportunity study on ecological wastewater renovation in Eastern Chad), Groupe URD, soon online available in French at: www.urd.org)
- Productive sanitation in Aguié (Niger) (2009), http://www.ecosanres.org/aguie/english.htm
- République du Tchad, HCNE, MEE, ONU DAES, PNUD (2003) Schéma Directeur de l'Eau et de l'Assainissement (SDEA) du Tchad (Trend-setting agreement on water provision and sanitation), http://www.un.org/esa/sustdev/tech_coop/sdea/principal/
- Sokpoh, B., Collins, O., Patinet, J., Renaudin, B. (2010) Enjeux d'une transition: Rapport de l'Observatoire des pratiques de l'aide au Tchad (Transition challenge: monitoring report on practical aid in Chad), Groupe URD, http://www.urd.org/IMG/pdf/Enjeux_d_une_transition_juin_2010.pdf
- UNHCR (2010) Plan Stratégique pour l'approvisionnement en eau et l'assainissement au Tchad 2008 – 2010 (PSEA) (Strategic plan on water provision and sanitation in Chad between 2008 and 2010).

14 Institutions, organisations and contact persons

Julie Patinet, Researcher "WASH": *jpatinet@urd.org* What has been Julie's role in the project?
Groupe URD - Emergency, Rehabilitation, Development
Head office: La Fontaine des Marins
26170 Plaisians, France
Tel: + 33(0)4 75 28 29 35
www.urd.org

SECADEV details. What exactly was their role?

Other stakeholders' details?

Case study of SuSanA projects

Household pit latrines with urine diversion
Farchana refugee camp, Chad - draft

SuSanA 2011

Author: Julie Patinet (Groupe URD) (jpatinet@urd.org)

Editing and reviewing: Juliana Porsani (juporsani@gmail.com), Ase Johannessen (ase.johannessen@gmail.com), Elisabeth von Muench and Julia Seitz (GIZ, ecosan@giz.de)

Community-managed wastewater treatment system El-Moufty El-Kobra, Kafr El-Sheikh, Egypt

Fig. 1: Project location

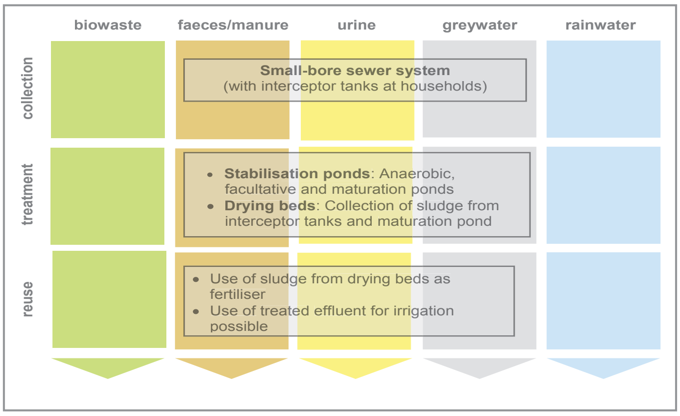


Fig. 2: Applied sanitation components in this project.

1 General data

Type of Project:
Pilot project for a community-managed wastewater treatment system with ponds in a Nile Delta village.

Project Period:
Project Start: April 2002
Start of construction: 2003
End of construction: February 2005
Start of operation: May 2005
Project end: December 2011 (operation ongoing)

Project Scale:
Number of inhabitants covered: 2,750 (design population: 4,500), 420 households (6.5 people per household), flowrate 316 m³/d
Total investment: approx. 300,000 EUR (109 EUR per capita; or 67 EUR per capita if plant was fully loaded as per design)

Address of Project Location:
Village of El-Moufty El-Kobra
Sidi Salem District
Kafr El-Sheikh Governorate (Northern Nile Delta)
Egypt

Planning Institution:
Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, contracting RODECO Consulting GmbH, Germany

Executing Institution:
Kafr El-Sheikh Water and Sewerage Company (KWSC), Egypt

Supporting Agency:
BMZ (German Federal Ministry of Economic Collaboration and Development) via GIZ

2 Objective and motivation of the project

The motivation of the project was to establish a decentralised wastewater treatment system that offers a simple solution to existing shortcomings and is cost-effective and efficient, hence allows self-management by the village community.

The overall goal of this GIZ "component" (which is part of a larger GIZ programme) was formulated as follows *"Hygienic, appropriate, low-cost wastewater disposal possibilities are accepted and applied by the population and the responsible institutions."*

3 Location and conditions

The project area is located in the middle part of the Nile Delta, close to the Mediterranean Sea. The Nile Delta makes up about two thirds of the total cultivated area in Egypt. The low annual average rainfall has necessitated the dependence on irrigation for agricultural production. To that end a dense network of irrigation and drainage channels, diverting water from the Nile to the Nile Delta for agricultural purposes, is in place. The topography of the Nile Delta is flat and there is a high groundwater table.

Fig. 3: The village Kafr El-Sheikh (source: H. Husselman, 2010)

In this area, small scale farmers form the majority, with about 50% owning less than 1 feddan (0.42 ha). Major cultivated crops are maize, rice, wheat, cotton and berseem (animal fodder). The population density[1] is high, around 1600 inhabi-

[1] The average population density worldwide is 50 persons per km² and measures as population per square kilometre of surface area.

tants per km², with a population growth of around 1.9% per year.

Fig. 4: Project location in the Nile Delta (source: GoogleMap, 2011).

In the Nile Delta, around 99% of the urban population have access to drinking water supply, in rural areas only about 96%. In contrast, the sewerage coverage is low and the hygienic conditions are of poor standards. In comparison to urban areas, where about 86% of the population are connected to a sewerage system, in rural areas only around 34% are connected. Very often wastewater is running on the streets.

Due to a missing sewer network, in many villages open trenches[2], sometimes starting inside the houses, are used for drainage which leads to groundwater contamination and pollution of drainage channels with wastewater. In many areas, shallow drain ditches are still used (see Fig. 5). Here, the sewage is directly discharged into the nearest drain without any treatment. In many cases, drainage water is used for irrigation purposes. Accordingly, health risks aroused.

The per capita water consumption in the pilot village of El-Moufty was quite low at 35 l/cap/d (prior to the intervention of the project) which generally indicates low hygienic standards. One reason amongst others was that villagers had to save water due to their unsolved wastewater management problems.

A connection to a central sewer system is generally not foreseen for smaller villages in Kafr El-Sheikh Governorate due to governmental budget constraints, amongst others.

The institutional and legal framework with regard to the protection of the Nile and the environment comprises of the following:

- Law 48/1982 (quality parameters for effluent) and Law 4/1995 concerning Pollution Protection of the River Nile and Water Channels
- Law 93/1962: Executive Regulations for Effluent Discharge
- Decree 9/1989
- Law 44/2000 (quality parameters for reuse)

Fig. 5: Wastewater in the streets of El-Moufty El-Kobra before the project in 2002, a common situation in the villages of the Nile Delta (source: GIZ; 2002).

The project village of El-Moufty El-Kobra in the Kafr El-Sheikh governorate has around 2750 inhabitants, of which approximately 90% are farmers with a relatively low income. There are three schools, three mosques, one health clinic and one youth club in the village.

4 Project history

The project was part of the GIZ component called "Decentralised Wastewater Management in the Governorate of Kafr El-Sheikh" (2001 to 2011) as part of the larger programme called "Water Supply and Wastewater Management"[3] which runs until 2017. During this period, a framework concept was developed, a pilot village selected, and the construction, implementation, and later replication of the project was initiated.

El-Moufty El-Kobra was chosen as a pilot project based on the following selection criteria:

- < 3,000 inhabitants (in 2002: only 1,000 to 1,500 inhabitants).
- Existing electricity and water connections.
- Availability of drain for the treated effluent.
- Readiness to establish a Community Development Association (CDA).
- Provision of land for pump station(s) and treatment plant by villagers.
- Agreement of households to pay a monthly fee for operation and maintenance of the wastewater system.
- Additional criteria applied:
  - Some channels are already existing in the village.
  - Provided land for the treatment plant must not be more than one kilometre away from the village.

The start-up phase was accompanied by the organisation of planning workshops and execution of detailed surveys. Technical solutions for decentralised systems and financial models for construction and operation with the participation of the

The average population in Egypt was 75 persons per km² in 2008. Source: United Nation's Demographic Yearbook 2008, URL: http://unstats.un.org/unsd/demographic/products/dyb/dybsets/2008%20DYB.pdf.

[2] Trenches = pit of rectangular shape 2-3 m in length, 1 m wide and 2 m deep; bottomless; lead to pollution in worst case when overflowing in drainage channels.

[3] For further information: http://www.gtz.de/en/weltweit/maghreb-naher-osten/aegypten/23074.htm.

community and the private sector were developed. In 2003, the final design report was presented, the tendering process conducted and a Community Development Association[4] (CDA) established. The construction, electrical connection and commissioning were completed in February 2005. In May 2005, the Operation and Maintenance (O&M) contract started.

Within the following 'Water Supply and Wastewater Management' (2005 – 2011) programme the project is continued and monitored. Advice is still given where necessary, especially for strengthening the partner organisation, the Kafr El-Sheikh Water and Sewerage Company (KWSC). Furthermore, surveys for the identification of further villages, suitable for such a decentralised approach, were conducted.

During the whole project period, several awareness campaigns and trainings for O&M have been carried out. The performance of the system is good.

The village of El-Moufty was selected as a pilot and replication of the model in other villages was planned and undertaken (see Section 11).

5 Technologies applied

A simple and cost-effective wastewater treatment system (Fig. 6) was chosen in order to allow for self-management of the village community. A **Small-bore sewer**[5] system and a treatment plant have been installed. In contrast to the conventional sewer system, here an **interceptor tank** is installed between the connected houses and the sewerage line, which is connected to the treatment and disposal network. Most of the households in the village now use flush toilets (still to be determined if this applies to all households and what toilets were used before the intervention).

In the interceptor tanks, solids like grit and grease are collected in order to avoid blockage in the sewerage line. The liquids, which often have the highest pollution potential, are discharged into the wastewater. Part of the anaerobic digestion is taking place already in these tanks.

Several households are connected to one interceptor tank. For this system, no changes were necessary in the squatting toilets and wastewater pipe network of houses. The interceptor tanks have to be cleaned out every six months. The liquids are transported through sewers to a pumping station (Fig. 7) that is connected to the treatment plant. The pumping station consists of two alternatively operating submersible high pressure pumps with a standby generator.

[4] The Community Development Association functions as a local non-governmental organisation. It is in charge of managing, operating and maintaining the wastewater system for the village community.

[5] A small bore sewer is a solids-free sewer. A network of small-diameter pipes that transports solids-free or pre-settled wastewater (such as the effluent from septic tank or biogas settlers). As solids are removed, the diameter of the sewers can be much smaller than for conventional sewers and they can be constructed using less conservative design criteria (lower gradients, fewer pumps, reduced pipe depth, etc.) resulting in significantly lower investment costs. (see also: http://www.sswm.info/category/implementation-tools/wastewater-collection/hardware/sewers/solids-free-sewers)

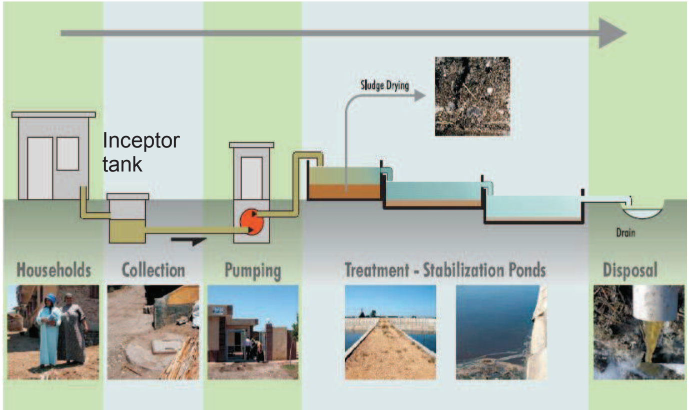


Fig. 6: Schematic of the rural sanitation system, with a Small Bore Sewer System connected to a pond system for treatment (source: GIZ; 2006).

Fig. 7: Pumping station of El-Moufty El-Kobra. On the right picture: Head of the CDA (source: N. Stuber; 2010).

The **treatment plant** consists of 2x3 stabilisation ponds (Fig. 8). The first stabilisation pond is for anaerobic processes (not covered), the second for facultative treatment, and the third for maturation (for details regarding this technique see also Tilley et al., 2008). The first two ponds reduce organic matter content, measured as biological oxygen demand (BOD), the maturation pond reduces pathogens. No information is available on the daily quantity of effluent.

Fig. 8: Treatment plant of Moufty El-Kobra, with the three stabilisation ponds. In the forefront, the sludge drying bed is seen (source: N. Stuber; 2010).

The solids collected in the interceptor tanks and the sludge of the anaerobic ponds are deposited in four **drying beds** (Fig. 8). A routine in desludging the interceptors as well as the anaerobic ponds does not exist (for details see Chapter 11).

6 Design information

The wastewater system is designed for a period of 20 years, taking into consideration population growth, thus the design population is 4,500 (population at start of project in 2002: 2,750 citizens).

The following design data gives an overview on the design:

- Interceptor tanks: round tanks with a capacity of 1.25 m³
- Diameters of the sewers: 100 to 250 mm
- Length of sewers: approx. 9 km
- Distance of pumping station to treatment plant: 700 m
- Sewage discharged per day: approx. 200 m^3
- Nominal capacity of plant: 450 m^3 per day
- Total surface used by the plant: 6,000 m^2. This means an area of 2.2/4.8 m²/EP (calculated with 2,750/1,250 persons)

Dimensions of the stabilisation ponds:

- Anaerobic pond: mid-depth area 970 m^2; depth 5 m,
- Facultative pond: area 2,070 m^2; depth 1.5 m,
- Maturation pond: area 1,490 m^2; depth 1.5 m.

The sludge has to remain for 5 years in the anaerobic ponds to be stable, according to Egyptian standards. Sludge removal is therefore done once in 5-6 years.

7 Type and level of reuse

By treating the wastewater, organic matter and obtained nutrients which are collected in the sludge, could be reused after a certain resting time in the drying beds.

Nitrogen and phosphorus contained in the wastewater are not removed in the ponds, and are thus still contained in the treated wastewater. This can actually be an advantage if the treated wastewater was used for irrigation purposes. Currently, the treated wastewater is discharged into a nearby drainage channel from which it is partly reused for irrigation purposes (to be confirmed).

At the beginning of the project, the quality of the final effluent from the treatment plant met the codes of the Egyptian Standard (Law 48/1982, see Table 1). It was even better than the water quality in the drain (The water in the drains comes from the irrigated fields which are equipped with a drainage system to avoid capillary rise). However, some households dumped animal faeces into the system, and as a result of this misuse, the effluent quality does not comply with the Egyptian Standards anymore (no measured values available).

The low quantities of sludge from the stabilisation ponds do not allow large scale use, but the O&M contractor uses it on his private land for agricultural purposes.

Table 1: Performance of wastewater treatment in stabilisation pond system.[6]

Criteria	Inlet	Outlet	Egyptian standard for effluent quality
Suspended solids (mg/l)	152	21	<60
COD (mg/l)	782	40	<100
BOD_5 (mg/l)	450	28	<60
Total coliforms	$1.5x10^{12}$	$2.6x10^2$	$<5x10^3$
Nematode eggs	no data	2 eggs /100 ml	<5 eggs /100 ml

8 Further project components

Most important factor was the community based approach and thus the participation of the population in each step. In this regard a community development association (CDA) was established in order to represent the community and to assure a legal framework for the collection of fees for the wastewater services. The CDA board meets weekly or at least monthly to discuss project affairs. Women are encouraged to participate. Capacity building courses on finance, administration and management topics have been carried out. The responsible persons for the operation and maintenance (O&M), contracted by the CDA, received on-the-job training, and were trained on the development of an operational manual, record keeping and basic report writing skills.

The public company KWSC (Kafr El-Sheikh Water and Sewerage Company) was strengthened and support has been provided by GIZ for capacity development in order to be able to provide advice with respect to design and O&M of decentralised systems.

Awareness raising campaigns in local schools and mosques made up important parts of the project. It comprised topics like

- Objective of the project and role of the villagers and other stakeholders,
- Health promotion trainings for women,
- Water pollution and water borne diseases,
- Environmental sanitation and protection,
- Personal hygiene,
- Solid waste management.

Furthermore, the project team gave support and advice to relevant authorities, e.g. regarding stopping the application of groundwater lowering systems.

9 Costs and economics

The investment costs (Table 2) are relatively low compared to other systems (around 300,000 EUR), but still too high to be financed by the community alone. 10% of the capital costs were financed by the community (as by provision of land), the remaining investment costs for planning, design and construction were supplied by GIZ. A split of the investment costs between infrastructure and labour is not available.

[6] Date of measurement and number of samples is unknown.

Taking the design population into account, the construction costs for the small bore sewer system were 38 EUR/cap (267 LE[7]/cap), and for the wastewater stabilisation ponds around 31 EUR/cap (220 LE/cap). Taking the village size at the time of the construction into account (i.e. less population), the construction costs of the sewer system and stabilisation ponds were approx. 110 EUR/cap. At project start, each household was supposed to pay around 100 EUR mainly for the provision of land (amounting to approx. 40,000 EUR). Furthermore, each household had to pay the connection to the interceptor tank or sewer network. How much each household paid is not known anymore.

Operating costs are totally covered by the villagers. The CDA collects a monthly fee from each household. This tariff covers costs of O&M (around 0.6 EUR) and reinvestments (future expenditures). The O&M costs include staff, transport, maintenance, repairs as well as solid waste collection. The households have to pay a flat rate of around **1 EUR per month**. For people with little or no financial means the tariff differs (e.g. social tariff) and is defined by the CDA in a case by case approach (no information is available on details). If full cost recovery of the system was required, the households would have to pay around 3 EUR per month.

The fee is collected every six months. The person in charge of money collection receives 7% of the sum as salary. The CDA is responsible for managing the assets and the collected fees in a profitable way. Fig. 9 shows the collected, disbursed and surplus money from 2006 to 2009.

The Ministry of Social Insurance and Social Affairs supervises the financial flows of the CDA and gives advice. The KWSC is paying the electricity bill (to be checked).

Table 2: Investment and operation costs of the wastewater treatment system of El-Moufty El-Kobra.

Total investment cost*	300,000 EUR
Investment cost per capita	60 EUR
Operating cost (monthly)	ca. 214 EUR
Monthly fee/household	1 EUR

*: 49% was cost for sewer system (is the approximate length of sewer pipes known?), 51% cost for treatment station, pumping station and force main. Costs for land are not included.

Before the implementation of the project, the trenches had to be emptied twice a month, for a cost of around 5.30 EUR per month per household. Thus, the operation of the new system is cheaper.

Recently, the costs for similar treatment systems increased enormously. The reasons are unknown, but it can be assumed that inflation plays a role as well as lacking interest of construction companies in such small size contracts (and hence raise the prices so to make it attractive to them). Also, the fact that the World Bank is going to finance some of the projects is assumed to raise prices.

[7] LE = Egyptian Pound; 2006 cost reference. The average monthly salary of a family in Moufty El-Kobra is approximately 200 to 250 LE. 1 EUR ~ 7 LE.

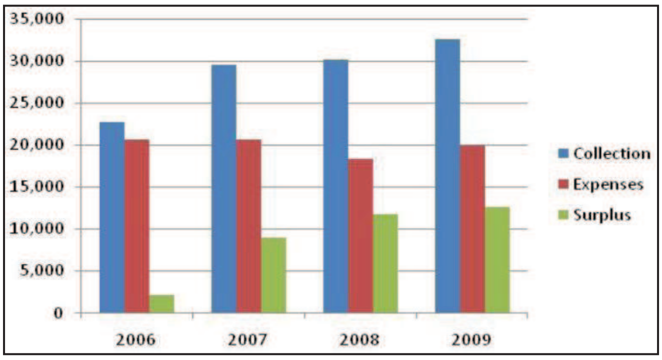
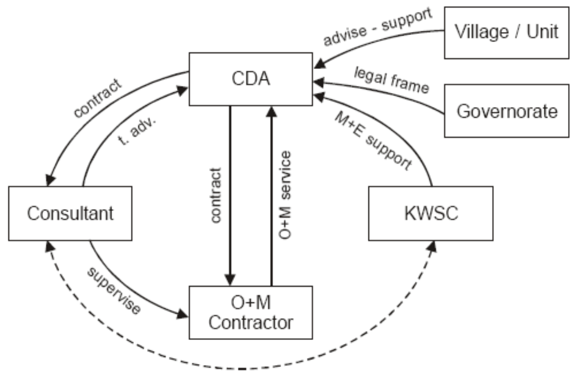


Fig. 9: Money collection, expenses and surplus (in Egyptian Pound) of the CDA of El-Moufty El-Kobra (source: GIZ; 2010).

10 Operation and maintenance

Operation and management is in the responsibility of the CDA. Responsibilities are (theoretically) clearly defined. The applied management system is shown in Fig. 10.



FUNCTION	STAKEHOLDER IN CHARGE
Principal service provider / project manager	Community Development Association (CDA)
Operation & Maintenance	O&M Operator (Contractor from private sector)
Work supervision & technical advise	Consultant (private sector)
Overall supervision and monitoring	KWSC
Provision of legal framework	Governor's office
Support in management and legal enforcement	Village Unit

Fig. 10: Applied management system, key stakeholders and functions (GIZ, 2007). Dashed line between consultant and KWSC means that the actual contract is between them, but the CDA is officially the main contract partner of the consultant.

The CDA leads the central role as community agent, service provider and project manager. It is responsible for the selection and employment of an O&M contractor and can purchase necessary material. The contracting of the O&M service provider during the project phase was supervised by the consultant. The Local Village Unit (LVU[8]) and the consultant provide the CDA with (technical) advice and support. The contractor received on-the-job training and an O&M manual.

The KWSC, in general, is responsible for water and wastewater service provision in the governorate, and is the executing

[8] Local Village Unit: administrative body that represents the governorate for a group of villages.

institution of the project. The role of the KWSC for the wastewater system in El-Moufty El-Kobra is monitoring and provision of advice, and they are responsible for regular inspections, as well as for the tendering procedure. Within the project a reporting and monitoring system was established. What is more, KWSC is foreseen to take over the role of the leading external support agency (i.e. GIZ) after its exit.

On the national level, the Holding Company for Water and Wastewater (HCWW – state-owned company belonging to the Ministry of Housing, Utilities and Urban Development) has the overall responsibility for water and wastewater, it coordinates and supervises water and wastewater companies at governmental level, like the KWSC. It has to monitor and supervise the O&M, as well as give technical support if requested.

11 Practical experience and lessons learnt

The approach is highly participatory through the community based approach and the involvement of the villagers through the CDA, the Local Village Unit, the private sector entrepreneur, and the KWSC in planning and decision making from the beginning of the project. For future projects it is important to stress that the villages themselves (the CDA of a village) have to request a wastewater system. This was not the case in this pilot system. Here, the village was selected on a higher level and then people were asked if they are willing to participate.

In general, the villagers are satisfied with the involvement and project planning. Through the formation of the CDA the villagers were empowered, including women. Due to great participation, villagers developed a sense of ownership and a feeling of responsibility towards the sanitation system. Awareness campaigns were essential and have shown promising results with greater understanding with regard to sanitation and environmental issues.

Due to the simple technology chosen and the simple O&M, the CDA was able to easily contract a private service provider for this task. For a successful O&M it is important that the O&M contractor is from the village and accepted by the villagers. He must have knowledge about the village, can be held accountable and has a strong feeling of commitment. This guarantees a higher level of sustainability and effectiveness of the system.

Furthermore, the payment by the community members for such a system is very crucial to gain ownership and to sustain the system in the future. Through the supervision of the financial transactions of the CDA by the Ministry of Social Insurance and Social Affairs, transparency and accountability should be assured.

In summary, the main lessons learnt and conditions for similar projects are the:

- Importance of demand driven approach and agreement on terms of cooperation,
- Creation of ownership, responsibility and accountability,
- Involvement of all relevant stakeholders,
- Sharing of financial responsibility from the beginning of the project.

The monthly fee for the services is within the willingness to pay. Some villagers stated that they even would pay a higher price, if a good and trouble free sewerage system was provided. However, others state that they are not willing or, what is more, not able to pay higher fees. In this regard, future project planning must consider how to allow higher fees in order to gain a cost recovery of the construction investment costs, what is not yet the case.

The responsibility and willingness of the CDA to use the revenues of the collected fees effectively has to be improved. The revenues should be invested by the CDA whenever needed (e.g. for damages, measurements, etc.). This responsibility is not fully developed yet. For the time being, the CDA still expects monitoring and technical support by GIZ when required.

Currently, misuse of the system is a challenge. Animal husbandry (animals living within the households/farms) is very common in the village. As some villagers loaded animal faeces in the system, several problems arose. Firstly, the water quality of the effluent decreased, and was not anymore in accordance with the Egyptian Standards of Law 48/1982. The Ministry of Health is conducting water analyses and is seeking to punish the violator or the respective responsible body (which is the CDA, as being responsible for the management). Punishments include fines or even jail sentences, depending on the violating act.

However, newer surveys in May 2011 showed that the misuse by disposal of stable-wash water (manure pollution) was tremendously reduced (almost nil). However, it was discovered that industrial wastewater is causing a new conflict of interest. A milk-lab (= yoghurt and local cheese maker) is discharging wastewater with a very low pH into the system, which made the system/ponds almost septic. Also, a huge backlog of maintenance on interceptors and treatment plant is contributing to the low effluent quality (For some maintenance heavy equipment needs to be rent, therefore, the O&M contractor postpones maintenance as this costs him additional money). Desludging of the milk-lab interceptor and anaerobic pond already improved the quality of the effluent. The CDA is reluctant to disconnect the milk-lab due to conflict of interest as the CDA chairman is a relative of milk-lab owner.

The villagers are expected to have a clear regulation in the future, on how to take legal actions against those abusing the system. A linkage to the Local Village Unit, which can take legal actions, should be improved in order to make it easier for the CDA to report to them. The CDA demands more support by the KWSC in monitoring and advice, and in conducting analyses. The project team in cooperation with the villagers is in the process of identifying solutions to improve the effluent quality. It needs to be a feasible technical solution. One proposal by the villagers is to collect the animal waste in separate containers, which some villager already do.

With regard to the KWSC, its interest and commitment to the project remains a challenge. As the KWSC does not receive any financial benefits, given that the community-based approach is in the hands of the village community, the interest in the project is low. Furthermore, experience and management capacities are lacking for a responsible and sustainable infrastructure management. Trust is lacking between the CDA and the KWSC.

A disadvantage of the chosen simple treatment system, i.e. ponds, is the requirement of relatively large areas which could otherwise be used for farming. As more and more agricultural land is lost due to urbanisation, this fact should not be neglected.

Table 3: Similar community-managed wastewater treatment systems with ponds, operational and in planning, in the governorate of Kafr El-Sheikh with support of GIZ (source: http://wwmpegypt.com/43.html, 2011).

Village	District	Type of Wastewater System	Present Population (capita)	Source of Funding	Comments
El Moufty	Sidi Salem	Small bore sewer	3,779	GTZ	operational since 2005
Om Sen	El Reyad	Shallow sewer	4,848	SFD	operational since 2007
Koleaah	El Hamoul	Shallow sewer	1,517	SFD	operational since 2009
Om Shour	El Hamoul	Coventional	3,800	Egyptian gov.	operational by April 2011
Handakokha	El Hamoul	Conventional	2,249	Egyptian gov	operational by Dec. 2010
Kafr El Gedid	Kafr El Sheikh	Conventional	4,396	Egyptian gov.	operational by Jan. 2011
Kouzman	Keleen	Conventioanl	5,158	Egyptian gov.	operational by Jan. 2011
Kheregin 3 - El Fayrouz	El Reyad	Small bore sewer	3,400	WB	being tendered
Kheregin 5 - Om El Koraa	El Reyad	Small bore sewer	3,500	WB	being tendered
Kheregin 6 - El Kadesaya	El Reyad	Small bore sewer	2,000	WB	being tendered

The pilot village and its system, which is unique in Egypt, serve as a model in the governorate for upscaling this concept of simple community-managed wastewater treatment plants. Since the start of the operation in 2005 it provided around-the-clock service. In two other villages, construction of similar wastewater treatment systems have been completed, and systems in four further villages are currently under construction. For another five villages, designs have been completed. Funds are provided by the World Bank and the Egyptian government (Table 3).

After the departure of the GIZ-funded project staff in December 2011, the wastewater treatment system and the established structures with the CDA, O&M contractor and other stakeholders should be strong enough to continue the system in a sustainable manner.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 4) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects are not emphasised (weaknesses).

Remarks on the assessment:
Health and hygiene: Stabilisation ponds are marked "0" as sometimes there is odour from the ponds. The distance of ponds to houses is approx. 1 km.
Transport and reuse: Marked "0" as depending on the weather and possible misuse of the system the quality of the effluent into the drain may vary.
Environmental and natural resources: Sewer network and stabilisation ponds are marked "0" due to the construction materials and flush water used, especially the PVC pipes (effluent is directed in an existing drain, no materials used.)
Technology and operation: Marked "0" for sewer network: A small bore sewer system approach has been used and so pipelaying needs to be quite accurate to ensure proper slopes and sufficient flow rate. Small mistakes can have quite some influence.

Finance and economics, socio-cultural and institutional: no comments.

Table 4: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project ("+" means: strong point of project; "o" means: average strength for this aspect and "–" means: no emphasis on this aspect for this project).

	collection and transport*			treatment **			transport and reuse***		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X			X	
• environmental and natural resources		X			X		X		
• technology and operation		X		X			X		
• finance and economics	X			X			X		
• socio-cultural and institutional	X			X				X	

* sewer system ** stabilisation ponds *** effluent reuse (currently not taking place or not in a controlled manner)

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

With regards to long-term impacts of the project, the main impact of the project is improved community hygiene through a wastewater treatment system based on a community approach. Before the project, there was no wastewater management in the village. In comparison to the traditionally used wastewater trenches, the new system reduces health risks significantly. No wastewater is found in the streets of the village anymore.

Another positive development is that households now can use washing machines due to the connection to a sewerage system. This relieves burdens especially from the women, who before had to do their washing at the closest water source (river or channel). The water consumption has increased from around 35 l/person*d to 68 l/person*d, which implies higher hygiene standards.

Awareness about health and environmental issues was lacking before the start of the project. Through the awareness campaigns, knowledge about water related diseases, hygienic and environmental aspects improved. People now are trying harder to keep the environment clean. One example is that the village started with the collection of solid waste. In general, with the CDA the people now have an institution through which they can communicate their demands.

13 Available documents and references

- Rodeco & Aldar (2003). Sludge collection. Treatment and Disposal/ -Reuse. – Mission Report.
- GIZ (2003). Appropriate wastewater management in the Governorate of Kafr El-Sheikh. The potential for resource recovery and reuse and appropriate technical sanitation options. Report.
- GIZ (2004). Project Progress Report of the Adapted Wastewater Disposal Schemes in the Governorate of Kafr El-Sheikh Project.
- Duncan, M. (2005). Review of the Decentralised Sanitation Project in Kaft El-Sheikh Governorate, Egypt. Mission Report. URL: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1368
- GIZ (2007). Decentralised Wastewater Management in Kafr El-Sheikh Governorate, Egypt. El-Moufty El-Kobra Pilot Concept & Lessons Learnt. URL: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1369
- GIZ (2008). Project Progress Review of the Decentralised Wastewater Management Project in the Governorate of Kafr El-Sheikh.
- Tilley, E., Lüthi, C., Morel, A., Zurbrügg, C., Schertenleib, R. (2008). Compendium of sanitation systems and technologies. Swiss Federal Institute of Aquatic Science and Technology (EAWAG). Duebendorf, Switzerland. URL: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=454
- Eisele, T. (2011). Difficulties in implementing decentralised sanitation systems in Egypt exemplified through the “GTZ model”. Master Thesis, Faculty of Graduate Studies, University of Jordan and Institute for Technology and Resources Management in the Tropics and Subtropics (ITT), Cologne University of Applied Sciences, Germany. http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1361

Internet: http://wwmpegypt.com/43.html

14 Institutions, organisations and contact persons

Kafr El-Sheikh Water and Sewerage Company (KWSC) (Executing Authority)
Kafr El-Sheikh, Egypt
E: info@kwsc.com.eg

Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (supporting organisation)
Hans Werner Theisen (Programme Manager until Dec 2011, followed by Ernst Döring from Jan. 2012 onwards)
Located at:
Water Supply and Wastewater Management (WWM)
Holding Company for Water and Wastewater (HCWW)
Corniche El Nile, Water treatment plant Rod El Farag
Cairo, Egypt
T: +20 22459 8405
F: +20 22459 8411
E: hans-werner.theisen@giz.de or ernst.doering@giz.de
I: www.giz.de

RODECO Consulting GmbH (Planning institution)
Johan Husselman and Magda Riad
Hindenburgring 18
D-61348 Bad Homburg
Germany
T: +49 (61 72) 68 17 – 0
F: +49 (61 72) 2 57 48
E: johan.husselman@rodeco.de
I: www.rodeco.de

Case study of SuSanA projects
Community-managed wastewater treatment system, El-Moufty El-Kobra, Kafr El-Sheikh, Egypt
SuSanA 2012
Authors: Nicole Stuber (formerly GIZ), Magda Riad, Hans Husselman, Friedrich Fahrlaender (all three RODECO)
Editing and reviewing: Martina Winker, Elisabeth von Muench, Tina Eisele (all GIZ, ecosan@giz.de)

Urine-diverting dry toilets at Adama University Adama, Ethiopia (draft)

Fig. 1: Project location

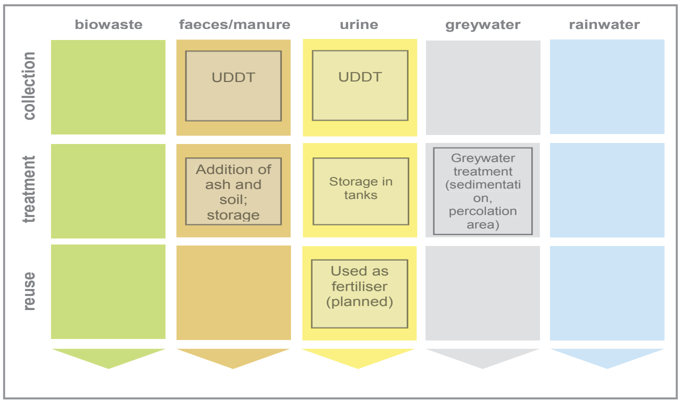


Fig. 2: Applied sanitation components in this project (UDDT stands for urine-diverting dry toilet).

1 General data

Type of project:
Urine-diverting dry toilets (UDDTs) at Adama University, Ethiopia (pilot scale)

Project period:

Start of planning:	2008
Start of construction:	June 2009
End of construction:	June 2010
Start of operation:	June 2010

Project scale:
Size: Toilet block with 24 UDDTs and 6 urinals (designed for 400 users)
Number of current users: approx. 80 staff members, 400 male urinal users
Estimated total investment cost (in EUR): 21,600

Planning institutions:
University Capacity Building Program (UCBP)
GIZ International Services Ethiopia
Adama University, Ethiopia

Executing institution:
GIZ International Services, Ethiopia
OtterWasser GmbH, Germany

Supporting agency:
None (Ethiopian government)

2 Objective and motivation of the project

The Urine-diverting dry Toilet (UDDT) is a sanitation option which has proven to be waterless, odourless and affordable and can be suitable for implementation at the institutional level.

A major challenge for most Ethiopian universities is the insufficient water supply and the situation at AU is no exception.

Based on this, the University Capacity Building Programme (UCBP), Ethiopia with the support of GIZ International Services (formerly, GTZ International Services) in Ethiopia and OtterWasser GmbH, designed, funded and constructed a UDDT complex for some(but not all) staff and students at AU in Ethiopia.

Fig. 3: The UDDT blocks showing the male (left) and female (right) blocks at Adama University, Ethiopia. **(**source: K. Misganaw, 2010)

The fact that UDDTs are waterless makes them a possible solution to both the toilet and water supply problem. The project is aimed to demonstrate a sustainable sanitation solution. It aimed to create awareness among students, staff and other stakeholders for sustainable, hygienic and economical types of toilets that do not use water for flushing.

3 Location and conditions

Adama is one of the largest cities in Ethiopia located right above the Rift Valley, about 100 km southeast of the capital, Addis Ababa.

The Adama University (AU) is located on the eastern slopes of the hills of the valley town Nazareth, 96 km southeast of the capital. The campus is spread over 60 acres of land with the main building located in the centre and a population of more than 13,000 students.

In Adama University (AU), accommodation facilities (hostels and halls) on campus have toilet facilities for students. Furthermore, lecture rooms and libraries are not equipped with toilet facilities for students, and thus, there is the demand from students for toilets especially during teaching sessions.

The UDDT block is located at the south-western part of the university campus, close to the faculty buildings, which is one of the future main traffic areas in the university. This is to help adapt to the insufficient water supply problem and provide students and staff with a decent toilet facility.

4 Project history

The project is part of the University Capacity Building Programme (UCBP) in Ethiopia. The planning of the project with the various project partners began in 2008. The project started as a pilot-scale demonstration unit in June 2009 and was completed and commissioned within a year.
GIZ was responsible for construction and handed the block over in mid 2009 to AU facility management who is responsible for operation and maintenance.

5 Technologies applied

The technology of UDDTs is based on the separation of urine, faeces and greywater into three different flowstreams, and where water is used for anal cleansing, a fourth flowstream is considered This is to enable the proper and separate management of each flowstream, treatment and possible reuse. It usually has two outlets – one for faecal matter and the other for urine. These facilitate the separation of liquids (urine, grey water) from the solids (faecal matter) and therefore enable the toilet to operate without using water to flush excreta. The system also can produce fertilizer from the excreta for agricultural use. Fig. 4 shows a basic schema of the UDDTs.

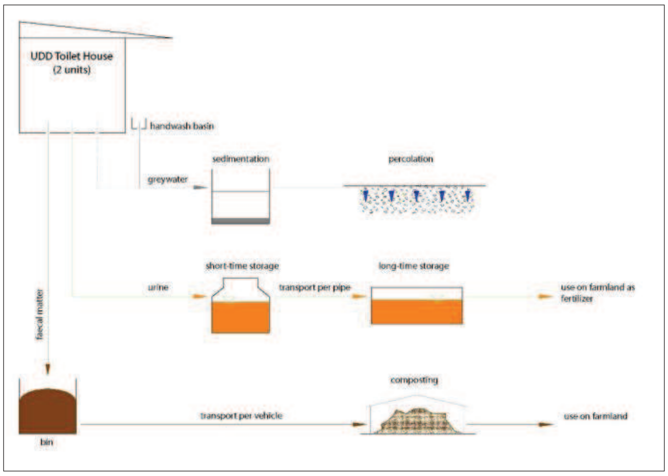


Fig. 4: Design of the UDDT system (source: Oldenburg et al. (2009)).

Compared to conventional toilets, investment costs are more than 30% lesser and about 10% reduction in operating costs (Oldenburg et al, 2009).

6 Design information

Two locations are required for successful operation of the UDDT. First, the toilet building itself which in this case is sited between the faculty buildings on AU campus for easy accessibility. Secondly, the treatment site off-campus in the southern part of the compound, where long term urine storage and composting takes place.

The design of the UDDT complex as with toilet facilities is made up of a super-structure and a substructure.

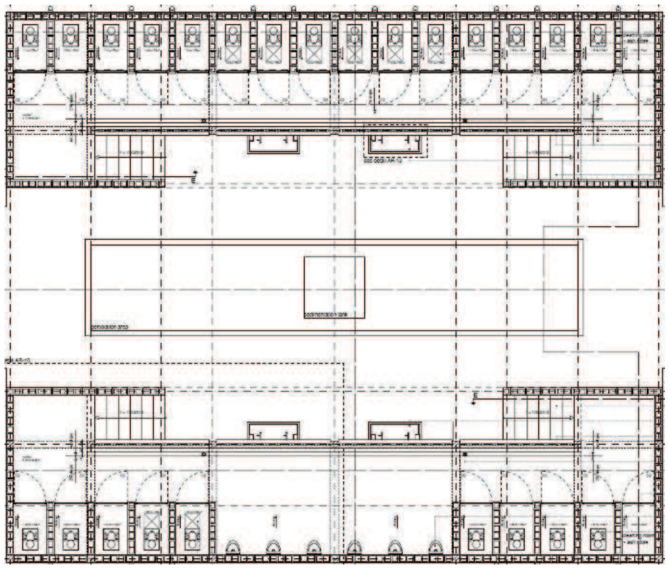


Fig. 5: The floor plan of the UDDTs complex. Top: female section; Bottom: male section (Source: GTZ-IS (2008)

The super-structure:
The super structure of the UDDT complex is constructed which cement blocks and similar to conventional public toilets with two blocks with toilet rooms – one for males and the other for females. The female block has 15 toilet rooms whiles male block has 9 toilet rooms and 6 waterless urinals (see fig. 5). The toilets have two entrances raised approximately 1m above the ground and therefore connected with stairs.

Good ventilation system is critical for this type of toilet construction and this was well considered in this case. Large vent pipes are positioned at the back of the toilet buildings (as can be seen in fig. 6). The 110mm PVC vent pipes extend above the roof in the chamber to aerate the toilet cubicles. This helps to avoid the generation of odours from the toilets. In addition there a sizable windows at the back of each unit block which improves ventilation and lightens the toilet cubicles.

The sub-structure:
The toilet rooms are equipped with urine diversion squatting pans which have two outlets as required of UDDTs: a larger one at the back for the faeces and a smaller one in front for the urine (see fig. 7) to enable separation of the urine from the faeces. Furthermore, this type of toilet is considered as more

hygienic and well suited for public facilities. These urine diversion toilets have been produced in Ethiopia as well.

Fig. 6: Back view of the UDDT block showing vent pipes and doors to faeces vaults, Ethiopia. (source: K. Sintayehu (2010))

Six toilets in the female block and 2 units in the male section are equipped with a third outlet in front (as shown in fig. 6). This outlet is meant for people who use water for anal cleansing due to religious beliefs or other reasons (e.g. Muslims). Basins for hand-washing are installed in front of both the male and female buildings.

Faecal matter is collected into 120 L bins which are placed underneath each toilet cubicle (see Fig. 7). Urine on the other hand is collected into 2 temporary storage 2 m^3 tanks – one for each block. From the 2 tanks the urine is goes to another set of storage tanks (8 tanks each 5 m^3 capacity).

Fig. 7: Urine diversion squatting pans which an extra outlet in front for anal cleansing with water. (source: K. Sintayehu (2010)).

7 Type and level of reuse

It is recommended that users add dry material (ash, soil or compost) to the vaults after defecation. This added material covers the faecal material and prevents odour. The reduction of the moisture content additionally avoids the accumulation of flies or other insects and vermin.

Both faecal matter and urine could be used as fertilisers in agricultural production. However at the moment both faecal matter and urine are simply disposed off in an existing oxidation pond.

Some of the urine collected is applied as fertiliser to a papaya plantation on the university campus. The papaya plantation is close to the UDDT facility.

There are some ideas for the application of the urine in cooperation with local authorities (agricultural research centre, agricultural department, farmers, etc.). This is based on first analytical results of measuring the nitrogen content in urine. The use of urine has shown approximately 38% more yield than the use of artificial fertiliser (the expectation would be same yield).

According to *AUdacious News* (2011), reutilisation of toilet wastes combined with greywater treatment at the AU site aims to show alternative solutions for sanitation and create awareness amongst students and other stakeholders for sustainable, hygienic and economical sanitation systems that use less water. The excreta from the dry toilets can be properly treated to be fertilizers and this was proven by the practical operation undertaken at the AU demonstration site.

8 Further project components

Awareness raising campaigns:
These should have been undertaken before the construction of UDDT was completed and ready for use. This is to ensure that the diffident groups of users are made aware of the proper use and operation of the UDDT facility. By so doing, students and staff are introduced to sustainable sanitation concept

It is not clear if such awareness raising campaigns actually took place.

9 Costs and economics

The costs for constructing the UDDTs were 21, 600 EUR.

The total cost of operating and maintaining the UDDT facility is estimated at 954 EUR (approx. 15, 180 ETB) annually. The cost elements in the operation and maintenance are labour, transportation and material costs. The bulk of this is labour cost which includes the cost for three for the operation and maintenance of the facility (cleaning staff). The cost for routine operation and maintenance works for the project is summarised in Table 1 below.

Table 1: Summary of all cost for O&M for one year (Source: Oldenburg et al. (2009)

Item	Unit	Quantity	Unit Price (EUR)[1]	Total cost (EUR)[1]
Vim	pcs	52	0.75	39
Mop	"	4	1.89	7.56
Broom	"	4	0.38	1.52
Toilet soap	"	208	0.16	33.28
Powder soap	"	12	0.16	1.92
Tissue paper	"	20	0.19	3.8
Pens	"	4	0.09	0.36
Registration book	"	2	1.13	2.26
Towel	"	4	0.63	2.52
Flit	pcs	8	1.57	12.56
Abu Jedi	Mt	12	0.63	7.56
Rag	Kg	1	0.44	0.44
Sponge	pcs	8	0.25	2
Gloves	pcs	4	0.44	1.76
Boots	"	1	3.77	3.77
Mask for nose and mouth	"	2	1.57	3.14
Uniform	"	3	7.54	22.62
Ash Bucket	"	2	1.57	3.14
Ash cup	"	2	0.13	0.26
Shovel	"	2	2.5	5
Spade	"	2	2.5	5
Hoe	"	1	2.5	2.5
Fork	"	1	2.5	2.5
Bucket for anal washers	"	2	1.57	3.14
Water jar for anal washers	"	2	0.16	0.32
Fibre Brush	"	4	0.75	3
Sanitary pad collecting basket	"	2	0.94	1.88
Spider removing mob	"	2	0.75	1.5
Wire brush	"	2	0.94	1.88
Plastic rope for tying bins	"	20	0.13	2.6
Total				179
Contingency (5%)				9
Labour cost				603
Transportation cost				163
Total				**954**

10 Operation and maintenance

The management of AU is in charge of the operation and maintenance of the constructed UDDT facility. Technical and/or administrative issues are handled and supervised exclusively by AU. The management is supposed to ensure efficient and economical maintenance and smooth operation of the facility. In doing so it must make sure that the caretaker and cleaners are efficient and responsive.

Efforts to maintain the UDDTS include recruiting caretaker (male) and 2 women as cleaning staff. Instructions and task list for the caretaker and cleaning staff are provided in English and Amharic (national language of Ethiopia). There are also posters indication the “dos and don’ts” for the users.

At the moment, the UDDTs are only used by university staff members. On average 80 persons use the toilet rooms each day. Students are restricted to use the toilets because of limited technical and administrative capability to manage the mass use. However about 400 students use the urinal facilities. As a pilot scale project, the UDDT was not meant to be used by all students and hence they (both the male and female students) do not rely on it.

Cleaning and Maintenance:
There has been a conscious effort to keep the toilet clean and odourless. This is because the cleaning staff regularly clean the toilets. Some other activities undertaken by the cleaning staff to ensure the cleanliness of the UDDT include dehydration, odour and fly control and disposal of anal cleansing materials.

Common problems observed during the usage of the system:

- Blockage of urinal pipes as a result of ammonia formation by the urine. This problem can be solved by regular cleaning and flushing of the pipes with by water.
- Sometimes out of negligence or the lack of knowledge some water is added to the faecal matter. This sometimes can result in bad smell from UDDTs because of the mixing of water with the sludge. The provision of proper instructions will help inform users and thus will reduce the occurrence of this situation.

Fig. 8: The urinals of the UDDT facility at AU (source: K. M. Sintayehu, 2010).

Collection and treatment of excreta:
Faecal matter is collected in bins which are replaced in specified intervals or when they are full. The empty bins are lined with organic material (e.g. compost) at the bottom to absorb the liquid from the faeces.

The filled bins will be transported to the treatment site and together with the added material (ash, soil or compost) and organic bio waste from other sources (kitchen, gardening etc.). It will then be composted at the composting site (which

[1] Costs have been converted to Euros with 2009 average exchange rate of 1 ETB = 0.063 EUR (computed with data from www.gocurrency.com/v2/historic-exchange-rates.php)

is approximately 300 m from the toilet building) and possibly reused. After emptying, the bins are cleaned and prepared for the next cycle. The faecal matter is stored for approximately 6-12 months in the composting ditches to convert organic material into compost before use at the university site.

Urine from the UDDTs and the urinals is transported through a pipe to a collection tank near the building. The transporting pipe is designed to have a larger diameter than necessary because precipitation may occur in the urine which can block a smaller pipe. The urine is stored in a short-term tank close to the UDDT building which is connected to the long-term storage tank located near the treatment site via another pipe to enable the urine to flow by gravity. The connection is controlled by a valve which has to be opened frequently for discharge. To prevent clogging, the transport pipe is only used for emptying of the short-term storage tank.

The storage of urine for a long time is in accordance to recommendations by WHO (2006), which stipulated a storage time of 1 month for sufficient treatment of urine for fertilising crops that are to be processed. Additionally, the use of the nutrient urine as a fertilizer on farmland is only possible during the two short seeding seasons per annum.

Grey water from the hand washing, anal cleansing and cleaning is treated in-between the two toilet buildings in a percolation area. The collected water is pre-treated in sedimentation tank where solids and other materials settle down. This is necessary to avoid clogging of pipes in the following treatment steps. The pre-treated grey water is fed into a percolation field (made up of gravel beds planted with reed) on both sides of the sedimentation tank by percolation pipes. The plants as well as the bio film located on the gravel bed reduce the pollution of the grey water before its infiltration in the ground.

Fig. 9: Long-term urine storage tanks for UDDT at AU, Ethiopia. (source: S. Kore (2012)).

11 Practical experience and lessons learnt

- The operation of the UDDT at AU at the moment is not fulfilling the designed and targeted purposes. This is because the toilets are not used to capacity and the reuse is very minimal. Students are not allowed to use the toilet because of operational and administrative limitations.
- In the course of operations, blockage of urinal pipes occurs as a result of ammonia formation by the urine. This problem can be solved by regular cleaning and flushing of the pipes with by water.
- Sometimes out of negligence or the lack of knowledge some water is added to the faecal matter. This sometimes can result in bad smell from UDDTs because of the mixing of water with the sludge. The immediate replacement of the bin and the provision of proper instructions will help inform users and thus reduce the occurrence of this situation.

Fig. 10: A bin containing feacal matters (ash should have been added). (source: S. Kore (2012))

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 2: Qualitative indication of sustainability of system: A cross in the respective column shows assessment of the relative sustainability of project ('+' means: strong point of project; 'o' means: average strength for this aspect and '–' means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene		X		X				X	
• environmental and natural resources	X				X		X		
• technology and operation	X			X			X		
• finance and economics		X		X			X		
• socio-cultural and institutional	X			X				X	

Urine-diverting dry toilets at Adama University Adama, Ethiopia (draft)

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

Monitoring activities of the systems would be performed throughout the entire process to ensure (i) the proper and hygienic use and operation, (ii) the long-term quality assurance of the end-product and (iii) the documentation of the change in the original situation for research and development purposes (with respect to the environment, hygiene, user satisfaction, costs, profits, resource use, productivity, increase in harvests, job creation etc.). Monitoring activities should consist of technical and social monitoring.

External evaluations should take place in order to evaluate whether optimization and fundamental adjustments of operation activities and construction works should be done. It also focuses on best practice made.

13 Available documents and references

More photos of the project are available on Flickr at www.flickr.com/photos/gtzecosan/sets/72157625119941095/with/5679448119/

Short reports by Mammo Beriso Bulbo and Solomon Kore in 2012: Summary of the UDDT implementation (see posting on discussion forum: http://forum.susana.org/forum/categories/34-urine-diversion-systems-includes-uddt-and-ud-flush-toilet/1533-ethiopia-adama-uni-uddt-project-seems-oam-to-blame-again)

Adama University (2011). Sanitation systems, demo site recorded best results, AUdacious News & Views Vol. 2, No. 20. www.adama-university.net/fileadmin/user_upload/img/Vol.2_No.20.pdf

Oldenburg, M., Ayele, A. W., Hartmuth, N. (2009). UDDT at Adama University - Concept, Design, Operation and Maintenance & Construction of the Demonstration Project. www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=725

GTZ-IS (2008). UDDT complex at Adama University, Ethiopia - Overview plan of UDDTs and treatment site. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) International Services. www.susana.org/lang-en/library?view=ccbktypeitem&type =2&id=665

14 Institutions, organisations and contact persons

Planning, design, construction and supervision:
Solomon Kore
University Capacity Building Program (UCBP)
P.O. Box 2255, Adama, Ethiopia
Tel: 0221116812
Internet: www.ucbp-ethiopia.com
E-mail: solomon.kore@giz.de

GIZ International Services, Ethiopia
PO Box 28127, Code 1000
Addis Ababa
Tel: +251 11 662 2260
Email: giz-is-ethiopia@giz.de
Internet: www.giz.de/en/worldwide/336.html

Supplier of urine diversion squatting pans:
Tabor Ceramics Products Share Company
Awassa, Ethiopia
E: taborceramic@ethionet.et

Responsible company for design:
Martin Oldenburg
OtterWasser GmbH
Schüsselbuden 313
23552 Lübeck
info@otterwasser.de

Responsible for operation and maintenance:
Ato Tesfaye Bora (a focal person regarding the UDDT)
Head of General Service, Adama University
P.O.Box 1888
Adama, Ethiopia
Tel: +251-221-100-042.
Email: tes_bor@yahoo.com

Case study of SuSanA projects
Urine-diverting dry toilets at Adama University, Adama, Ethiopia
SuSanA 2012
Author: Bismark Agyei Yeboah
Editing and reviewing: Trevor Surridge, Cynthia Kamau and Elisabeth von Muench (GIZ, sanitation@giz.de)

This document is available from:
www.susana.org

Fossa alterna for household sanitation Arba Minch, Ethiopia

Fig. 1: Project location

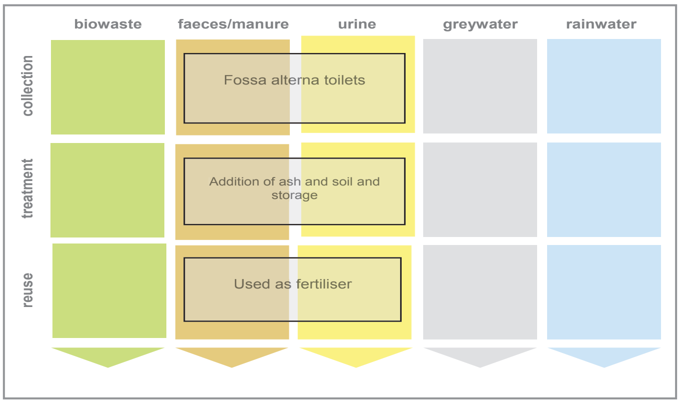


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Fossa alterna for household sanitation in Arba Minch, Ethiopia (pilot scale)

Project period:
Start of construction: 1 April 2007
End of construction: 30 March 2009
Start of operation: 30 March 2009

Project scale:
Number of fossa alternas built for households: 30
Number of inhabitants covered: 177
Total investment (in EUR) 2600

Planning institution:
Arba Minch Town Water Supply and Sewerage Enterprise (ARB)
Arba Minch University (AMU)

Executing institution:
Arba Minch Town Water Supply and Sewerage Enterprise (ARB)
Arba Minch University (AMU)
Jupiter construction micro and small enterprise
Daylight construction micro and small enterprise

Supporting agency:
European Union (EU)

The work was carried out within the project ROSA (*Resource-Oriented Sanitation concepts for peri-urban areas in Africa*; Contract No. 037025-GOCE; duration: 1.10.2006 – 31.3.2010), a Specific Target REsearch Project (STREP) funded within the EU 6th Framework Programme, Sub-priority "Global Change and Ecosystems".

2 Objective and motivation of the project

The EU-funded project ROSA (Resource-Oriented Sanitation concepts for peri-urban areas in Africa) proposes resources-oriented sanitation concepts as a route to sustainable sanitation and to meet the UN MDGs. The main objective of the project is to develop adaptable, affordable and replicable solutions for sanitation.

The Fossa alterna is one sanitation option which is easy and affordable for many inhabitants of Arba Minch. Such construction would provide improved sanitation in places facing problems with rocky ground and pit collapsing as is the case in central parts of town.

3 Location and conditions

Arba Minch town has an estimated population of about 80,000 with 4.5% annual growth rate. It is located 500 km south of Addis Ababa in southern Ethiopia.

Fig. 3: Fossa alterna with urine diversion (source: ROSA project, Arba Minch, 2008)

Arba Minch is one of the fastest growing towns in Ethiopia. However, there are wide ranging sanitation problems in the town. And these are expected to grow even worse with the rapid population growth. The town does not have pit desludging services forcing residents to dig another pit, or manually desludge the pit, which is unacceptable practice from health and hygienic point of view. 10% of the population practice open defecation. There are portions of the town that have congested settlements with rented houses in which land is not available for digging pits and people either share a single latrine, defecate open or use flying toilet.

A significant portion of the town has loose black cotton soil in which pit collapse is a major problem. Others have rocky ground where digging is very difficult. These problems urge to look for better sanitation options to be implemented in the town.

In Ethiopia, the under-five child mortality rate is currently[1] 104 children per 1,000 (compared to 210 per 1,000 in 1990).

4 Project history

The ROSA project started in October 2006. On the basis of the overall goal of developing and disseminating "Resource-Oriented Sanitation Concepts in Peri-Urban areas, like Arba Minch town, the project conducted research including a baseline study and demand assessment on sanitation. The project identified different sanitation options (involving safe disposal and re-use) through research conducted by Arba Minch University and other international partners, discussed and prioritized feasible options with active involvement of the local administration and community groups, undertook pilot experiments of the different options and disseminated them through practical demonstration, The project also supported to scale-up implementation in the local community, and provided skill training to ensure proper management and operation.

5 Technologies applied

Since its inception in October 2006, the ROSA project has introduced different resource oriented sanitation systems that include three types of toilets, greywater treatment units, a biogas unit and composting schemes. At the moment there are 15 urine diversion dehydration toilets (UDDTs), 30 Fossa alternas, 9 Arborloos, 9 greywater towers, 1 biogas unit and more than 5 composting schemes.

In this case study Fossa alternas are described. It is a double pit compost toilet and is made up of six parts (Morgan, 2007):
• Two pits
• Two ring beams to protect the two pits
• A single concrete slab which sits on one of the ring beams
• The toilet house which provides privacy

In this type of toilet urine is not separated from faeces. Three cups of soil and one cup of ash are added after every use. One pit fills up first. During the first season the second pit is unused. After the first one or two years, depending on the number of users, the first pit will get filled. When the first pit is full, the toilet slab and structure are moved on to the second pit and top soil is placed over the contents of the first pit which is then left to compost. The second pit is then put to use whilst the contents of the first pit are composting.

When the second pit gets filled, the first pit will be ready for emptying the compost of the pit. After the original pit is emptied, the toilet slab and structure can be placed back again over the empty pit and the recently filled pit is covered with soil and left to compost for a further year. This changing of the pits can continue for many years in the same site.

6 Design information

The pits
The two pits dug for fossa alterna are having a depth of 1.5-1.8 m and have a square section of 90 cm x 90 cm.

The ring beams
Square ring beams, made of hollow concrete blocks, are cast on the pits. The external measurements of the beam are 1.3 m x 1.3 m and the internal measurements - the size of the hole - are 0.9 m x 0.9 m (refer Fig. 4.).


a

The reinforced concrete slab
The reinforced slab has 5 cm thickness and a dimension of 1.2 m x 1.2 m. It can be cast onsite or be cast at a central place and transported to the construction sites. A mould of wooden purlin (5 cm x 7 cm) was used to cast the slab.
Materials used for casting five rectangular reinforced concrete slabs for Fossa alterna were:
1. Cement = 2 bags (100 kg)
2. Sand = 0.14 m^3
3. Gravel = 0.28 m^3
4. Reinforcement dia. 6 mm = 44 m (9.8 kg)
5. Canvas = 9 m^2 (Reusable)
6. Wooden form work cross-section (7 cm x 5 cm) and length 4 m =6 pcs (Reusable)


Fig. 5: Fossa alterna slabs during construction (source: ROSA Project, Arba Minch 2007)

[1] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before the age of five if subject to current age-specific mortality rates. (http://www.childinfo.org/mortality.html and http://www.childmortality.org).

The toilet superstructure

The toilet superstructure is portable and is made of ‘karta’ (woven bamboo), canvas or corrugated iron sheet (refer Fig. 6).

Fig. 6: Fossa alterna toilet superstructures (source: ROSA Project Arba Minch, 2008)

In cases where digging even a shallow pit is difficult, Fossa alternas can be constructed above ground (refer Fig. 7.).

Fig. 7: Fossa alternas above ground (source: ROSA project Arba Minch, 2009)

7 Type and level of reuse

The regular addition of soil and ash to the pit helps the composting process considerably. The pit compost is removed by a shovel when the pit in use is full (after 4 to 6 months) and applied on plants. The existing practice in Arba Minch is using the pit compost in the respective compounds. There is also a possibility of selling the compost in the future.

Flowers or plants that can be harvested in 3 to 6 months can be grown on the filled pit while it is undergoing composting. One of the households planted plants on the filled pit (refer Fig. 8).

Fig. 8: Plants on the filled pit (source: ROSA project, Arba Minch, 2009)

8 Further project components

The absence of credit facilities for households which are interested to construct the demonstrated innovative toilet options has constrained efforts for further scaling-up of the implementation. The project has recently worked to generate seed money from other sources with a 50 % grant scheme from the Dutch government and 50 % loan arrangements to facilitate credit access to households who are willing to construct the toilets. The total amount of money is about one million Euro and this money will be used as a revolving fund.

9 Costs and economics

The details on investment cost for constructing one Fossa alterna is given in the table below.

Table 1: Investment cost for constructing one Fossa alterna.

S. No.	Item	Unit	Qty	Unit Price in Birr	Total in Birr	Total in Euro
1	Cement	Qtl.	1	350	350.00	18.92
2	20 cm HCB	Pcs.	24	10	240.00	12.97
3	Eucalyptus dia. 8 mm	No.	6	15	90.00	4.86
4	Eucalyptus dia. 10 mm	No.	4	20	80.00	4.32
5	Nails #8 mm	Kg	0.5	25	12.50	0.68
6	Nails # 10 mm	Kg	0.5	25	12.50	0.68
7	Sand	m3	0.04	120	4.80	0.26
8	Aggregate 02	m3	0.06	180	10.80	0.58
9	6 mm dia. bar	Kg	2.7	25	67.50	3.65
10	7 cm x 5 cm wooden Formwork	Pcs.	2	9	18.00	0.97
11	Φ110 mm PVC Pipe	Pcs.	1	175	175.00	9.46
12	Φ 110 mm Vent cap	Pcs.	1	45	45.00	2.43
13	Φ50 mm PVC Pipe	Pcs.	1	85	85.00	4.59

S. No.	Item	Unit	Qty	Unit Price in Birr	Total in Birr	Total in Euro
14	Φ50 mm PVC Elbow	Pcs.	1	15	15.00	0.81
15	CIS Nails	Kg	1	25	25.00	1.35
16	Door hinge	Pcs.	2	6	12.00	0.65
17	Door lock	Pcs.	2	7	14.00	0.76
18	'Karta' (wooven bamboo) for walling	Pcs.	4	10	40.00	2.16
19	CIS for roofing	Pcs.	2	100	200.00	10.81
20	CIS for door	Pcs.	1	100	100.00	5.41
	Total				**1597.10**	**86.33**

Labor cost is EUR 20 for construction of one Fossa alterna. If the wall is constructed by corrugated iron sheet (CIS) the material cost will be EUR 117. If the Fossa alterna is constructed above the ground the cost of one vault is EUR 50.

There are thirty Fossa alternas in Arba Minch. The total number of users is 177 out of which 78 are male and 99 female.

Two of the Fossa alternas were built for demonstration purposes making use of different designs and different materials. These units were considered as first testing units and the construction cost was covered fully from ROSA project budget. The other twenty eight Fossa alternas were built with cost sharing whereby 75% of the total construction cost was covered by the households and the remaining 25% was covered from ROSA project budget. The operation and maintenance cost is about EUR 4 as of 2008. This cost is basically to move the slab & the toilet structure and remove the pit contents.

10 Operation and maintenance

In Fossa alternas the contents of the filled pit can be emptied easily and applied in the compound of the household as compost. If there is no space for applying this compost in the household's compound it will be collected by solid waste collectors. In this case the solid waste collectors should buy the compost when awareness is raised among the community. After buying it, the solid waste collectors sell it to other persons who need compost.

The feedback from the users indicates that using the compost in the compound is the best option. No solid waste collectors bought the compost generated by the Fossa alternas so far. The reason may be the suspicion of the solid collectors on the profitability.

11 Practical experience and lessons learnt

- Compared to the other types of resource oriented toilets tested in Arba Minch the Fossa alterna has been accepted to a larger extent. The main reason is the similarity of the toilet to the traditional toilet.
- One of the users, Ms. Meselech Geda, started selling a locally produced alcoholic drink called 'tej'. The number of customers who urinate in the Fossa alterna are a lot. Therefore, upon her request, a waterless urinal was installed. The filling rate is high (2 to 4 jerry cans per week). She changes the filled jerry cans by herself. She is paying Eur 5 per month for transporting the urine to a micro and small enterprise called 'Wubet le Arba Minch' Solid Waste Collectors Association for transporting the urine and for using it as a fertilizer. Refer Fig. 9. for the urinal installed in her compound.

Fig. 9: Waterless urinal (source: ROSA project Arba Minch, 2009).

- At the Fossa alterna of Ato Belay Mamo, a modification was made to divert the urine from the Fossa alterna in order to utilise urine separately for agriculture. The sitting pan was made of a used bucket, chicken wire mesh reinforcement (6 mm in diameter) and concrete (refer Fig. 10).
- Some users want the foot seat to be raised because they are used to such types of foot seats.
- The users of two Fossa alternas are Muslims and are washers. In these toilets most of the time the pit contents become wet. For these households, an additional hole should be provided on the slab for the anal cleaning water and a separate pit (ca. 0.5 m^3) should be dug and filled with gravel to treat and infiltrate the anal washwater.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Fossa alterna for household sanitation Arba Minch, Ethiopia

Table 2: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project ('+' means: strong point of project; 'o' means: average strength for this aspect and '–' means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene		X		X				X	
• environmental and natural resources	X				X		X		
• technology and operation	X			X				X	
• finance and economics	X			X			X		
• socio-cultural and institutional		X			X			X	

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as. from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

With regards to long-term impacts of the project, the main expected impact of the project would be improved public health. This was however never formally assessed.

13 Available documents and references

1. Morgan, P., (2007): Toilets That Make Compost: Low-cost, sanitary toilets that produce valuable compost for crops in an African context. EcoSanRes Programme, Stockholm Environment Institute: Stockholm, Sweden. http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=195
2. ROSA AMU, ROSA ARB (2009) Arba Minch Town ROSA Project booklet, Arba Minch, Ethiopia, http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1189
3. ROSA AMU, ROSA ARB (2007) Baseline study report of Arba Minch Town, Arba Minch, Ethiopia.

14 Institutions, organisations and contact persons

Planning, design, construction and supervision
Arba Minch Town Water Supply and Sewerage Enterprise
Wudneh Ayele Shewa (coordinater of ROSA Arba Minch water supply services) and
Bogale Gelaye Geleta (constructing Engineer and currently manger of the Enterprise)
P. O. Box 40
Arba Minch
Ethiopia
T: +251-46-8815115
M: +251-916-825611, +251-911-798018
E: wudexa@yahoo.com, abiboge@yahoo.com
I: http://rosa.boku.ac.at

Arba Minch University
Partners of ROSA
Kinfe Kassa Ayano (Work package leader of Arba Minch ROSA and Lecturer at Arba Minch University)
P. O. Box 21
Arba Minch
Ethiopia
T: +251-46-8815115
M: +251-911-745172
E: kinfe_k@yahoo.com
I: http://www.amu.edu.et/rosa.shtml

Case study of SuSanA projects

Fossa alterna for household sanitation, Arba Minch, Ethiopia

SuSanA 2010

Authors: Wudneh Ayele Shewa (ROSA project), Bogale Gelaye Geleta (ROSA project)

Editing and reviewing: Norbert Weissenbacher (BOKU Vienna), Elisabeth von Muench (GIZ, ecosan@giz.de)

This document is available from:
www.susana.org

Greywater tower for peri-urban areas Arba Minch, Ethiopia

Fig. 1: Project location

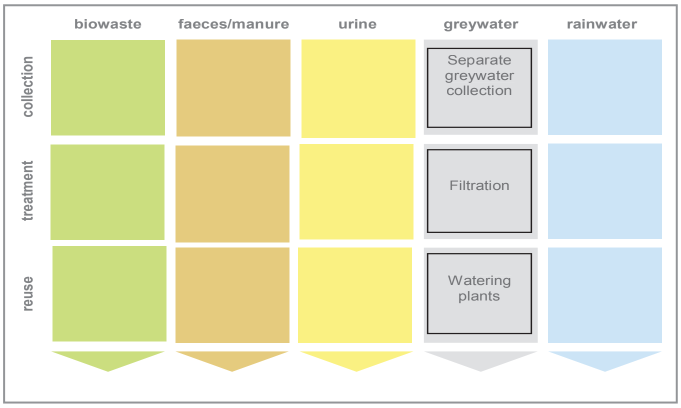


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Household sanitation - pilot scale implementation of greywater reuse in peri-urban areas

Project period:
1 April 2007 – 30 March 2009

Project scale:
Number of greywater towers built for households: 9
Number of inhabitants covered: 47
Total investment (in EUR) 180

Planning institution:
ROSA Arba-Minch Team: Arba Minch Town Water Supply and Sewerage Enterprise (ARB)
Arba Minch University (AMU)

Executing institution:
ROSA Arba-Minch Team: Arba Minch Town Water Supply and Sewerage Enterprise (ARB)
Arba Minch University (AMU)
Jupiter construction micro and small enterprise
Daylight construction micro and small enterprise

Supporting agency:
European Union (EU)

The work was carried out within the project ROSA (*Resource-Oriented Sanitation concepts for peri-urban areas in Africa*; Contract No. 037025-GOCE; duration: 1.10.2006 – 31.3.2010), a Specific Target REsearch Project (STREP) funded within the EU 6th Framework Programme, Sub-priority "Global Change and Ecosystems"

2 Objective and motivation of the project

A greywater tower was selected as one of the methods that can be adopted to treat and safely reuse greywater in Arba Minch town. Nine such units were constructed in which the grey water can be used for growing vegetables successfully. The construction of the units does not require skilled labor. The aim was to raise awareness about the unit in the community of Arba Minch and promising demand has been created.

Fig 3: Greywater tower with leafy plants. Source: ROSA project document in 2007-2009.

3 Location and conditions

Arba Minch town with a total population of 75,000 and annual growth rate of 4.5% is one of the fast growing towns in Ethiopia. There are wide ranging sanitation problems in the town and these are expected to worsen owing to rapid population growth. A baseline study carried out in Arba Minch town by the ROSA project (Resource-Oriented Sanitation concepts for peri-urban areas in Africa) in the year 2007 revealed that 73% of the households in the town spill their greywater in their compound, 13% spill it outside their compound, 8% spill it in a pit filled with gravel and only 6% use greywater for gardening. This study indicated that 94% of the greywater is recognised as a waste and is not reused.

4 Project history

The EU-funded project ROSA proposes resources-oriented sanitation concepts as a route to sustainable sanitation and to meet the UN MDGs. The ROSA project started in October 2006. On the basis of the overall goal of developing and disseminating “Resource-Oriented Sanitation Concepts in peri-urban areas” like Arba Minch town, the project conducted research including a baseline study and demand assessment on sanitation. The project team also identified different sanitation options (involving safe disposal and re-use) through research conducted by Arba Minch University and other international partners working on the ROSA project.

5 Technologies applied

Since its inception in October 2006, the ROSA project has introduced different resource oriented sanitation systems. One of the objectives of the ROSA project is to develop sustainable decentralized solutions for greywater treatment and reuse. Therefore, a greywater tower was proposed as one of the methods that can be adopted to treat and safely reuse greywater for Arba Minch town and nine such units were constructed in private compounds.

6 Design information

The greywater tower is a circular bag which has got soil, ash and compost mixture in it and a gravel column at the center. It is used to treat and reuse greywater, water that has been used for bathing, washing clothes and utensils. Leafy plants or vegetables are planted in holes cut in the sides of the bag itself and each day the available greywater from a household is poured directly on the gravel column.

The material required to construct one greywater tower included the following

- Bucket without bottom
- Five poles 2m in height
- 1m x 2.5m shade cloth
- 0.05 m^3 soil
- 0.2m^3 compost
- 0.14 m^3 ash
- 0.085 m^3 gravel

Fig. 4: Left: Marking out the circle. Right: Planting the poles.

Steps followed for the construction

Step 1

A circle is marked out which has a radius of 40 cm using a nail and a thread (refer Fig. 4). As the next step the bottom layer of the tower is dug out and the side poles firmly planted into the bottom (refer Fig. 4).

Step 2

The shade cloth is then wrapped around the poles (Refer Fig. 5).

Step 3

The sides of the shade cloth cylinder are rolled down out of the way before filling and placing the bucket on the ground in the middle of the tower (Refer Fig. 5).

Fig. 5: Left: Wrapping the shade cloth around the poles. Right: Rolling down the sides of the shade cloth.

Step 4

Gravel is then packed in the bucket and soil mixture (3 parts soil, 2 parts compost and 1 part ash) is then backfilled around the bucket (refer Fig. 6).

Fig. 6: Left: Mixing soil, compost and ash to fill the tower. Right: Filled greywater tower.

The bucket partially pulled out, leaving the gravel in position and backfill with the soil mixture. This procedure is repeated up to 1m level is reached. The greywater tower should finally look like the one shown in Fig. 6.

7 Type and level of reuse

Each day the available greywater is poured into the bag directly on the gravel pack and leafy plants/vegetables are planted in holes cut in the sides of the bag (refer Fig. 7.)

Fig. 7: Pouring greywater in to the tower.

The studies conducted by ROSA project revealed that the daily average amount of greywater produced in Arba Minch is 45.7 liters per family.

8 Further project components

The absence of sufficient finance for households interested to construct the demonstrated innovative option has constrained efforts to further scale-up implementation. The project team has recently acquired additional funding from other sources. The SPA–Programme (Sanitation Programme Africa) offers 50 % grant from the Dutch government and 50 % loan arrangements to facilitate credit access to households who would like to construct sanitation facilities including greywater towers. The total amount of available money is about one million Euros and this money will be used as a revolving fund.

9 Costs and economics

The details on investment costs for constructing one greywater tower are given in the Table 1.

Table 1: Material cost

No.	Description	Unit	Qty	Unit price (Birr)	Amount (Birr)	Amount (Euro)
1	Shade cloth	m^2	2.50	5.50	13.75	0.74
2	Wire mesh	m^2	2.50	35.00	87.50	4.73
3	Natural compost	Qtl	200.00	1.00	200.00	10.81
4	Ash	m^3	0.14	0.00	0.00	0.00
5	Soil	m^3	0.05	0.00	0.00	0.00
6	Eucalyptus poles (Height: 2m; Dia: 6cm)	Pcs.	5.00	6.00	30.00	1.62
7	Gravel 02	m^3	0.09	180.00	15.30	0.83
8	Bucket	Pcs.	1.00	30.00	30.00	1.62
	Total				**377**	**20**

Two of the greywater towers were built for demonstration purposes. These units were considered as first testing units and the construction costs were covered fully from ROSA project budget. The other seven units were built with cost sharing whereby 75% of the total construction cost was covered by the households and the remaining 25% was covered from ROSA project budget.

10 Operation and maintenance

The units can be operated and managed by the users. There is not any waste emission caused by the unit. The unit can serve for more than one year without any problem. After one year strengthening the unit and planting new leafy plant seedlings may be required. This can all be done by the household.

11 Practical experience and lessons learnt

This project provided critical insight in the construction grey water towers.

- Clogging of the gravel column was observed in some of the units. Putting a wire mesh on the gravel was therefore recommended to filter bigger particles that may be found in the greywater.
- It is possible to reduce the height of the poles to 1.2m to reduce costs.
- It was observed that the shade cloth gets old and starts tearing after about one year. Therefore it was recommended to use the shade cloth in two layers or search for a material which does not tear easily. A satisfactory result was found when a wire mesh was used together with the shade cloth.
- The system is successfully adopted in Arba Minch town.

- Additional (fresh) water was needed to water the vegetables.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 2: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X			X				X	
• environmental and natural resources	X				X		X		
• technology and operation	X				X			X	
• finance and economics	X				X		X		
• socio-cultural and institutional	X			X				X	

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

With regards to long-term impacts of the project, the main expected impact of the project would be improved public health but this has never been assessed.

13 Available documents and references

1. ROSA AMU, ROSA ARB (2009) Arba Minch Town ROSA Project booklet, Arba Minch, Ethiopia, http://www2.gtz.de/Dokumente/oe44/ecosan/en-rosa-project-booklet-arba-minch-2009.pdf
2. General project information: http://rosa.boku.ac.at

14 Institutions, organisations and contact persons

Arba Minch Town Water Supply and Sewerage Enterprise

Wudneh Ayele Shewa (coordinater of ROSA Arba Minch water supply services) and
Bogale Gelaye Geleta (constructing Engineer and currently manger of the Enterprise)
P. O. Box 40
Arba Minch
Ethiopia
T: +251-46-8815115
M: +251-916-825611, +251-911-798018
E: wudexa@yahoo.com, abiboge@yahoo.com
I: http://rosa.boku.ac.at

Arba Minch University
Kinfe Kassa Ayano (Work package leader of Arba Minch ROSA and Lecturer at Arba Minch University)
P. O. Box 21
Arba Minch
Ethiopia
T: +251-46-8815115
M: +251-911-745172
E: kinfe_k@yahoo.com
I: http://www.amu.edu.et/rosa.shtml

Case study of SuSanA projects
Greywater tower, Arba Minch; Ethiopia
SuSanA 2010
Authors: Wudneh Ayele Shewa (ROSA project), Bogale Gelaye Geleta (ROSA project)
Editing and reviewing (only in updated version): Norbert Weissenbacher (BOKU)

Case study of sustainable sanitation projects

Co-composting of faecal sludge & organic solid waste Kumasi, Ghana

Fig. 1: Project location

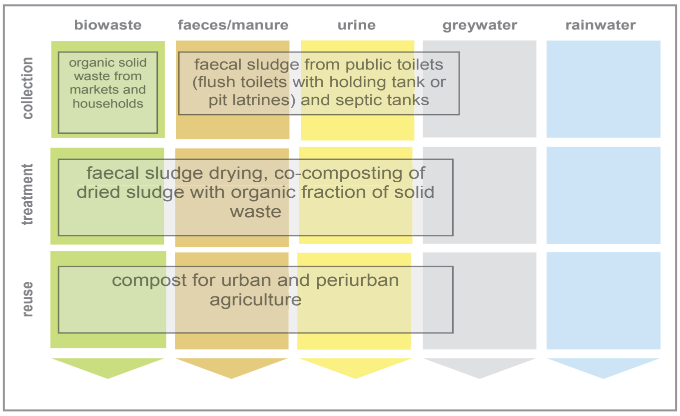


Fig. 2: Applied sanitation components in this project (urine and faeces are mixed with some flush water from pour flush toilets and with some anal washwater).

1 General data

Type of project:

Research and demonstration project: Combined treatment of faecal sludge and organic solid waste for reuse in agriculture (pilot scale in urban area).

Project period:

Start of planning: July 2001
Start of construction Oct. 2001
Start of operation: Feb. 2002 (not continuously in operation, depending in research phase)

Project scale:

Total land area covered: ~500 m²
Faecal sludge treated: 45 m³ per month
Capital investment costs: EUR 16,500

Address of project location:

Buobai, 15 km East of city centre of Kumasi, Ghana

Implementing institutions:

Joint planning by 4 institutions led by International Water Management Institute (IWMI):

- International Water Management Institute (IWMI); executive institution, Accra, Ghana
- Department of Water and Sanitation in Developing Countries (SANDEC) of the Swiss Federal Institute for Aquatic Science and Technology (EAWAG), Dübendorf, Switzerland
- Kwame Nkrumah University of Science and Technology (KNUST), Accra, Ghana
- Waste Management Department of Kumasi Metropolitan Assembly (KMA), Kumasi, Ghana

Supporting agencies:

- Ministry of Foreign Affairs, France
- National Centre of Competence in Research (NCCR) North South, Switzerland (e.g. funding of PhD students)
- KEZO, Switzerland (Waste Disposal Services Zurich Oberland, German name is: Zweckverband Kehrichtverwertung Zürcher Oberland)

2 Objective and motivation of the project

The objectives of the project were:

- To gain scientific knowledge on the technical and operational aspects of co-composting (co–composting refers to having two input materials: organic solid waste and faecal sludge).
- To evaluate socio-economic aspects of co-composting as well as the impact of compost utilisation on crop and soil
- To raise awareness and know-how of co-composting as a waste recycling option
- To train people in being able to operate co-composting plants (capacity development component)

The main focus of the project is the production of hygienic and nutrient rich compost made from organic solid waste and faecal sludge and its utilisation in agriculture for sustainable food production.

The co-composting plant was designed as a fully functioning small-scale facility; however it is operated at pilot scale with the objective to serve as an experimental site rather than having a high waste turnover and compost output. The ultimate aim of this process is to contribute to improving the faecal sludge management situation in Kumasi and hence improve public health.

3 Location and conditions

Kumasi is the second largest city in Ghana, West Africa. The city has 1 million inhabitants (growth rate of 3% per year).

Fig. 3: Co-composting facility (open windrow system) in Kumasi (source: IWMI, 2003).

The city is an industrial centre with formal industries in timber, food processing and soap manufacturing, together with informal activities in woodwork, vehicle repair, footwear, furniture manufacture and metal fabrication.

About 38 % of Kumasi residents use public toilets: There are about **400 public toilet facilities** in Kumasi, equipped with either flush toilets with a holding tank or KVIP latrines[1] with two pits per latrine (used alternatively) or one pit per latrine. Another 26% of the population use household water closets linked to septic tanks and seepage pits. Only 8 % of the population is connected to a sewerage system and the remaining 28% of the population have no toilet facilities at all (practising open defecation instead).

The residents in Kumasi produce daily 860 tons of solid waste and 500 m^3 of faecal sludge (human excreta and water) collected from on-site sanitation systems (septic tanks, pit latrines and unsewered public-toilets). Approx. 70% of the produced solid waste is biodegradable (organic) which can be co-composted together with the faecal sludge and utilised as a fertiliser and soil conditioner.

Of the 500 m^3 /d of faecal sludge produced, only 1.5 m^3/day is treated in the pilot plant. Kumasi has a full-scale faecal sludge treatment plant (formerly, the faecal sludge treatment plant at Buobai was used; currently, the FSTP at Dompoase is the main plant used). The pilot plant was only established to investigate the aspect of co-composting. And it is not a daily operation as the FSTP.

The overall faecal sludge treatment situation in Kumasi is as follows, according to Vodounhessi and von Münch (2006) (see Section 13): "*The collection companies discharge the collected FS at the privately operated FS treatment plant (FSTP) at Dompoase and there is now no longer illegal FS dumping in the city. This has been successful through the strictness of the District Assembly rules and the community participation in denouncing defaulters. The FSTP is located at the Dompoase solid waste landfill site and consists of five anaerobic, one facultative and two maturation ponds to treat FS and landfill leachate. The facility became operational in January 2004. The treated liquid effluent is mixed with the underground drainage from the solid waste landfill and discharged into Sisai River without further treatment, despite questionable effluent quality (based on visual observation; no analytical data available)."*

The former FSTP, a pond system at Buobai, was in operation during 2001-2003, but is currently no longer operational because the sedimentation ponds are full and yet to be emptied. Also, the community surrounding the plant was not satisfied with the quality of the effluent discharged in the neighbouring river."[2]

[1] KVIP stands for "Kumasi ventilated improved pit latrine": an alternating VIP latrine (= double pit latrine in the USA) while a conventional VIP is not alternating.

[2] In August 2009: There is currently no discharge at Buobai faecal sludge treatment plant. There is a KMA staff member who guards the place though. KMA still plans to use it but according to the waste management director, they are still searching for fund to adequately compensate the community.

The climate is sub-equatorially wet with two rainy seasons, the major one from late February to early July and the minor one from mid September to early November.

Crop production is practised at different sites: approx. 70 ha in open space urban farming (vegetables, tubers[3] and cereals) while more than 12,000 ha in peri-urban farming. Backyard gardening is also commonly practised within the city as well as peri-urban cultivation of maize and plantain.

The under-five child mortality rate[4] in Ghana is currently 115 children per 1000, and the trend since 1999 is sadly in an slowly increasing direction
(http://www.childinfo.org/mortality.html).

4 Project history

The drivers for this project were IWMI and Sandec together with the project partners, led by IWMI (see Section 14). Significant milestones were building the plant, acceptance by the community and first batch of compost produced.

The pilot co-composting plant is located within the **Buobai faecal sludge treatment plant** which was built to treat part of the FS generated in the city. The Buobai faecal sludge treatment plant has two anaerobic, two facultative and one maturation pond (currently it is no longer in use for faecal sludge treatment as mentioned in Section 3).

The construction of the pilot plant started in October 2001 and the operation started in February 2002. The plant has been in operation ever since then. Over the years, considerable knowledge was gained and large quantities of compost were produced for field trials. The plant is seen as a facility to gather useful information for future upscaling by the municipal assembly.

The plant is currently not operational because the research funds for this project are currently depleted and KMA has not taken the pilot plant over. Therefore, no more composting is taking place since January 2009. IWMI still keeps one worker in charge while IWMI develops the next research steps on the one hand and engages the waste management department in discussion for next steps

IWMI is continuing with scientific investigations and is preparing a guideline on co-composting which will be made available to the municipal assembly (KMA). Whether a full-scale co-composting plant will be built or not depends on KMA. Currently, KMA does not consider it a high priority (one problem is that the reference point for composting in Ghana is still the failed large scale Teshi plant in Accra).

5 Technologies applied

The basic technology chosen for this project consists of two main process steps:

1. Faecal sludge drying on unplanted drying beds and
2. Windrows co-composting of dried faecal sludge (FS) and organic solid waste (oSW).

[3] A tuber is a type of crop with the edible part under the soil surface (examples include yam, cassava, cocoyam).

[4] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates.

Co-composting of FS and oSW is advantageous because the two materials complement each other well: FS has a relatively high nitrogen content while oSW is high in organic carbon and has good bulking properties.

FS (excreta mixed with water) is collected from unsewered public toilets (type of toilet is described in Section 3) and household septic tanks by vacuum trucks within the city of Kumasi and transported to the project site for drying on sludge drying beds. Due to its too high moisture, fresh FS is unsuitable for direct aerobic composting. Hence a solid-liquid separation is needed to produce sludge of adequate water content for co-composting. For solid-liquid separation, sludge drying beds including a sand-gravel filter medium for drainage were built. They are loaded with the faecal sludge (a mixture of public toilets sludge and septic tanks FS in the ratio of 1:2). The drying process is enhanced by evaporation and gravity percolation.

Fig. 4: Faecal sludge drying beds (source: Olufunke Cofie, 2002).

The dried FS is removed from the drying beds once it has become spadable (after 10 days) and stored prior to co-composting.

The **leachate** (also called drainage or percolate) from the drying beds is collected in a percolate storage tank and discharged into the facultative stabilisation pond of the Buobai faecal sludge treatment plant before final discharge into a nearby stream.

Municipal solid waste from markets or residential areas is collected and delivered by trucks to the composting site. This waste is sorted manually. The organic fraction of the SW and the dried FS are mixed in a ratio of 3:1 and composted using an open windrow system where the feedstock is aerated by manual turning. During a composting cycle, the following activities are carried out: turning, watering, temperature measurement, weighing, sampling and laboratory analysis (analysed for physicochemical and microbiological properties). The matured compost is sieved, packed in bags (50 kg each) and stored prior to reuse e.g. in field trials.

This technology has been chosen because it is easy to build and operate, has low costs, can be implemented on a decentralised basis, no energy supply is needed and it is suitable for tropical regions such as Ghana. The drying bed is a more efficient solid-liquid separation system than the settling/thickening ponds commonly used in Ghana. Its efficiency however depends on climatic conditions and of the type of both filter material and feedstock.

Thermophilic conditions (i.e. temperatures greater than 50°C) are achieved through the composting process. These high temperatures are effective in killing pathogens such as Ascaris eggs contained in excreta. Thus, both wastes are converted into a hygienically safe soil conditioner and fertiliser.

6 Design information

Two unplanted drying beds were built with a surface area of 25 m^2 each (to hold 15 m³ excreta with a depth of 30 cm). They consist of different layers of a gravel-sand filter material of different thickness and particle sizes. Design criteria and assumptions used for the pilot plant in Kumasi are shown in Table 1 below.

The composting area is a roofed and sealed composting pad of 10 x 12 m. The composting pad has a slight slope of 1% towards the centre where a narrow drainage channel is located. This serves as a drainage system in case of leachate generation. The maturation area is a roofed and sealed pad of 7 x 6 m. Further technical details are provided in Fig. 5 and Table 2 below. These can be applied for similar climatic conditions and faecal sludge characteristics in other countries.

Table 1: Design criteria and assumptions used for pilot plant in Kumasi

Faecal sludge dewatering

- volume of FS treated: 15 m^3/cycle = 45 m³/month = 1.5 m³/d
- 3 dewatering cycles/month
- 3 faecal sludge truck loads/cycle (1 truck carries ~5m^3)
- ratio of public toilet sludge to septage sludge = 1:2
- surface of sludge drying beds: 50 m²
- hydraulic load on drying beds: 30 cm/cycle
- FS volume reduction through dewatering assumed: 90%
- dried sludge produced: 1.5 m^3/cycle = 4.5 m^3/month

Co-Composting

- ratio of organic SW to dried FS = 3:1 (by volume)
- 1 month thermophilic composting + 1-2 months maturation
- 1 composting cycle starts each month
- required volume of organic SW: 3 x 4.5 = 13.5 m³/month
- assumed organic fraction in household waste: ~50% (being less than 70% indicated in Section 3 for taking into account a safety margin because waste composition may vary in time)
- required volume of unsorted SW delivery: approx. 27 m^3/month
- raw compost produced: 4.5 + 13.5 = 18 m^3/month
- volume reduction through co-composting: 50%
- mature compost produced: ~9 m^3/month = 4-5 t/month (density = 0.5 t/m³)

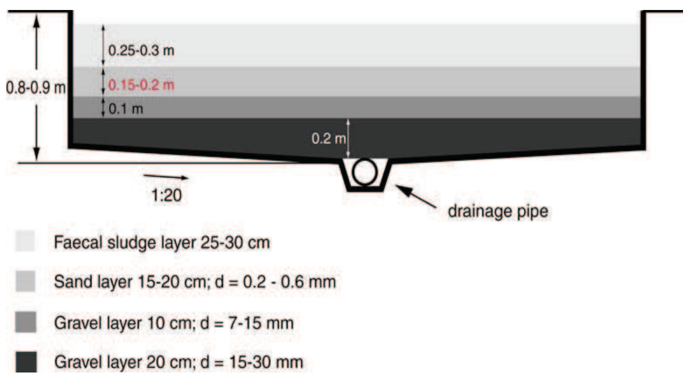


Fig. 5: Structural principle for a drying bed profile (for faecal sludge dewatering).

Table 2: Technical details and characteristics recommended for faecal sludge dewatering in drying beds.

Sizing of the beds
- 15 days drying cycle
- 25 – 30 cm sludge layer on beds
- 100-200 kg TS/m² / year (TS stands for total solids)
- 0.08 m^2/cap

Raw sludge characteristics
- Partly stabilised (septage or mixture of septage and public toilet sludge with ≤ 30 % share of public toilet sludge)

Sand characteristics
- Sand particles do not crumble
- Sand easily available locally
- Sand thoroughly washed prior to application onto the gravel base

Production of filter layers
- Reduce pressure flow via splitting chamber, inlet channel, and splash plates

Drying bed removal efficiency
- 97% SS (suspended solids), 90% COD (chemical oxygen demand), 100% HE (helminth eggs)

Biosolids
- 0.1 m³ per m³ fresh FS
- Hygienisation necessary prior to use in agriculture as biosolids

Percolate
- Quality fairly comparable to tropical wastewater
- Salinity too high for irrigation
- Percolate treatment e.g. waste stabilisation ponds or constructed wetlands

7 Type and level of reuse

The compost has been tested for its impact on the germination capacity and early growth of selected vegetables commonly grown in the urban and peri-urban areas (tomato, sweet pepper, lettuce, cabbage, spring onion and carrot). The germination capacity varied between 70-100% for all vegetables, which is an acceptable range. Some of the compost was given to selected urban farmers from the Gyenyasi Farmers Association in Kumasi for its application on their farms. The feedback received was encouraging. There was no difference in performance between this compost and poultry manure for lettuce production.

Furthermore the compost was tested on a demonstration field with maize and compared with a control field without compost application. The field with compost achieved a significantly higher crop yield than the control field.

The compost has been used to grow cereals and vegetables. Also the composting plant operators use it for their own production. This is a demonstration plant to convince policy makers, researchers, farmers, city planners and waste managers of the merits of compost production from faecal sludge.

It is important to find out the perceptions of the farmers as the direct beneficiaries and to determine if a project of this nature is financially and economically viable. Therefore, a study on farmers' perception of excreta-based compost and willingness to pay was carried out. The results of this study were that a large number of farmers (83%) were willing to use excreta-based compost. However, the actual amount that farmers were willing to pay was low (between EUR 0.1 to 2.5 per 50-kg bag)[5] which was far below a price which would cover production costs.

The farmers who were skeptical (17%) feared that the excreta component could still spread infections and thought that consumers might avoid crops being fertilised with excreta-based compost (there is however no evidence that consumers would avoid crops that were fertilised with excreta-based compost).

Fig. 6: Lettuce farm fertilised with compost at Gyenyasi farmers Association in Kumasi (source: Nikita Eriksen-Hamel, 2002).

Research on the produced compost has shown that the compost quality is within an acceptable range. The composting process is efficient in reducing the Ascaris eggs concentration to a safe level. Ascaris eggs viability is reduced from 40-60% in the raw FS to less than 10% in the final compost with a total count of <5 Ascaris eggs/gTS (TS stands for total solids). The viable Ascaris eggs are <1 viable Ascaris eggs/gTS, thereby complying with the WHO guidelines of 2006 for the safe use of excreta[6]. The macro- and micro-nutrients as well as heavy metal contents are within an acceptable range.

Thus this compost made of FS and organic SW will not pose health risks to farmers and consumers. The necessary health and safety plans are available on site. Safety equipment (boots, overalls, gloves and nose masks) are always used by the workers. Hands are thoroughly washed with soap and disinfectants. The workers periodically undergo medical check-ups. SW rejects (non-organic component) are properly land filled by the KMA Waste Management Department.

Compost is not sold to farmers but given to them for free or used by the plant operators for field tests. The reason why it is given away for free is because the plant was not for commercial use but just meant to gain technical knowledge on co-composting of faecal sludge and organic solid waste. However the farmers are willing to use excreta-based compost provided its nutrient content is high enough and it is available at an affordable price.

[5] For comparison: Common compost used in Kumasi is poultry manure which at the time of calculation was free except for transport cost.

[6] http://www.who.int/water_sanitation_health/wastewater/gsuww/en/index.html

8 Further project components

Due to the implementation of this project, an increased awareness can be observed among farmer groups in using excreta-based compost. Many farmers understood that co-compost made from human excreta and organic solid waste is a safe product and poses no health risk to them. Scientists and engineers carried out training of project assistants and MSc and PhD students who also worked on various system components. The project offered many Northern and Southern students the opportunity to do applied research on this subject.

The scientific investigations were carried out by IWMI and other research partners from Eawag/Sandec and KNUST, coordinated by the project leader.

9 Costs and economics

Total investment costs were about EUR 16,500 which were funded mainly by the Ministry of Foreign Affairs (France). Operation costs (PhD students, video documentary, initial operation and maintenance costs) were funded by NCCR North-South and KEZO (in Switzerland).

The first phase (2001-2004) was funded by France and the project partners own budgets, in particular, IWMI and Sandec (funding from KEZO). The second phase (2005- 2008) was funded by NCCR North-South through PhD research. Funding for 2009 has been a constraint.

Operation of the co-composting plant is labour intensive. Solid waste sorting is the most costly activity contributing to approx. 30% of the total operation and maintenance costs.

It was estimated that the amount of compost produced from the pilot plant will be approx. **37 tons/year**[7]. A subsequent study valued the compost produced at the plant to be approx. EUR 3.5 per 50-kg bag.

If the plant was working at full scale the production costs would decrease or possibly increase (e.g. in cases where manual shoveling had to be replaced by machines). These figures however refer to this demonstration project only and are not applicable for other full-scale projects.

The operation and maintenance costs include mainly just labour. There are normally no electricity or chemicals costs (except for research activities). The labour costs vary for different activities at the plant e.g. waste sorting was about 30% of total cost. The labour costs vary with the number of compost heaps under investigation during the different research phases.

The combined process of FS drying and co-composting is costly for a private company and hence requires a considerable government subsidy especially for the initial investment. Sales revenues would hardly cover operating expenses.

The economic analysis showed that the plant is economically viable, though financially it is not. However, the project has numerous external benefits (such as reducing waste volume, transport costs, increasing the agronomic value of compost and improving public health). Thus compost production - even without a market - saves money at other places which in turn could be used to subsidise such a co-composting plant.

[7] The plant was not operated continuously to full capacity due to the research focus. Information about the exact amount of compost produced over the years is currently not available.

10 Operation and maintenance

Collection and transportation of excreta and solid waste to the project site are performed by the Waste Management Department of KMA (Kumasi Metropolitan Assembly).

The plant manager is responsible for the management and supervision of the operation of the plant. Two labourers work under the supervision of the plant manager. The labourers are not employed by KMA but normally paid by the project (although there is currently a problem with the funding). Hence, KMA is currently not paying for the O&M costs of the plant.

The operational activities can be summarised as follows:

- FS delivery
- FS loading on drying beds
- De-sludging of drying beds
- Solid waste delivery
- Solid waste sorting
- Mixing and piling of co-composting feedstock (dried FS and organic SW)
- Turning of windrows and watering
- Sieving and bagging of the compost
- Sampling (for analysis and agronomic field trials)

The maintenance activities consist of a periodic changing of the filter medium of the drying beds when it is clogged: The top layer (sand) is then removed from the drying bed, the underlying gravel layer is washed and the top layer replaced by new sand. Time intervals for changing of the sand filter can range from several months to more than 15 years depending on the sand quality: In order to reduce the risk of clogging, sand with no or a low amount of silt/clay has to be used (to be obtained e.g. by washing).

General cleaning of the site is carried out periodically to keep it tidy. Grass is planted to beautify the place and to minimise erosion.

11 Practical experience and lessons learnt

Functional improvements of the drying beds are necessary to guarantee a continuous and sustainable compost production: Improvements are needed on the filter quality and how to control the effect of rainfall.

The co-composting plant has experienced the following operational problems:

- Occasionally, long delays in waste delivery to the site occur (due to logistical problems with the waste collectors) which consequently cause a disruption of the operation.
- If there is excessive rain then the sludge drying process takes longer than the usual 10 days, as the drying beds are not covered (clogging of the beds may also occur in this case).
- It has been observed that the nitrogen content of the compost is lower than would be required for high yield of short duration crop production as practiced in the urban areas. This is due to nitrogen losses during both faecal sludge drying and the composting process itself.
- Some measures (e.g. reduction of the compost turning frequency, fertiliser enrichment) are taken in order to reduce

these nitrogen losses. An enriched form of the compost called *Comliser* (mixture of compost and chemical fertiliser) is prepared and tested with farmers (see references in Section 13).

Addition of pure urine to the compost to increase the nitrogen content was considered but not carried out yet. IWMI, as one of the research partners, is in the process of developing a follow up research

The compost is generally of high quality as sorting of the solid waste (to removed inorganic matter, e.g. pieces of plastic and metal) is done very carefully and diligently be the plant workers.

Social problems faced were as follows:

- A few years ago, the residents of the Buobai community prevented trucks from delivering waste to the site on several occasions, making operation of the plant impossible. They claimed that KMA had used their land for setting up a faecal sludge stabilisation pond without compensating them for the land. So they used their power on this co-composting project to force KMA to act. It took a combined effort of IWMI and KMA to solve the conflict by meeting with the chief and the community.

12 Sustainability assessment and long-term impacts

The fact that this pilot plant has been operating for 7 years can be taken as a good sign for sustainability. However, for financial sustainability, external support or subsidies are needed.

A basic assessment (Table 3) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

The long term impacts of this project are:

1. The erection of a demonstration plant has served to demonstrate to policy makers, engineers, farmers, city planners and waste managers the merits of co-composting.
2. This co-composting demonstration plant has become well-known and served as a basis for similar projects in Senegal and Mali funded by Sandec.

Improved public health of residents in Kumasi would be a long-term impact if the plant was upscaled to treat a significant proportion of the faecal sludge produced in Kumasi. This is the ultimate goal.

Table 3: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene	X			X			X		
• environmental and natural resources		X		X			X		
• technology and operation			X	X			X		
• finance and economics			X		X			X	
• socio-cultural and institutional			X	X				X	

Sustainability criteria for sanitation:

Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.

Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.

Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.

Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, e.g. from fertilizer and the external impact on the economy.

Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

13 Available documents and references

A video documentary entitled "Co-treating faecal sludge and solid waste: the Buobai co-composting pilot project, Kumasi, Ghana" was prepared in 2003 describing the activities and operation of the project and giving an overview of the sanitation situation in Kumasi and Ghana at large (Maradan, J. and Schaffner, R. (2003) Co-treating faecal sludge and solid waste. The Buobai Co-composting Pilot Project, Kumasi, Ghana, video documentary)[8].

Various documents (reports, theses, papers) are available as listed below (shown in reverse chronological order, starting from 2004).

Published papers

- Olufunke, C., Doulaye, K., Silke Rothenberger, Daya Moser and Chris Zurbrügg (2009) Co-Composting of Faecal Sludge and Organic Solid Waste for Agriculture: Process Dynamics. Water Research Abstract and pdf file available at

[8] It is available to order from this website: http://www.nccr-north-south.unibe.ch/document/document.asp?ID=1907&refTitle=NCCR&Context=NCCR

http://www.sciencedirect.com or doi:10.1016/j.watres.2009.07.021

- Noah Adamtey, Olufunke Cofie, Godfred K. Ofosu-Budu, Seth. K. A. Danso and Dionys Forster (2009). Production and storage of N-enriched co-compost. Waste Management: 29 (2009) 2429–2436. Abstract and pdf file available at http://www.sciencedirect.com.
- Miezah, K. Ofosu-Anim, J. Budu, G.K.O., L. Enu-Kwesi and O.Cofie (2008) Isolation and identification of some plant growth promoting substances in compost and co-compost. International J. of Virology. 4 (2): 30-40. Abstract and pdf file available at http://www.sciencedirect.com.
- Kuffour, A.R., Awuah, E., Anyemedu, F.O.K., Strauss, M., Kone D. and Cofie, O. (2008) Effect of using different particle sizes of sand as filter media for dewatering faecal sludge. In: Richards B.S and Schafer, A.I. (eds). Water and Sanitation in International Development and Disaster Relief. Proceedings of International Workshop Edinburgh, Scotland, (UK), 28-30 May 2008. 347 – 354. http://www2.gtz.de/Dokumente/oe44/ecosan/en-filter-media-for-dewatering-faecal-sludge-2008.pdf
- Adamtey, N., Cofie, O., Ofosu-Budu, G. K. and Forster, D. (2008) Turning Waste into a Fertiliser. Sandec News 9: 16. http://library.eawag-empa.ch/sandecnews/sandecnews_9.pdf
- Nikita S. Eriksen-Hamel and George Danso (2008) Urban Compost: A Socio-economic and Agronomic Evaluation in Kumasi, Ghana in Mark Redwood (ed) Agriculture in Urban Planning: Generating Livelihoods and Food Security Earthscan/IDRC. http://www.idrc.ca/en/ev-135127-201-1-DO_TOPIC.html
- Agbottah S., Awuah E., Cofie O and A. Montangero (2007) Anaerobic Treatment of Percolate from Faecal Sludge Drying Beds – Journal of the Ghana Institution of Engineers Vol. 5 (1&2): pp. 25-30
- Koné, D., Cofie, O., Zurbrügg, C., Gallizzi, K., Moser, D., Drescher, S., Strauss, M. (2007) Helminth eggs inactivation efficiency by faecal sludge dewatering and co-composting in tropical climates. *Water Research* 41(19), 4397-4402. Abstract and pdf file available at http://www.sciencedirect.com.
- Cofie, O., Agbottah, S., Strauss, M., Esseku, H., Montangero, A., Awuah, E. and Koné, D. (2006) Solid-liquid separation of faecal sludge using drying beds in Ghana: Implications for nutrient recycling in urban agriculture. *Water Research* 40(1), 75-82. Abstract and pdf file available at http://www.sciencedirect.com.
- Vodounhessi, A. and v. Münch, E. (2006) Financial Challenges to Making Faecal Sludge Management an Integrated Part of the Ecosan Approach: Case Study of Kumasi, Ghana, Water Practice & Technology, 1(2), http://www.iwaponline.com/wpt/001/wpt0010045.htm

MSc Theses (soft copies are available on request)

- Vodounhessi, A. (2006) Financial and Institutional Challenges to Make Faecal Sludge Management Integrated Part of Ecosan Approach in West Africa. Case Study of Kumasi, Ghana. MSc thesis, UNESCO-IHE Institute for Water Education, Delft, the Netherlands. http://www2.gtz.de/Dokumente/oe44/ecosan/en-financial-institutional-challenges-ecosan-2006.pdf
- Quarshie, S. (2005) Filter material and loading rate for the optimal dewatering of faecal sludge. M.Sc. thesis in Water Supply and Environmental Sanitation, Dept. of Civil Engineering, KNUST, Ghana
- Eriksen-Hamel, N. (2003) Introduction of biowaste compost in urban farms in Kumasi, Ghana. M.Sc Thesis in Ecological Agriculture. Wageningen University and Research Centre, the Netherlands
- Boateng, O. (2003) Composting market and household solid wastes with dewatered faecal sludge: changes in microbial and helminth egg population. M.Sc. thesis, Dept. of Biological sciences, KNUST, Ghana
- Agbottah, S. (2002) Anaerobic treatment of leachate from faecal sludge drying beds. M.Sc. Thesis in Water Supply and Environmental Sanitation, Dept. of Civil Engineering, KNUST, Ghana

14 Institutions, organisations and contact persons

Project leader responsible for overall scientific coordination and project implementation.

International Water Management Institute (IWMI)
Contact person: Dr. Olufunke Cofie (o.cofie@cgiar.org)
West Africa Office
PMB CT 112, Accra, Ghana
http://www.iwmi.cgiar.org/index.aspx

Co-implementer and student supervisor

Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC)
Contact person: Dr. Doulaye Koné
P.O. Box 611, Ueberlandstrasse 133
CH-8600 Duebendorf, Switzerland
http://www.sandec.ch/

Supervision of students

Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana
Contact persons: Prof. Esi Awuah (Civil engineering Dept.) and Prof. Robert Abaidoo (Biological Sciences Dept.)
http://www.knust.edu.gh/

Logistic support, waste collection and transportation[9]

Kumasi Metropolitan Assembly (KMA), Waste Management Department
Contact person: Mr. Anthony Mensah
http://www.kma.ghanadistricts.gov.gh/

Case study of SuSanA projects

Co-composting of faecal sludge & organic solid waste, Kumasi, Ghana

SuSanA 2009

Authors: Olufunke Cofie (IWMI), Doulaye Koné (Eawag/Sandec)

Editing and reviewing: Christian Olt, Carola Israel, Elisabeth v. Münch (GTZ ecosan programme - ecosan@gtz.de)

[9] In the future, KMA should become the owner and operator of this facility once it is completely handed over (currently, KMA is a partner in the operation).

UDDTs implemented via CBOs and Water Services Trust Fund, Nyanza, Western and other provinces, Kenya

Fig. 1: Project location

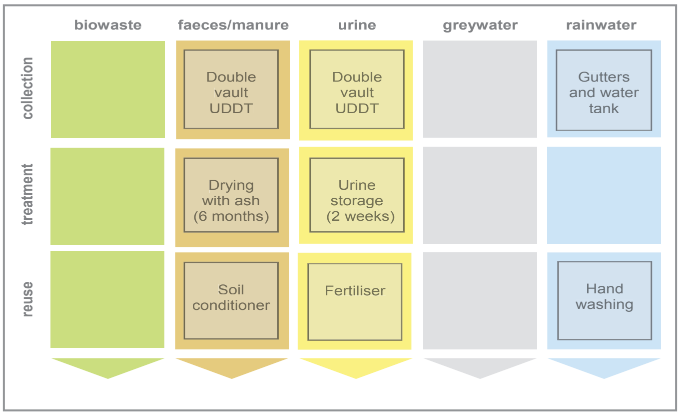


Fig. 2: Applied sanitation components in this project (UDDT stands for urine diversion dehydration toilet).

1 General data

Type of project:
Pilot UDDTs for rural and peri-urban households+schools

Project period:
Start of project: November 2006
Completed UDDTs, start of use: January 2008 onwards
End of external funding for EEP: May 2010
Monitoring by GTZ until Nov 2010 and possibly longer

Project scale:
- 658 double vault UDDTs at households
- 326 double vault UDDTs at schools
- People reached approx. 20,000 (average of 15 people per household and average of 30 students per school)
- Unit cost: average of EUR 500 for hardware, EUR 100 for software activities (such as trainings, workshops, supervision, monitoring and overheads)
- Total costs of approx. EUR 600,000

Address of project location:
Lake Victoria region with Nyanza and Western Province as well as Rift Valley Province, Eastern, North-Eastern, Central and Cost Provinces in Kenya

Planning organisation:
EcoSan Promotion Project (EEP) - supported by the EU, SIDA, GTZ and embedded in the GTZ Water Sector Reform Program) in cooperation with the Ministry of Water and Irrigation in Nairobi

Executing institution:
- Community based organisations (CBOs)
- Kenyan water sector institutions:
  - Water Services Boards (WSBs)
  - Water Services Trust Fund (WSTF)

Supporting agency:
- European Union (EU) – ACP EU Water Facility
- Swedish International Development Agency (SIDA)
- German Technical Corporation (GTZ) - on behalf of German Federal Ministry for Economic Cooperation and Development (BMZ)

2 Objective and motivation of the project

The project described in this case study is part of the much larger EU-SIDA-GTZ EcoSan Promotion Project (EPP). Its objective was to reach a total of 50,000 users with reuse oriented sanitation systems. It piloted reuse oriented sanitation projects through three intervention lines:[1] (1) household toilets in rural and peri-urban areas, (2) institutional toilets at schools and prisons and (3) public toilets in bus parks, markets and recreation areas.

Fig. 3: Rural household UDDT in Nyanza Province (source: Paul Mboya, GTZ-Kenya, Aug. 2009 – Note distance between house and toilet is approx. 20 meters)

This case study describes the activities of the first and partially second intervention lines which had the following objectives:

- Introducing the concept of recycling human waste as fertiliser to small scale farmers as a strategy to generate additional income ("productive sanitation").
- Installation of urine diversion dehydration toilets (UDDTs) to improve public health in cholera affected areas and other areas with high occurrence of water related diseases mostly caused by seasonal flooding.

[1] See also the cases studies for a public toilet in Naivasha and school UDDTs http://www.susana.org/lang-en/case-studies/region/ssa

- Assisting communities that experience challenges with conventional pit latrines due to flooding, high groundwater table, collapsing soils and rocky soils.
- Building capacity amongst the local communities, artisans, private sector, NGOs and water sector institutions in Kenya to implement UDDTs as an alternative sanitation option.

3 Location and conditions

The project areas are villages in rural and peri-urban areas where farming is practiced. The target areas have frequent cholera outbreaks due to seasonal flooding or generally suffer from other water related diseases. The targeted areas were distributed throughout Kenya in order to include various ethnical groups with diverse learning cultures and social backgrounds. However the area with highest number of implemented UDDTs was Nyanza and Western Provinces surrounding Lake Victoria which are critical cholera hotspots. 60-88% of all diseases in Kenya are linked to insufficient water supply and basic sanitation.[2]

Fig. 4: Overview of 7 project areas in Kenya where UDDTs were implemented (indicated by circles).

In Kenya, the under-five child mortality rate is currently[3] **128 children per 1000**, and sadly there has been an upward trend towards more child deaths since 1985 when the value was 98 child deaths per thousand.

Fig. 5: Household UDDT and shower on the left in the semi-desert area of Wajir, North Eastern Province (source: Paul Mboya, GTZ-Kenya, March 2009).

Generally, the greater Lake Victoria area is characterised by sufficient rainfall for agricultural production. Highland regions around Lake Victoria like Kisii and Bungoma receive heavy rainfall with up to 1,800 mm of annual rainfall whereas the lowland areas receive less rainfall with less than 1,000 mm of annual rainfall. The rainy period is March/May and October/November.

The people in the target areas mostly use simple pit latrines (VIP, covered and uncovered pits). According to the Kenya Integrated Household Budget Survey about 56% of urban households in Kenya use latrines compared to 79% of rural households.[2] Hence open defecation is also a common practice in Kenya.

The majority of the people in the rural target areas are subsistence farmers with an average income of approx. EUR 30 (3,000 Kenyan Shilling) per month. Health statistics from hospitals in the area show that cases of cholera and other water borne diseases like diarrhea, typhoid and parasitic infections occur especially during the rainy season, when pit latrines get flooded and pollute the drinking water resources like wells and rivers.

The average household size is 20 people consisting of a few family generations living on one compound of average 1-5 acres and with one toilet. Thus up to 20 people may share one UDDT. It also occurs that smaller households share one common toilet as it is practiced within the Luo community. To estimate the number of users for this project, we used a figure of 15 people per toilet in household and 30 students in schools.

4 Project history

The Ministry of Water and Irrigation (MWI) has committed itself through the Water Sector Reform Program to facilitate the improvement of water supply, sewerage and sanitation service provision in Kenya. GTZ is supporting the Kenyan Water Sector Reform Program through its Water Program which has several components. The fifth component was the EU-SIDA-GTZ EcoSan Promotion Project (EPP) which was implemented from end of 2006 to mid 2010.

---

[2] The Water Sector Sanitation Concept – WSSC (Ministry of Water and Irrigation/MWI, Kenya, August 2009).

[3] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

The EPP was financed by the ACP-EU Water Facility[4] (EUR 1,734,000) and co-financed by SIDA (EUR 816,000), GTZ-Kenya Water Program (EUR 100,000) and the GTZ-Kenya Agriculture Program (EUR 100,000). The project was implemented by GTZ-Kenya.

The total number of installed UDDT units in May 2010 was 658 at households and 326 in schools implemented directly through CBOs or via channelling funds through the Water Services Trust Fund (WSTF) to the Water Services Boards (WSBs). The WSTF is still in the process of implementing more units with funds that were provided by EPP in advance.

Tab. 1: Total number of constructed UDDTs in rural and peri-urban areas (based on final report of EPP May 2010). The school UDDT are described in a separate case study.

	UDDTs constructed in	
	Households	**Schools**
via CBOs	541	263
via WSTF-WSBs-CBOs	117	63
Sub-total	**658**	**326**
Total		**984**

Ecological sanitation (ecosan) with UDDTs is not new in Kenya. It has been implemented on a small scale through some NGOs such as KWAHO, ALFEF and SANA over the last 10 years. There were positive as well as negative examples which were used to determine the right strategy and approach to promote UDDTs in Kenya.

Process and partners

The EPP offices were located at the Ministry of Water and Irrigation as the main local partner. In the beginning of the project in 2007 the project assigned three sanitation officers (also called regional site managers) that were coordinating the participatory work directly with the communities and community based organisations (CBOs). UDDTs were directly implemented with the CBOs and initial service support from the NGOs KWAHO (Kenyan Water for Health Organisation) [5] and ALDEF (Arid Land Development Focus). This provided firsthand experience to fine tune strategies and concepts for the coordination of ecosan activities with the water sector and other important stakeholders which are important for future up-scaling.

Mid of 2007 the first toilets were constructed directly with CBOs. The approach was to always set up a cluster of 10 to 20 toilets at households and at one local primary school within one community - walking distance of less than 20 minutes to each other was envisaged. The central focus was to include both households and schools as they form one community which can provide much better for a crucial momentum for sanitation improvements instead of focusing only on households or schools individually. In the past it was also observed that “numbers also matter” in order to achieve behaviour change and to increase social acceptance of new development within a community. Moreover schools are fundamental for promoting good hygiene behaviour of children who then try to pass this on to their families at home. This passing on of information and behaviour change from school to households is only fruitful if the community as a whole is part of the process and has access to adequate toilets.

From 2009 onwards the EPP gradually started to work more closely with the water sector institutions that are responsible for water and sanitation infrastructure in Kenya. The two main partners were the Water Services Boards (WSBs) who are the responsible regional institutions for infrastructure development and asset management. Secondly the Water Services Trust Fund (WSTF) is a basket fund for financing water and sanitation infrastructure in low-income urban and rural areas of Kenya (see Section 14 for contact details). Other stakeholders like the Ministry of Health, Ministry of Public Health and Sanitation, Ministry of Agriculture and others were contacted, involved and capacity built on ecological sanitation.

The EPP together with WSTF and WSBs developed a project cycle and implementation programme for the implementation of UDDTs via the water sector institutions in late 2009 (see Annex 1,2). It was based on a demand-responsive approach and a great emphasis was placed on community participation and ownership as according to the experiences gained from the first 2 years of EPP (see Section 5). It was agreed that interested communities after awareness creation direct their letter of interest to the WSBs, who then submit an official application for funding to the WSTF. WSTF is then forwarding the funds to the WSBs, who engage their own human resources and the private sector for the project oversight, training, monitoring and follow up of the sanitation facilities together with the communities. EPP acted as the quality control agent and capacity building partner with its sanitation officers on the ground.

Simultaneously the GTZ Water Program and EPP entrenched basic principles of ecological sanitation (ecosan) in the national sanitation concept of the Ministry of Water and Irrigation that was issued in August 2009 (see Section 13 for available documents). This “mainstreaming” of ecosan and sustainable sanitation systems into governmental structures was an important factor for the desired preparation of up-scaling of sustainable sanitation services beyond the duration of the EPP project.

5 Technologies applied

The toilet technology used under this project in rural areas was the double vault urine diversion dehydration toilet (UDDT). The promotion of this toilet type was chosen to showcase an alternative to the widely used pit latrines that are a source of water contamination as well as not allowing reuse of human waste. Often people have problems with pit latrines after rains due to flooding and instable soils (collapsing of pits). Moreover there are problems with high groundwater tables and rocky soils that make digging of pit latrines very costly and limited.

The toilet owners were not given any other choice of toilet design other than the UDDT type. In other settings more suitable for water based sanitation, the EPP has also implemented pour flush and low flush toilets with waste water

[4] ACP-EU stands for Africa, the Carribean, the Pacific and the European Union. This project was funded under the first call of the first water facility in the category of “improving water management and governance” and “Co-financing water and sanitation infrastructure” in September 2006. http://ec.europa.eu/europeaid/where/acp/regional-cooperation/water/

[5] www.kwaho.org

treatment systems, which is documented in other case studies.[6]

Fig. 6: Back view of household UDDT near Bungoma town in Western Province with two faeces vaults and ventilation pipe (source: Moses Wakala, GTZ-Kenya, Jan. 2010). Note: The inclination of faeces vault doors is not necessary for proper function – see Section 11. Moreover note the toilet is in relative close distance to house.

The main principle of the UDDT is the separation of faeces and urine at source through the installation of a special urine diversion squatting pan or sitting pedestal. In this project only squatting pans were used. The faeces are collected in the vault below the toilet, where the faeces dry over time assisted by a ventilation pipe. After each use the user pours a cup of ash into the faeces vault for absorption of water, fly prevention, pH treatment via pH increase and to cover the fresh faeces which results in a more pleasant look. Alternatively, dry soil or dry leaves can also be used, but they do not provide for pH treatment.

There are two faeces vaults per UDDT, which helps in avoiding handling of raw or insufficiently dried human excreta. When the first vault is full after approximately 3 to 6 months, the first defecation hole is closed and the second defecation hole is opened which lies above the second vault. By the time the second vault has filled up, the first vault's faeces have dried up. It was recommended to the user to work with a 6 month period which has proven as sufficient time for treatment and for a user number of 20.

[6] Case study: UDD toilets and Decentralised wastewater treatment systems for schools in Kenya http://susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=750

Fig. 7: Faeces collection vault which is half full (source: David Watako, GTZ-Kenya, July 2009). Note: Sufficient use of ash and appropriate use results in a dry and odour free condition of the vault.

Fig. 8: Inside view of a UDDT with ash container on the right. The squatting pan has two faeces outlets: only the one on the left is currently in use. In the left corner is the ventilation pipe (not visible) (source: Moses Wakala, GTZ-Kenya, June 2008).

Most of the pathogens in the faeces die due to the drying process. Hence the handling is relatively safe, if certain precautionary measures are followed (see Section 7). The user and/or caretaker empty the vault with a shovel or similar tool and transport the dried faeces to the farm for use. In general the farm is located next to the house and toilet at a distance of less than 100 meter.

The urine is diverted via the urine hole of the squatting pan which is connected to a flexible hose pipe or PVC pipe and drains into a standard container (20 Litre jerry can) located in a separate storage vault. Furthermore the toilet has a hand washing facility consisting of a 100 liter plastic tank with tap which is placed on top of the urine storage vault. A rain water harvesting system from the toilet´s roof is also connected to the hand washing facility to provide additional water and to demonstrate usefulness of rainwater harvesting.

Community participation

The EPP developed a strategy on how best to approach the communities for successful implementation of UDDTs. This is described in detail in the project cycle (see Appendix 1). It was based on a demand-responsive approach with strong participatory elements that create ownership within the community. Therefore the project worked in collaboration with Community Based Organisations (CBOs) as legitimate groups representing the communities at grass-root level. The EPP developed pre-selection criteria for the areas in which the communities should be contacted for UDDT awareness creation. These criteria are related to ground conditions that cause challenges to the use of conventional pit latrines such as frequent flooding, rocky underground, collapsing soils and high groundwater table. The overarching selection criteria were areas with public health problems due to inappropriate sanitation systems.

The acceptance of reuse oriented sanitation systems such as UDDTs depends on people's perception to view treated human waste as a useful resource. This requires a clear understanding of the people's learning culture in order to align the ecosan principles to indigenous practices and knowledge. For example the culture of pouring ash on a pile of faeces from open defecation meant in one area that the person who defecated becomes cursed (bewitched). For fear of this curse people avoided to defecate in the open. Now the Kenyan trainers explained to the people that their cultural handling of open defecation has made perfect sense, since it prevented the dangerous habit of open defecation and at the same time treated the faeces with ash in order to prevent spread of diseases. Once people understand the context, they will not fear witchcraft when pouring ash on faeces but instead realise that the procedure was already common practise in their community for the good of the community (anecdotal evidence).

Moreover the Kenyan trainers developed a special language to get people's attention on ecosan like saying "we are preaching ecosan" and that we talk about "factories" that produce fertiliser instead of a toilet (Blume, 2010).

The future toilet owners were required to provide a contribution equivalent of to at least 20% of the total costs per UDDT by providing locally available building material and unskilled labour. Depending on the capacity of the person, a higher contribution was encouraged in terms of more locally available materials or direct hardware and construction costs. Sometimes more than one family or household share one toilet, depending on cultural preferences. A maximum of 20 users per UDDT is proposed. The average family size is around 10 to 15 members.

In many cases the sanitation officers organised exchange visits for members of the community to other ecosan projects to see firsthand how it works and how productive ecosan can be. This approach of "seeing is believing" has worked very well. After return from such a trip the people were very convinced of UDDTs and acted as strong opinion leaders to change the attitudes amongst their whole community.

The community was also tasked to source suppliers (artisans, hardware shops, brick merchants etc.) and take charge of inventory and quality control under the guidance of the sanitation officer. A Memorandum of Agreement specifying the roles and responsibilities of the different players was developed and signed by the parties as a commitment to roll out the process (see project cycle in Appendix 1 for details).

6 Design information

Each family either has one or two UDDTs (as one toilet block) depending on the number of family members (up to 20 users per toilet). The toilet building is made of masonry from locally available burnt bricks, concrete blocks or in some cases hydraform blocks depending on the availability of materials (see Section 8). A few examples are also known from people who replicated UDDTs on their own by using sun-dried clay bricks. On the outside the masonry is keyed, on the inside plastered and painted in light colors. Roof boards and doors are also painted.

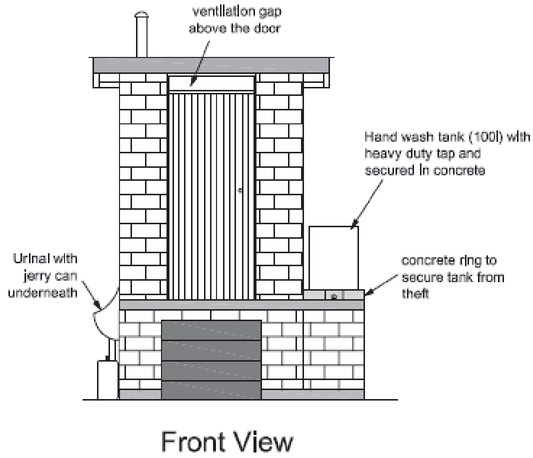


Fig. 9: Design drawings of UDDT (for website link of drawings see Section 13)

The plastic squatting pan is from the local manufacturer Kentainers[7] and was designed in cooperation with GTZ. It was sold for approx. EUR 35. It is a double hole urine diversion squatting pan made from plastic in various colors. Two lids are provided. One lid has a handle for the active vault and can be operated either by foot or by hand. The other lid has no handle and is used to cover the inactive vault. A heavy stone or similar is tied to the lid so that nobody removes the lid by accident. Alternatively a stone or heavy item can be placed on top. The urine pipe is a flexible hose pipe, size 1" (inch), or a 2-3" PVC pipe that leads directly to a plastic container in an attached urine storage vault. Flexible hose pipes have shown high sensibility to blockage and should therefore be avoided.

A sitting pedestal for urine diversion was not developed and installed due to the limited project time frame. Similarly urinals were not installed at the household level. However it might be of interest to the toilet owners to have an urinal in order to increase urine harvest and have a sitting type for more convenience and suitability for elderly and disabled users.

Urinals for the household toilets were not promoted for no certain reason. In preparation for the construction there was no evaluation done on possible demand for urinals and other designs options.

[7] http://www.kentainers.com/kent/home.html

Fig. 10: Various urine diversion plates at the factory of Kentainer. The double vault plate was developed by EPP (source: C.Rieck, GTZ-Kenya, Jan 2010).

The urine container, or so called jerry can, is of standard size (20 liters) and is often a cooking oil container as bought in most supermarkets. It is then re-used for water collection and other domestic purposes. About two to three jerry cans can fit in the urine storage vault, which can be locked to protect the containers from being stolen (see Fig.12). On top of the vault sits the 100 liter plastic water tank with tap for hand washing purposes. The tank is ideally fitted into a concrete ring to protect it from theft.

Fig. 11: Inside of urine storage vault with a number of urine containers (Source: Moses Wakala, GTZ-Kenya, Jan. 2010).

The faeces collection vaults each have a size of approx. 600 litre (length, width and height: 75 x 110 x 75 cm). They are plastered inside (though not strictly necessary) and have a concrete floor that is slanted towards the outside in order to drain excess liquid. The vault doors were initially made of a wood frame and covered with a flat iron sheet, but termites quickly damaged them. Later a metal frame and lid were used for better durability. The doors can be closed with locks, wire or other local methods. Alternatively the doors can be made from concrete slabs or brick work. The faeces collection vault doors were initially inclined and painted black to absorb heat from sunshine for enhancement of the dehydration process. However the inclination is not strictly necessary for dehydration process and not recommended anymore for various reasons (see Section 11).

Each toilet has a bucket with ash, a scoop and a laminated instruction poster inside the toilet. The inclusion of anal cleansing with water was not integrated in the design, since none of the beneficiaries practiced it (toilet paper is only used). The technical drawings and BOQ are freely available (see Section 13).

The toilets were built about 10 to 30 meters away from the houses depending on the preferences of the toilet owners. They were not built adjacent or inside the houses because the EPP this as there were still doubts about the absence of odour.

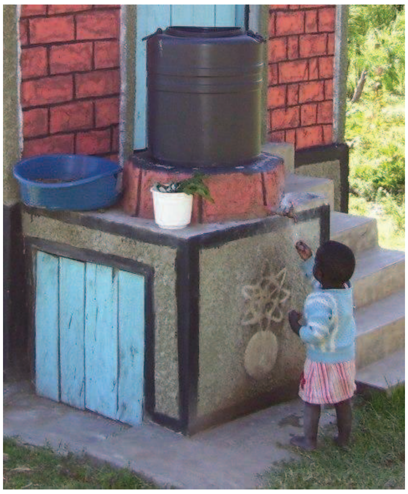


Fig. 12: Hand wash facility with 100 litre tank and tap secured in concrete located on top of urine tank storage vault (Source: Moses Wakala, GTZ-Kenya, Jan. 2010).

Note that the design described in this section here was optimised later at the end of the project (see section 11 to learn about modified design guidelines).

7 Type and level of reuse

The toilet owners, who are mostly subsistence farmers, were trained on use of urine as fertiliser and use of dried faeces as soil conditioner in agriculture. The urine is directly used in the farms of the respective households once the available jerry cans (2-3 pieces) are full. This means that the users apply the urine frequently depending on the number of storage containers and the number of toilet users. The amount of urine also depends on the male users, who might tend to urinate in the open. Ideally one family of 10 users produces about 10 litre of urine per day (half of standard jerry can) assuming 1 litre of urine per person per day.

A dilution of urine with water is widely practiced and demonstrated during trainings at a rate of 1:1 to 1:10, although urine can also be applied undiluted.[8] The user digs a small shallow depression next to the crop, pours the urine and covers the depression again with soil. Thereby the nitrogen is not lost due to evaporation of ammonia. The crops which have been fertilised using the urine include kales, spinach, maize, mangos and bananas.

The EPP has distributed cultured mangos and tissue culture bananas to some users to initiate the commercial production of fruits with urine fertiliser. The positive effects of ecosan fertiliser on the production were easily seen by the users compared to the plots that did not use fertiliser. In most cases

[8] See GTZ Technology Review: Urine diversion components http://www.gtz.de/en/dokumente/gtz2009-en-technology-review-urine-diversion.pdf

the farmer did not have the financial capacities to buy fertiliser in the first place.

The faeces are used directly in the farm after a drying period of six months. No further treatment (such as external composting) was promoted though it is also practiced. The dried faeces are filled in a shallow pit as a layer and then covered with at least 20 cm of top soil. This protects further contact to humans and animals. It was advised to use the dried faeces for fruit trees like bananas and mangos. Accordingly there should be no cultivation of root vegetables. In May 2010 the first households have started using dried faeces. There is no exact data available on improved yields yet.

Fig. 13: Caroline Atieno using urine for maize and bananas in Rongo District, Nyanza Province (Source: Wycliffe Osumba, GTZ-Kenya, June 2010).

Over a period of three months in early 2010 various samples of urine and dried faeces were collected and analysed at the University of Egerton in Nakuru, Kenya (Kraft, 2010). The results show a sufficient rate of pathogen die off in faeces to levels required by WHO[9] if the toilets are used properly and sufficient storage time is provided. One key element for pathogen die-off has been identified being the addition of ash causing elevation of pH level above 9. However some households were not using the UDDTs the right way by mixing urine and water with faeces resulting in cross-contamination of urine with faeces, slow drying process (odour) and therefore insufficient pathogen die off. Hence the users are advised to apply health risk reduction measures like wearing gloves, rubber boots and washing hands when using the toilet product. Additionally it is important to select the appropriate crops. For example the use of urine and dried faeces for fruit trees reduces the health risk since the edible parts are not getting in touch with the fertiliser. In case of excess urine the users are advised to infiltrate the urine as a fall-back option.

In areas of Mumias in Western Province and parts of Nyanza Province there is plenty of anecdotal evidence showing a very strong and positive uptake of UDDT technology by subsistence farmers. The toilet owners are becoming impatient to wait for the appropriate time to harvest the dried faeces for their farms. They praise their fertiliser and lock up their urine and faeces storages for fear of theft by neighbours who have seen the increase of crop yield due to fertilisation with urine and dried faeces.

8 Further project components

The EPP team trained local artisans in the construction of the UDDTs. This qualification might create the possibility of income generation for local artisans in a growing sanitation market. About 50 artisans were invited to a follow-up workshop in Ugunja in March 2009 and each received a certificate from the EPP about the successful attendance. This will help them in acquiring work in the sanitation business.

There were also UDDTs being constructed in primary schools of each cluster. This component is described in another case study (see Section 13).

Furthermore, the project promoted the introduction of an innovative technology, called hydraform blocks, which can be a source of income for young people and also help in making affordable construction of decent housing and sanitation facilities. The advantage of hydraform blocks compared to burned bricks is that no firewood is needed in their production, local materials like specific clay soils can be used under addition of comparatively small amount of cement, which makes production relatively cheap.

The machines to make hydraform blocks were lent from the Ministry of Housing to train young people and government officials as well as produce a certain number of stones.

Fig. 14: Left: Production of hydraform blocks; Right: completed hydraform blocks (Source: Paul Mboya, June 2009).

The EPP has also implemented other ecological sanitation technologies such as pour-flush toilets with decentralized waste water treatment at schools, prison and public place, that produce biogas for cooking purposes and use the treated water for irrigation purposes (not mentioned in this case study)

9 Costs and economics

The capital cost of one UDDT was on average Kenyan Shillings (Ksh) 50,000 (approx. EUR 500). Software costs for awareness creation, trainings and monitoring was assessed with average costs of EUR 100 per toilet. Follow up activities are not included. Operation costs are negligible since it is the owner who collects the products from the toilet and maintains the toilet.

[9] http://www.who.int/water_sanitation_health/wastewater/gsuww/en/index.html

The costs for a conventional pit latrine are EUR 50-250 depending on soil condition, depth of pit, required lining and design. Hence the costs of UDDTs of EUR 500 built under this project are considerably higher than pit latrines. The UDDTs were not built in the cheapest way but rather with high quality and appealing character making it a rather "fancy toilet" with high construction costs. It was the idea of the EPP team to market the UDDTs as modern and uplifting which in turn should create a positive mindset on development and instil pride. The most significant cost items were cement and stones.

Tab. 2: Construction costs of a "fancy" double vault UDDT in Kenya build by the EPP in 2009 according to Blume (2009)

Item category	Costs in Ksh	Costs in Euro	in %
Foundation	4,525	45	9%
Double vaults	6,250	63	12%
Toilet slab	3,789	38	7%
Squatting plate (plastic)	3,500	35	7%
Urine storage vault with slab for water tank	3,900	39	7%
Urine storage vault doors	3,000	30	6%
Ventilation	630	6	1%
Steps	1,425	14	3%
Walls	7,579	76	15%
Doors	1,800	18	3%
Painting	1,000	10	2%
Roofing	3,268	33	6%
Hand washing unit	800	8	2%
Rainwater Harvesting	745	7	1%
skilled labour costs	7,000	70	13%
unskilled labour costs	3,000	30	6%
Total	**52,211**	**522**	100%

However the UDDT can be made cheaper by more than 50% if cheaper and locally available materials are used e.g. sun-dried mudstones, avoiding painting and other simplifications like omitting rainwater harvesting. See the study on costs and economics of UDDTs from Blume (2009) under Section 13. In other countries like Peru or China UDDTs are constructed for less than EUR 150.

Each cluster of about 10 to 20 UDDTs (per community) was provided with a total lump sum subsidy of EUR 5,000 by the EPP. Generally, a subsidy of approx. EUR 400 was allocated per UDDT for purchase of construction materials and skilled labour costs (equals 80% of the total construction cost). The purchases were paid directly by EPP. The provided contribution by the future toilet owner/client had a value of a minimum of 20% or above the total construction costs (see Step 5 of project cycle in Appendix).

The project promoted the linking of UDDTs with banana and mango production, which after two years would start returning about Ksh 5,000 (EUR 50) net per year. Using a basic calculation, this would require about 12 years generating "profit" from the toilet. The toilet design life is 20 years and so the profit would continue for another eight years.

Fig. 15: Young mango and banana plants were distributed for free by the EPP team to the users of UDDTs to support economic gain from urine and faeces use (source: Johannes Odhiambo, GTZ-Kenya, 2010). The users were also trained in production and marketing of the fruit products.

10 Operation and maintenance

The household is responsible for the correct use and maintenance of the toilet. Correct use includes cleaning of the facility, provision of wood ash (or other suitable materials), toilet paper, repairing urine pipe blockages, urine management and removal of dried faeces from the vault approx. every six months. The urine containers fill up on average one to three times a week. Storage space is limited, so application of urine is an ongoing activity for toilet owners. The maintenance includes minor repairs of the water tap (hand washing unit), vault doors (due to rusting, termites), roofing, rainwater harvesting tank and occasional repainting. It has not been identified who is usually doing the operation and maintenance chores in terms of gender.

11 Practical experience and lessons learnt

Project management lessons:

- The large geographical spread of the UDDTs made project management in terms of transport and monitoring very difficult and costly. In addition, health benefits are unlikely to occur when only small fractions of each community are served.
- Experience has shown that the contributions by the toilet owners/clients (materials, labour and/or cash) are essential for ownership of the UDDT. Ownership could be further enhanced by higher percentage of contribution through a less expensive design.
- The general approach of the EPP was to only offer one relatively expensive design with a fixed list of materials (see Section 13). This prescribed high initial standard and the offered subsidies might have created a culture of dependence on subsidies amongst potential clients. It has led to no significant replication and adoption of UDDTs yet. Many interested people are now waiting for subsidies instead of adopting the technology with their local means. In only a few cases spontaneous replication of UDDTs without subsidies has been reported. However it is increasingly noticed and documented that private ecosan entrepreneurs are starting to make an impact by promoting and

successfully selling UDDT technology to institutions and households.

- In future it is advisable to offer more technical options to cater for different user preferences and ability to pay. There should be options for installation of UDDTs inside or adjacent to the house. And of course cheaper UDDTs are also possible and only limited by the creativity of the people (see Section 9). Apart from UDDTs there are also simple and low-cost composting toilets like Arborloos and Fossa Alterna which can work well in rural areas. This way dependence on subsidies could be reduced and spontaneous replication is more likely.
- The community members might also be interested in the combination of toilets with showers and soak pits, greywater use for irrigation purposes or modification of existing toilets or showers. The people should learn and acquire the capacity to modify the design of structures as per their own context, requirement, budget and resources.
- It has been observed that the toilet users require a continuous follow-up for approximately 1.5 years after they have started using the toilets considering the full cycle of faeces recycling. Unfortunately the EPP did not have the resources and time to deliver this service as laid out in Step 11 of the project cycle (see Appendix 1) because it was only a 3-year project which is actually too short for such kind of project. Hence a number of households experienced problems with urine pipe blockages, leakages of rainwater into the faeces collection vault, breakage of water taps from the hand wash facilities and confusion about reuse of urine and faeces. However the GTZ program "Sustainable sanitation – ecosan" is providing some further follow-up from May 2010 onwards (see Section 13 for more information).

Technical design lessons:

- The slanted doors of the faecal collection vault, so called "solar panels", have not shown the desired effect of absorbing heat. The thick masonry walls keep the vaults rather cool. In most cases the toilets were located and orientated according to the toilet owner´s personal preferences and not towards the sun. Hence the alignment to the sun was rarely achieved. It was also observed that the roof overhang has shaded the vault doors considerably in this region close to the equator with almost vertical position of the sun. Moreover there were also problems with leakages of rainwater into the vault due to poor craftsmanship and insufficient material quality (such as untreated wood frame of the vault´s doors being destroyed by termites). In order to address this problem it is recommended to use a straight back for the faeces vaults with minimal risk of rainwater leakage. This design also reduces costs slightly and simplifies the construction process.
- Faeces vault doors should be made of metal, concrete or other material resistant to termites and other degrading and decomposing processes. Alternatively a wooden frame needs to be protected with anti-termites coating. Furthermore the vaults can also be closed with bricks or concrete slabs with the use of weak mortar, though this method requires frequent reconstruction once the vaults are opened for emptying purposes. It involves extra work and money.
- The majority of constructed UDDTs have no urinals for men. This is a disadvantage for men who do not want to squat for urinating or therefore urinate in the squatting pan or pedestal while standing. This bears the risk of male users urinating into the faeces vault (by accident or ignorance), urine splashing into the faeces hole and polluting the toilet interior causing odour and malfunction of the toilet. However this problem was not widely noticed, maybe because tend to urinate outside or the toilets were sufficiently cleaned from the slashed urine. In order to increase the amount of collected urine, it is recommended to provide to the client the choice of fitting a waterless urinal for men outside or inside the toilet.[10]
- The flexible hose pipes of 1 inch for urine collection have constantly blocked due to accidental use of ash, defecation and disposal of toilet paper in the urine section e.g. by untrained visitors or often children. The flexible pipe also develops sharp bends that can also easily block the drainage. Therefore it is recommended to use standard straight PVC pipes with a diameter of 2 or 3 inches. These pipes are also commonly stocked in local hardware shops as compared to the flexible hose pipe which could only be found in bigger cities.

Fig. 16: A double door UDDT with attached shower for a family with more than 20 users in Western Province. The shower was added on initiative of the toilet owner (source: Laura Kraft, 2009)

- The rainwater harvesting system with gutters and down pipes proved to be a rather luxury item. First of all the roof area is too small to provide a sufficient amount of water for hand washing and the 100 liter tank is also too small to store enough rainwater for a sufficient period of time. The toilet users have developed a habit to wait for the rain to fill the tank instead of manually refilling it! To save investment costs and to accustom the users to the manual operation of the hand washing facility (refilling) it could be of advantage to omit rainwater harvesting for household UDDTs.
- The plastic tank of the hand washing facility needs to be secured in a concrete ring to avoid theft and misuse: It was often witnessed that the tanks were missing or used in the household for other purposes due to fear of theft.
- Hardware subsidies should be minimised and only be used for (1) the squatting pan, (2) the hand washing unit and (3) skilled labour costs. Software inputs on the other hand like

[10] See example on flickr http://www.flickr.com/photos/gtzecosan/4874570749/in/set-72157624617691048/ ; or Urine Diversion Technology Review http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/9397.htm

awareness raising, hygiene education, trainings, construction supervision, monitoring and follow up should be fully subsidised. This way the process will be more demand driven (less subsidy driven) and foster up-scaling of UDDTs in rural and urban areas.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised.

Tab. 3: Qualitative indication of sustainability of the system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X			X	
• environmental and natural resources	X			X			X		
• technology and operation		X		X			X		
• finance and economics		X			X		X		
• socio-cultural and institutional	X			X			X		

Sustainability criteria for sanitation:

Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.

Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.

Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.

Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.

Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

The project has increased the interest for productive sanitation as most people were previously not aware of the fertiliser properties of human excreta. The new owners of the UDDTs are very interested in the UDDTs especially because of the fertiliser production and the resulting increase of crop yield. Some communities members have even formed a revolving fund where the additional income from the increased crop production is used for construction of more toilets for the members of the CBO [11]. In other cases toilet owners have joined hands by using urine from their toilets for commercial farming on hired plots.

The expected long term impacts of the project are:

- Enhanced ability of communities to build UDDTs on their own or with the trained artisan.
- Increased capacity at water sector institutions like WSTF and WSBs to implement ecosan in general, or UDDTs in particular in rural and peri-urban areas.
- The pilot projects and units should lead to copying and adaption of the toilet designs by households and institutions
- Increased agricultural production through use of fertiliser from UDDTs by toilet owners on their plots.
- Reduced waterborne diseases through installation of UDDTs and improved awareness on proper hygiene practices like hand washing. It is however practically impossible to prove such health impacts since the UDDTs were only installed in some households of a specific area.

The impacts are being observed by GTZ Kenya and the newly formed ecosan network Kenya which is supported

13 Available documents and references

The following documents are available:

Photos from this project are available on flickr:

- http://www.flickr.com/photos/gtzecosan/sets/72157623181078999/ and other sets under Kenya

Videos from this project are available on youtube:

- Project examples from EU-GTZ-SIDA EcoSan Promotion Project (01/2010) (part 1-4) http://susana.org/lang-en/videos-and-photos/resource-material-video?view=ccbktypeitem&type=3&id=8
- Opap Group, Nyanza province, by Tembea Youth Center for sustainable development (2009) http://www.youtube.com/watch?v=qeW9ZR97bIM
- Johannes Orodi Odhiambo explains the advantages of UDDTs at a new toilet in Ugunja (05/2009) http://www.youtube.com/watch?v=w_MsIuz50eo

Drawings:

- Drawings and BOQ of urine diversion dehydration toilet for households and schools (Kenya), April 2010 http://www.susana.org/lang-en/library/rm-technical-drawings

Publications:

- Blume, S. (2009) Study on costs and economics of UDDTs including BOQ, report for GTZ Eschborn,

[11] This particular CBO in Nyanza Province is well organised and structured due to former projects and capacity building by other organisation that had introduced the idea of a revolving fund. This concept was then modified by the CBO for that purpose. More information from Paul Mboya mboyapaul@gmail.com

Germany
http://www.susana.org/images/documents/07-cap-dev/a-material-topic-wg/wg02/blume-2009-cost-optimization-uddts-kenya-final-draft.pdf

- Kraft, L. (2010) Final sampling report for products from double-vault UDDTs, report for GTZ Eschborn, Germany http://www2.gtz.de/Dokumente/oe44/ecosan/en-eu-sida-gtz-ecosan-promotion-project-final-report-2010.pdf
- Miyona, J. (2008) Instruction poster for use of UDDT, consultant for GTZ Kenya http://susana.org/images/documents/07-cap-dev/e-visual-aids-drawing/posters/en-using-ecosan-toilet.pdf
- Odhiambo, J.O. (2008) Example of a Memorandum of Agreement, GTZ-Kenya http://www2.gtz.de/Dokumente/oe44/ecosan/en-memorandum-of-agreement-2009.pdf
- Mboya, P. (2010) Map of GTZ ecosan project sites, GTZ-Kenya http://www.susana.org/lang-en/resource-material?view=ccbktypeitem&type=2&id=733
- Onyango, P., Odhiambo, J.O. and Oduor, A. (2010) Technical Guide to EcoSan Promotion, GTZ-Kenya http://susana.org/images/documents/07-cap-dev/e-visual-aids-drawing/technical-drawings/en-technical-guide-ecosan-promotion2.pdf
- Blume, S. and Rieck, C. (2010) “Ecosan storying telling” - preaching ecosan by Johannes O.Odhiambo http://ecosankenya.blogspot.com/2010/06/sing-ing-gosp-el-of-ecosan-k-enyan.html
- MWI (2009) The Water Sector Sanitation Concept – WSSC, Ministry of Water and Irrigation (MWI) Kenya http://www2.gtz.de/Dokumente/oe44/ecosan/en-mwi-kenya-sanitation-concept-2009.pdf
- Kraft, L. (2010) Case study of UDDTs in schools, Kenya http://susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=750
- Rieck, C.: Sanitation project cycle for rural areas, Kenya http://www.susana.org/'.JRoute::_('index.php?option=com_ccbk&view=ccbktypeitem&Itemid='.397.'&type=2&id='.812)
- Implementation programme of EPP/WSTF/WSB, http://www.susana.org/'.JRoute::_('index.php?option=com_ccbk&view=ccbktypeitem&Itemid='.397.'&type=2&id='.813)

Continuous updates about the project sites and follow up activities are available on this blog http://ecosankenya.blogspot.com/ .

More communication is available on the facebook page http://www.facebook.com/ecosan.kenya .

14 Institutions, organisations and contact persons

Technical Planning and Implementing Support
EPP (EU-SIDA-GTZ EcoSan Promotion Project), Kenya (during Nov. 2007 to May 2010)
Ministry of Water and Irrigation (MWI)
3rd Floor/Suite 316, Maji House
Ngong Road, Nairobi, Kenya
T: +254-20 272 3353

Contact 1: Paul Patrick Onyango
Former project leader
T: +254 721 172 661
E: onyangopadak@yahoo.com, patrick.onyango@gtz-wsrp.or.ke
Contact 2: Odhiambo Johannes Orodi
Former project advisor and Communication officer, Lecturer
T: +254 725 658 150
E: orodiodhiambo@yahoo.com
Contact 3: Eng. Moses Wakala
Former GTZ sanitation officer, Western Province
T: +254 721 743171
E: wakala.gtz@gmail.com
Contact 4: Wycliffe Osumba
Former GTZ Sanitation officer, Nyanza Province
T: +254 712 930 516
E: osumbawycliffe@yahoo.com
Contact 5: Christian Rieck
Former GTZ Technical Advisor
E: christian.rieck@gtz.de

Partner organisation:
Ministry of Water and Irrigation, Nairobi, Kenya
Contact: Eng. Ombogo
E: patrick_ombogo@yahoo.com
Contact: Rose Ngure
E: ngure_rose@yahoo.com

Executing organisation:
Various Community Based Organisations (CBOs) and private construction companies (e.g. Comila in Kisumu)

Executing institutions:
Lake Victoria South Water Services Board, Kisumu (http://www.lvswaterboard.com/)
Lake Victoria North Water Services Board, Kagamega (http://www.lvnwsb.go.ke/)
Athi Water Services Board (http://www.awsboard.go.ke/)
Tanathi Water Services Board (http://www.tanathi.go.ke/)

Financing agencies:
Water Services Trust Fund (WSTF)
Engineer John Orwa
Engineer Mr. Macharia
GTZ Advisor Hans Seur
P.O. Box 49699 – 00100, Nairobi, Kenya
Email: macharia@wstfkenya.org
Email: orwa@wstfkenya.org
Email: hanseur@hotmail.com
Web: www.wstfkenya.org
T: +254 20 713020
F: +254 20 716481

Supplier of sanitary ware:
aquasantec (Kentainers Kenya)
Embakasi Office
Off Airport North Rd
P.O Box 42168,GPO Nairobi, Kenya.
T: +254 20 2519098/99
E: info@aquasantec.com
Contact: Paul Madoc
E: paul_madoc@kentainers.com

Web: http://www.kentainers.com/kent/kentainers.html

Local organisations implementing ecosan projects in Kenya:

- KWAHO (NGO) http://www.kwaho.org/
- ALDEF (NGO) aldef@nbnet.co.ke
- German Red Cross Kenya (NGO) http://www.kenyaredcross.org/
- German Agro Aid (NGO) http://www.welthungerhilfe.de/kenia-hilfsprojekt-wasser.html
- CDTF (GO) http://www.cdtfkenya.org/
- Engineers without Borders of Spain (NGO)
- Maji na Ufanisi (NGO) http://www.majinaufanisi.org/
- KARI (Kenya Agricultural Research Institute) http://www.kari.org/
- Rotary club Nairobi West (Sanitation group)
- KEWI (Kenya Water Institute) http://www.kewi.or.ke/
- EU UDISM - Integrated Sanitation Management Master program (nele.foerch@uni-siegen.de)

Case study of SuSanA projects

UDDTs implemented via CBOs and Water Services Trust Fund, Nyanza, Western and other provinces, Kenya

SuSanA 2010

Authors: Christian Rieck (GTZ – Sustainable Sanitation - ecosan programme – ecosan@gtz.de)

Editing and reviewing: Elisabeth von Münch (GTZ - ecosan@gtz.de)

Appendix 1: Sanitation project cycle for rural areas

This project cycle was developed by the EU-Sida-GTZ EcoSan Promotion Project (EPP) in Kenya to provide a structured procedure to communities, clients, trainers and involved institutions in order to give clear roles and responsibilities of the involved partners as well as to ensure participation and ownership. All financial issues are managed by the support agency (SA) being the relevant executing institution being the Water Services Board (WSB) who receives the funds from the Water Services Trust Fund (WSTF). Alternatively such a project cycle can also be directly implemented by NGOs and donor organisations. The community based organisation (CBO) does not handle financial issues. The CBO acts as the grass-root implementing partner responsible to establish collective ownership of the process. The detailed project cycle with all the main planning and implementation steps used in Kenya by EPP is illustrated in Table A-1 and explained in more detail below. A similar project cycle could be used for other donor-funded sanitation programs. However the lessons learnt from EPP should be integrated.

Step 1

Pre-selection of target areas by support agency. In the first step the support agencies (SA), here EPP or EPP-WSTF-WSB, who offer financial and/or implementation support, have to pre-select target areas, where demand for improving sanitation is expected. Alternatively CBOs can directly request

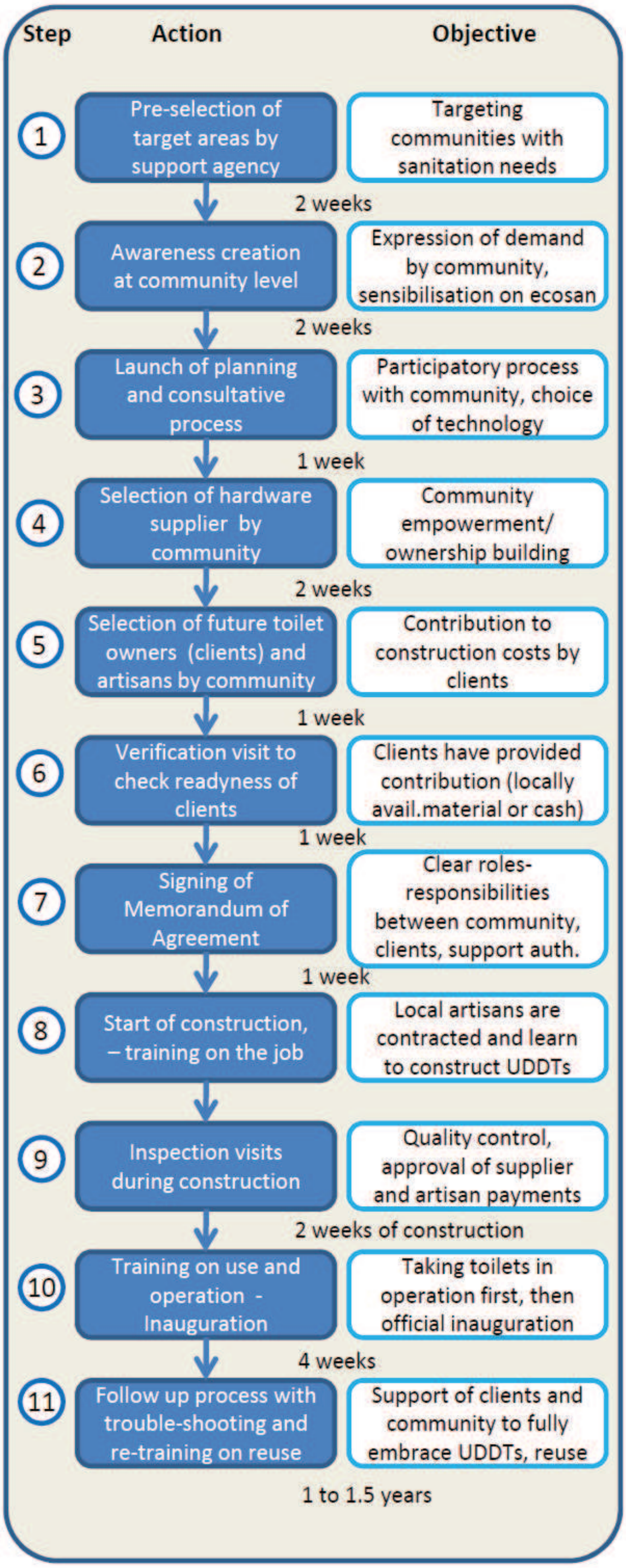
Generally communities are favourable and open-minded to change of their toilet system if they experience problems with their conventional systems like pit latrines that are not appropriate in the area due to reasons of seasonal flooding, rocky underground, collapsing soils and high groundwater tables among other things. Another driver can be poor soils in agricultural areas and lack of available or affordable fertiliser. Here farmers welcome a free fertiliser to improve their yields. Open defecation is also problematic and could also be a good reason for communities to change habits and directly adopt UDDTs or other suitable toilets.

Step 2

Awareness creation at community level. The communities are contacted directly or through the relevant Water Service Boards or provincial administration and invited to an awareness creation meeting carried out by the sanitation officer of the support agencies. A convenient location within the community (such as a school or church) is used for the half day meeting. The community is taken through a problem identification process, followed by a needs assessment exercise and general awareness creation on hygiene and sanitation education.

By raising awareness that common pit latrines bear the risk of disease through flooding and pollution of groundwater as well as ecosan providing fertiliser for improved food production, the community may generate the necessary desire for change. The ecosan concept can be tied to poverty reduction which means improvement of livelihood through increased agricultural production and better health through better hygiene. In order for the communities to be supported, they need to be or get registered as a CBO which is a standard procedure. Then the communities may send a letter of interest to the support agency for further action.

Table A-1: Project cycle for UDDT implementation in rural areas of Kenya, developed by EPP – time information indicates an approximate duration of one step.



Step 3

Launch of planning and consultative process. Once the community expresses their interest for new or improved sanitation systems (like UDDTs), the sanitation officer returns for a workshop on further awareness creation, triggering of willingness to participate, to contribute and to explain on how the planning, design and implementation stages of sanitation projects will work. It is important to provide the community with all the necessary information on the process and the available options so that they can make informed decisions.

The community analyses their situation through discussions and other means like "mapping exercise" and walks through the village, so called "transect walks". Thereby the whole community is engaged in drawing a sketch of the village (mapping exercise) showing houses, toilets, roads, wells, rivers, pipelines and also open defecation areas, if they exist.

Subsequently a transect walk of the whole community through their village follows to support the understanding of the identified problems. This joint community activity is important to get all community members engaged and generate ownership of the process. This mapping exercise is extensively used and described by the Community Led Total Sanitation (CLTS) approach, which was developed by Kamal Kar.[12]

Furthermore, the sanitation officer emphasises the necessary ownership of the future toilets, which is a prerequisite for the success of a sanitation project. Ownership is built through active participation of the community during the whole project process and the contribution of each future UDDT owner (client) to the construction costs. This must be clear and accepted by the community.

It is also recommended to organise an exchange visit for members of the community to see other ecosan projects (e.g. UDDTs). This approach of "*seeing and not smelling is believing*" has worked very well so far. When they return from the exchange visit they can pass on the message much better to the community and act as opinion leaders.

Step 4

Selection of hardware supplier by community. The materials for toilet construction which are not locally available from the clients need to be provided as a direct subsidy by the support agency (SA). The materials should be sourced from local hardware supplier(s). A hardware supplier is a private company that is selling and distributing construction materials and tools. The CBO is tasked to get quotations from three different local hardware suppliers including transport costs to the future toilet owner.[13] Then the CBO recommends one hardware supplier and sends all the quotations and the rationale for the chosen hardware supplier to the SA. This is part of the participatory and ownership building process and it also meant to support the local economy. Thereupon the SA visits the hardware supplier to check for reliability, professionalism, costs and capacity to deliver in bulk (many materials delivered at once). Nevertheless it might happen later that a hardware supplier becomes unable to supply due to various reasons, delaying the implementation process greatly.

Therefore it is important to know if the hardware supplier has sufficient financial capacities to deliver in advance because the materials must be delivered for one toilet at once or in two batches. This makes the accounting and payment process easy and construction fast since there won't be any delays caused by undelivered materials. It can be of advantage to award more than one supplier, especially when the suppliers are small and cannot pre-finance the materials fully. After approval of the hardware supplier by the SA and signing of the MOA (Step 7), the SA issues a local purchase order so that the hardware supplier can start delivering materials to the construction site.

Step 5

Selection of toilet owners (clients) and artisans by community. To ensure ownership, the interested communities are normally led by the sanitation officer (SA) through a visioning exercise to collectively and individually assess, identify and allocate resources required for the construction and management of the units. This would involve indication of the willingness of the intended future toilet owners to contribute locally available materials, unskilled labour and depending on the capacity of the person the direct hardware and construction costs.

The selection of future toilet owners is done by the CBO with the aim of selecting willing families and local champions as well as opinion leaders. It is up to the negotiation within the community to select the future toilet owner without causing conflict. More than one family or household may share one toilet, depending on cultural preferences. A maximum of 20 users per UDDT is proposed. The future toilet owners have to provide a contribution of at least 20% of the total costs per UDDT. The contribution of the future toilet owners can be either done through providing locally available materials like stones, sand, wood, or in-kind support of unskilled labour or cash. The contribution is indicated in a Bill of Quantity, which shows all the necessary materials and labour costs for UDDT construction, and is signed by the beneficiary and CBO.

Moreover the community is required to select several local artisans, who will be trained on the construction of UDDTs. This should foster ownership and lead to future replication of the technology.

Step 6

Verification visit to check readiness of future clients. After the community has selected the future toilet owners, artisans and hardware suppliers, the sanitation officer checks if the future toilet owners have provided their contribution of locally available construction materials. It is very important to have all materials ready before the construction starts in order to avoid delays. At this stage the future toilet owners are further informed about the coming steps and their roles and responsibilities. The SA starts to prepare the MOA according to the feedback from the future toilet owners and community from the previous steps.

Step 7

Signing of Memorandum of Agreement (MOA). This document clearly indicates all the roles and responsibilities between the CBO - as a representative of the community - and the support agency as well as other involved partners. It lists all the future toilet owners, their individual

[12] http://www.communityledtotalsanitation.org/
[13] Requirement according to EU regulations

contributions, the amount of subsidies per toilet, the names of the selected artisans and the costs for the hardware for each toilet (from the selected hardware supplier). In order for the entire process to be transparent and effective, enough checks and balances need to be included in the MOA. The payment process of the artisans and hardware suppliers needs to be very clear and transparent for everybody (see Step 8). Finally the MOA is jointly signed during a formal meeting (a standardised MOA was used; see Section 13 of case study).

Step8

Start of construction; training on-the-job. Before construction starts, the hardware supplier must deliver the materials for each toilet, either all at once or in two batches. This is verified by a signature from the sanitation officer and toilet owner on a delivery note. The toilet owner is responsible for the security of the materials. The supplier issues an invoice for each toilet, which is sent together with the delivery note to the support agency for payment. The invoices are compared with the agreed Bills of Quantities as per the MOA and if identical a cheque is issued accordingly. The payments should be done quickly to enable the suppliers to purchase more materials in times.

In preparation for the construction the selected artisans are first jointly trained on the construction of one toilet. Technical drawings, the Bills of Quantities (BoQs) and manuals are distributed. The artisans learn the skills of construction and also the background of ecosan. Later each artisan will construct a certain number of toilets alone as agreed in the MOA. Ideally the artisans should gain the ability to build UDDTs on their own as a business venture. The construction is closely supervised by the sanitation officer, CBOs and the future toilet owner who is usually contributing unskilled labor (Step 9).

Step 9

Inspection visits during construction. The supervision of the construction is jointly executed by the CBO, sanitation officer (support agency) and the future toilet owner (client). There are two stages of construction. First the artisan constructs up to the floor slab level which takes approximately 5-7 days as per experience and allowing for necessary curing time. The artisan then receives the first payment in cash from the sanitation officer (SA) after the signature of the half-completion certificate by the sanitation officer, CBO and client whereby confirming the quality of the structure.

After approximately another 7 days the toilets should be finished and ready for use. Now a completion certificate is signed and the remaining payment handed over to the artisan by the sanitation officer. However the construction was often delayed due to delayed delivery of materials. That is why it is very important that the hardware supplier is providing the materials on time and also that the client have all their materials (contribution) ready prior to start of construction. All payments to the artisan are done directly through the support agency to ensure transparency and avoid money disputes at community level.

Step 10

Training on use and operation; inauguration. After completion of construction, the sanitation officer should immediately provide an individual training session for the users of each toilet. This takes approximately one hour and includes all the main issues on use, maintenance and reuse. It is recommended to directly start using the toilets after completion and individual training. An official inauguration or a joint community training should only come after all constructed toilets are in full operation.

The official inauguration of all new UDDTs in one community is carried out with the CBO, local administration like public health officers, politicians and other stakeholders and only takes place once all toilets are in use (this should be stated in the MOA). This official inauguration is useful to build the confidence and ownership among the toilet owners who must understand that they fully own their toilets. The support of the official stakeholders is very crucial to gain support, instil pride and promote the ecosan approach in the region (even though some politicians may tend to misuse the occasion to elaborate on politics).

Step 11

Follow up process with trouble shooting and re-training on reuse. After approximately 1-2 weeks of operation the sanitation officer shall visit each toilet owner again to ensure proper use of the facility and safe reuse practice of the urine as well as to provide support and confidence to the toilet owner.

This visit entails individual re-training on certain issues and assistance for trouble shooting. It is crucial to provide such a timely follow-up support since during the first days and weeks of operation the users might experience problems and adjustment difficulties. The proper use of urine is an important issue. They are advised to use all urine on their plot; infiltration of urine should not be encouraged unless only limited agricultural area is available. A documentation of the follow-up should be done for future reference. Ideally the follow-up process should be continued for about 1.5 years in order to complete the full ecosan cycle of filling the faeces vault (6 months), storage in vault (6 months), application in soil and first harvest (3-6 months).

Hence the second visit should be done after approx. 6 months to ensure the toilet owners change the vault in time and to address any other arising issue. The next visit should be done after approx. one year at the time of the application of the dried faeces to the soil. This is a crucial step that can only be demonstrated on the ground. A few months afterwards the toilet owners can witness the positive effects on the crop production. Once they understand the benefits of the fertiliser and a clean, odourless toilet they will fully appreciate UDDTs as a source of fertiliser, good health and comfort. Therefore the sanitation officer should agree on a follow up schedule with the CBO for regular visits. The costs for follow up should be provided by the support agency.

Case study of sustainable sanitation projects

Public toilet with biogas plant and water kiosk Naivasha, Kenya

Fig. 1: Project location

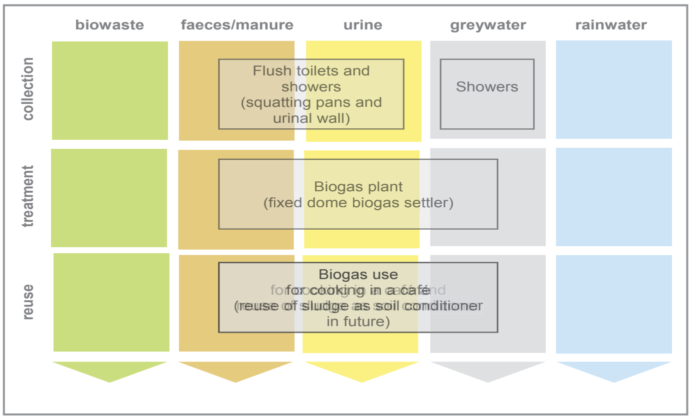


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Urban pilot and demonstration project

Project period:
Start of construction: Oct 2007
Start of operation: July 2008
Ongoing monitoring period until May 2010

Project scale:
300 visitors to public toilet per day (design figure was 1000 visitors per day)
Total investment EUR 40,000 (public toilet with 5 toilet cubicles and 2 showers, biogas plant and water kiosk)

Address of project location:
Naivasha Bus Park in Naivasha
Kenya (Rift Valley region)

Planning organisation:
EU-SIDA-GTZ EcoSan Promotion Project, Kenya (supported by the EU, SIDA, GTZ and embedded in the Kenyan Water Sector Reform Program)

Executing institution:
- Water Service Provider (WSP): Naivasha Water, Sewerage and Sanitation Company Ltd. (NAIVAWASS)
- Water Services Board (WSB): Rift Valley Water Services Board
- Water Services Trust Fund (WSTF)

Supporting agency:
- European Union (EU) – ACP EU Water Facility
- Swedish International Development Agency (SIDA)
- German Technical Corporation (GTZ) on behalf of German Federal Ministry for Economic Cooperation and Development (BMZ)

2 Objective and motivation of the project

The "EcoSan sanitation project" in Naivasha had the following objectives:
- To improve the living conditions of the residents and travellers by providing safe and environmentally-friendly sanitation solutions with a focus on the reuse of the human waste as a resource (ecological sanitation or ecosan).
- To find a business-orientated solution that creates economic incentives for the water sector institutions to invest in sanitation and to generate income for private operators.

The overall aim was to achieve sustainability through capacity building within the institutional water sector institutions towards professionalism, efficiency and commercialisation. The focus of this document is the public toilet; the water kiosk system is also briefly described.

Fig. 3: View of Naivasha bus park with the public toilet at the front of the plot (behind the large bus); during the construction in mid 2007. All photos in this document by C. Rieck (GTZ) in 2008/2009.

.

3 Location and conditions

Naivasha is a small town located at the shores of Lake Naivasha about 80 km north of Nairobi. The town covers an area of 30 km^2 and has a population of approx. 70,000 people. The excreta management in the town relies mainly on pit latrines. Less than 5% of households and businesses are connected to the sewer system which is connected to a poorly functioning wastewater treatment plant.

The town has five public toilets (at markets and bus stops) with flush toilets and sewer connections. They are managed by the municipal council and are in an appalling state because:

- There is no operation, maintenance and management concept for these toilets.
- The water supply to the toilets is only erratic.
- The toilets are frequently blocked and overflowing with human waste.
- The surrounding environment and the buildings are not maintained or kept clean.
- The municipal council is not showing any interest in these facilities since they are not generating any revenue that could be used to cover costs for operation and maintenance (there is no user fee).

To deal with the water and sanitation problems in Naivasha, a Water Service Provider (WSP) which is called Naivasha Water Sewerage and Sanitation Company Ltd. (NAIVAWASS) was formed under the Water Sector Reform Program of the Ministry of Water and Irrigation (MWI) a few years ago. The responsibility for water and sewerage was shifted from the Municipal Councils to the regional Water Services Boards (WSB) who delegates the management to the local WSP.

Public toilets are still a responsibility of the municipal councils according to the regulations of the local government, but may be handed over as well to the WSB/WSP.

The Ministry of Water and Irrigation (MWI) has committed itself through the Water Sector Reform Program to facilitate the improvement of water supply, sewerage and sanitation service provision in Kenya. GTZ is supporting the Kenyan Water Sector Reform Program through its Water Program which has five components. One component is the **EU-SIDA/GTZ EcoSan Promotion Project (EPP).**

The EPP, which ran from end of 2006 to mid 2010, is a project financed by the **ACP-EU Water Facility**[1] (EUR 1,734,137) and is co-financed by SIDA (EUR 815,842), GTZ-Kenya Water Program (EUR 100,000) and GTZ-Kenya Agriculture Program (EUR 100,000). It piloted sustainable sanitation projects in rural households[2], public places, public institutions and informal settlements.

Naivasha Bus Park was selected for a pilot public sanitation project combined with a water kiosk. The project was implemented through established institutions of the Water Sector Reform Program (Water Service Board, Water Services Trust Fund and Water Service Providers) in order to ensure sustainability in service provision.

The infrastructure was funded by EPP. The funds were channelled through the Water Services Trust Fund (WSTF) which is a basket fund for pro-poor service provision of water supply and sanitation. Rift Valley Water Services Board is the designated asset holder of the infrastructure while the responsibility to operate and manage the facility was given to the assigned local Water Service Provider (WSP), which is here the Naivasha Water, Sewerage and Sanitation Company Ltd. (NAIVAWASS).

The WSP has selected, contracted (for one year) and trained a private operator who runs the facility on a day-to-day basis. The operator is a Community Based Organisation called Banda Livestock Self Help Group. Usually two persons are working, one of them continuously cleans the facility and the other one operates the public toilet and water kiosk.

Naivasha Bus Park is located in the town centre. It operates 24 hours per day for overland buses. The old existing public toilet was poorly maintained by the municipal council. Approximately 200 people used the old public toilet per day (for free). The users were travellers on stop overs and business people from the shops within and around the bus park. The bus park is surrounded by residential areas where households mainly depend on individual or shared toilets. The water supply situation is characterised by unreliable water supply and insufficient quantities supplied (partly due to power shortages).

In Kenya, the under-five child mortality rate is currently[3] **128 children per 1000**, and sadly there has been a slight but consistent upward trend towards more child deaths since about 1985 when the value was 98 child deaths per thousand.

Fig. 3: New public sanitation facility with water kiosk (left side). Underground biogas plant in front.

[1] ACP-EU stands for Africa, the Carribean, the Pacific and the European Union. This project was funded under the first call of the first water facility in the category of "improving water management and governance" and "Co-financing water and sanitation infrastructure" in September 2006.
http://ec.europa.eu/europeaid/where/acp/regional-cooperation/water/

[2] See also the case study for UDDTs in Ugunja, Western Kenya http://www.susana.org/lang-en/case-studies/region/ssa

[3] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

4 Project history

Prior to 2007, the Water Services Trust Fund (WSTF) was only funding urban water supply projects as well as rural water and sanitation projects in Kenya. From 2007 onwards, it broadened its funding activities to also include sanitation in urban areas. The pilot project in Naivasha Bus Park was the first project in public sanitation aimed at developing appropriate procedures for funding and implementation of such facilities. EU, SIDA and GTZ provided the funds for implementation (hardware and software) that were channelled through the structures of WSTF. The Ecosan Promotion Project (EPP) acted as a support organisation in project preparation, implementation supervision and training activities.

The implementation procedures were adopted from the water supply projects that the WSTF is already funding such as standpipes and water kiosks. The sanitation facility was planned with the Water Services Board (WSB), the local Water Service Provider (WSP) and municipal council in early 2007. The technical design was done by the EPP. The EPP, WSTF, WSB, municipal council of Naivasha and the WSP formed a project task force and jointly developed the sanitation concept. A Memorandum of Understanding was signed between the WSB, WSP and municipal council to avail the site for the facility to the WSB. Then a final sanitation project proposal was presented to the WSTF for approval.

The public sanitation facility and a water kiosk were constructed adjacent to the bus park (next to the old public toilet which was demolished afterwards). The land is owned by the municipal council and availed through the MOU to the WSB.

After approval by WSTF, the funds were disbursed to the WSP in batches to execute the work according to work progress. First the WSP invited pre-qualified companies to tender for the construction works. The WSP awarded the tender, and supervised the construction works with assistance of the EPP, WSTF and WSB starting in October 2007. The completion of the facility was certified by EPP, WSB, WSTF and WSP and then handed over to the Rift Valley Water Services Board as the asset holder in late 2008.

The WSP selected a private operator, who was then trained by the WSP and WSTF on the operation and maintenance concept. Furthermore a sustainable operation and management system was put in place to ensure that the facility generates enough revenue to finance its operation and maintenance costs (see Section 9).

The construction period was from late 2007 to late 2008. The construction was repeatedly delayed due to poor construction quality and poor construction supervision by WSP. Moreover the post-election violence in Kenya in the beginning of 2008 caused further delays of several months.

The new sanitation facility at the Naivasha Bus Park was put in operation after handing over to the WSB in July 2008. During the start-up phase of operation the project partners were continuously supporting and consulting the WSP in terms of optimising the operation and maintenance of the toilet and biogas plant. Moreover the EPP and WSTF are now monitoring the performance of the facility and assist in further training if necessary. (note the EPP finishes in May 2010)

5 Technologies applied

The main reasons for choosing the technology of biogas sanitation for this project was to demonstrate that biogas production from human waste is possible under Kenyan conditions. The technology was not selected to be the cheapest alternative but to show that sanitation can be "productive". Further treatment of the wastewater could be done through baffled reactors and anaerobic filters, but available space was limited and instead a sewer connection was available.

Another alternative technology for this location would have been urine diversion dehydration toilets (UDDTs). However the situation in Naivasha with piped water supply, a habit of using flush toilets and existence of a sewer connection offered only few incentives for dry toilets. Therefore water-based sanitation was favoured especially in terms of social acceptance.

The new facility comprises a sanitation unit (toilets, handwash basins, a urinal and showers) and a water kiosk. The facility is connected to the town water supply network and has three overhead water storage tanks to cater for short supply interruptions. The wastewater from the toilets, showers and hand wash basins is drained into an underground biogas plant that treats the wastewater an-aerobically (under the absence of oxygen) on-site. Treated effluent is discharged to the sewer[4].

Fig. 5: Customers of the water kiosk. The water tank on the roof holds 5 m^3 (or 250 jerry cans) to bridge water supply gaps for a period of about 1-2 days.

There are in total 5 toilet cubicles (2 for males and 3 for females), 2 showers and one wall for urinating. The water is provided through 2 overhead water storage tanks (each 5 m^3) placed on the toilet roof. The water kiosk has a separate overhead water storage tank on its roof.

When an overland bus stops at the bus park an average of 5-20 people come to use the toilets at once. Men mostly use the

[4] Note: in other settings, local reuse of this treated effluent in agriculture could be possible.

urinals whereas women have to wait a little longer to use the toilets.

The water kiosk is located in front of the toilet building and sells water and other commodities. It also serves as the operator's room. The operator collects user fees, hands out toilet paper, sells other toiletries and cleans the facility.

Water-flushed toilets and urinals

The toilets are fitted with locally available standard ceramic squatting pans (without urine diversion). They were initially flushed with 10 L of water from locally available 10 L cisterns above the toilet. Due to shortage of water and repeated breaking of cisterns, the toilets are currently flushed by hand with a "pour flush" system. A small bucket is filled with 2-4 L of water taken from a small drum and is then poured into the toilet.

Fig. 6: Left: Urinal using a tiled wall (no door) with optional water flush. Right: Squatting pan with 10 L cistern (flush toilet); but these days a manual pour flush system is used for toilet flushing (see Fig.7).

Fig. 7: Pour flush system with small bucket (2-4 L) in drum. The small bucket is used to flush the toilet.

The urinal consists of a tiled wall and trough with flushing device connected to a 10 L cistern. But the urinals are rarely flushed due to water shortage, hence odour develops occasionally. The operators clean the urinal wall and trough on an irregular basis.

Showers

Shower heads were installed in two cubicles to provide cold showers. Hot water is usually not offered in public toilets in Kenya. Even if hot water showers were offered, the users would probably not be willing to pay extra for it.

Biogas plant (or "biogas settler")

All the generated wastewater from the toilets, urinals, showers and hand wash facilities is discharged into an underground 54 m³ fixed-dome biogas plant where the (quite dilute) wastewater is treated through settling and anaerobic digestion thereby lowering the organic content (pollution load) of the wastewater. Biogas is produced in the process.

The biogas plant has two outputs: treated effluent (continuous flow) and sludge (emptied once per year). Settling of solids occurs in the main chamber (or dome-shaped reactor).

The treated effluent from the biogas plant is drained into the existing public sewer line running along the nearby road. The reduction of organic load through the anaerobic treatment process is contributing to the protection of Lake Naivasha as the treatment efficiency of the existing wastewater treatment plant (pond system) at the end of the sewer pipes is very poor. If more such biogas plants were built, there could be a noticeable effect.

The accumulated sludge is removed once a year and can be used as fertiliser (see Section 7).

Biogas piping

The biogas is piped (half inch galvanised iron pipe, i.e. 1.5 cm diameter) to a nearby café where it is used for cooking (5 meters away). A water trap chamber was installed next to the biogas plant to collect condensed water in the pipeline. There is a main valve at the gas outlet point outside next to the dome and a secondary valve inside the café before the stove. Attached to the piping in the kitchen is a simple manometer consisting of a water-filled transparent pipe to indicate the pressure in the system. This pressure shows the actual amount of biogas available for use (see Section 7).

Fig. 8: Area of the top manhole (above biogas fixed dome) of the biogas plant. Clay is used for sealing the lid, and water to keep it wet and thus detect leakages that would show up as bubbles.

Biogas appliances

A biogas stove was fitted onto a stand. The stove was placed inside the kitchen area of the café for cooking food and making tea. A regular LPG stove can be converted to biogas by changing the gas-to-air ratio.

Water kiosk

The water kiosk design was developed by the WSTF and has been successfully implemented in Kenya and other African countries (see Section 13 for reference).

The water kiosk uses an overhead tank of 5 m^3 to bridge water shortages. A total of three water outlets are operated from the inside with valves. The kiosk is used as the operators room to serve the toilet customers and to sells toilet paper, other toiletries, cleaning utensils and other items.

Steel window shutters and doors protect the kiosk from theft and vandalism when it is closed. Hence the operator can safely store items and documents. The water meter for the water consumption is placed outside in a metering chamber jointly with the water meter for the toilet. The operators check the meter once a day for their own documentation. The WSP reads the meter once a month.

6 Design information

The biogas plant has a volume of 54 m^3 with two expansion chambers. The underground structure is located about 0.5 m below surface. The required area for the toilet building and biogas plant is approximately 10 x 15 metres. It is not recommended to build any structures on top of the biogas plant.

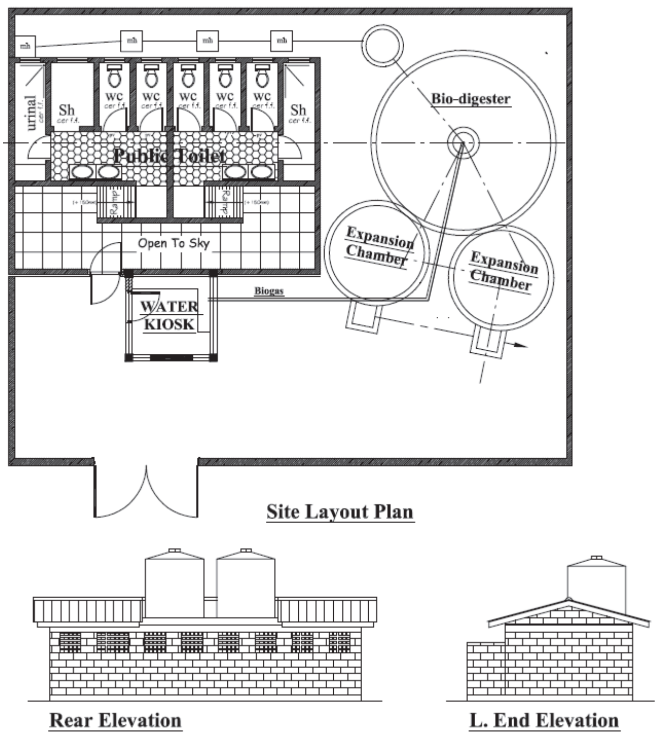


Fig. 9: Technical drawing of the facility and biogas plant (source: EPP). Space requirement for toilet and biogas plant is approx. 10 x 15 m.

Design parameters for the biogas plant assume 1,000 visitors per day. The dimensions of the plant were based on a sufficient settlement of solids which is achieved with a hydraulic retention time (HRT) of 5 days[5]. The solids settle and remain in the system for digestion and biogas production. The system works like a gas tight septic tank. The solids-free effluent is flowing over to the sewer connection.

This project did not focus on sanitising und treating the effluent for agricultural reuse since (i) the available space for further treatment was not available and (ii) there was no demand for irrigation water in the area.

The design of the fixed dome was based on the system implemented for livestock manure in Kenya by the GTZ-PSDA program (Promotion of Private Sector Development in Agriculture).

This type of fixed-dome biogas plant was selected due to its robust technology that works without moving parts. It is able to operate with inflow fluctuations caused either by lack or overuse of water. The production of biogas is continuous and the fixed dome technology provides for biogas storage. The pollution reduction in terms of BOD decrease is expected to be 30-40%. Measurement results are not yet available.

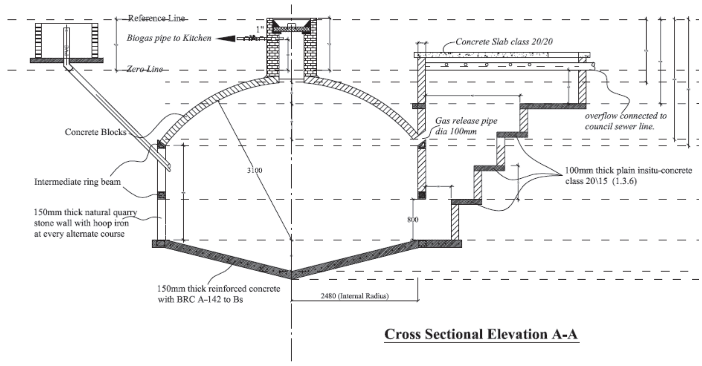


Fig. 10: Technical drawing of the biogas plant (built completely underground). Diameter of dome-shaped digester is 5 m. See section 13 for links to further drawings (source: EPP).

7 Type and level of reuse

The reuse of human waste comprises the use of biogas, settled sludge (slurry) and effluent water:

- Biogas is generated from the anaerobic digestion process carried out by micoorganisms. It can potentially substitute firewood, charcoal and Liquefied Petroleum Gas (LPG). The biogas from the Naivasha sanitation facility is used for cooking by a nearby café. The café owner is cooking tea and snacks during the whole day for about 50 customers. When there is excess gas it is ventilated (flaring would be preferable but is difficult to achieve at the small scale). Advantages of biogas as a cooking fuel are the smokeless and fast cooking compared to charcoal.[6].
- The settled sludge shall be used as a soil conditioner in the future. The Water Service Provider can use its treatment facility grounds to dry and compost the sludge for production of soil conditioner.

[5] This corresponds to a design flowrate of 11 m^3/d or 11 L/person. The current flow rate is not measured but is about 1.5 m^3/d (if 300 people per day use 5 L per person). Therefore, the current HRT is 36 days.

[6] It would theoretically be possible to install a generator to produce electricity, but the quantity of biogas produced here is not sufficient for a reliable production of electricity.

- The treated effluent (from the outlet of the biogas plant) could be used as a source of fertiliser and irrigation water, however it is not feasible here due to long transport distance to suitable agricultural areas.

Fig. 11: The café that uses biogas for cooking is located adjacent to the public toilet.

8 Further project components

The lessons learnt from this project now form part of the new implementation procedures for urban projects being finalised by the WSTF, called Urban Project Cycle.

The combination of the public toilet with a water kiosk was an additional service provision that was being tested in Naivasha. The water kiosk is not important for travellers but interesting for surrounding businesses and residents. So far there is positive feedback from the customers and the facility operator.

9 Costs and economics

The investment costs for the entire facility was approx. 40,000 EUR. A cost breakdown was not available at this time from the WSTF. The costs included material and labour costs for the ablution block, water kiosk, biogas plant and administrative costs for the supervision work of the Water Service Provider (here: NAIVAWASS). The WSP was responsible for construction, supervision, trainings and mobilisation. The funding came from the Water Service Trust Fund, a basket fund supported by Kenyan Government, donors and development partners[7].

The annualised investment costs are approx. 0.05 Euro per visit based on 9,000 visits per month, a life span of 10 years and a discount rate of 5%. The average operation and maintenance costs are illustrated in Table 1.

The financial sustainability of the facility depends on the number of users and the water and the toilet/shower tariff and the other operation and maintenance costs. Currently an average of 300 people uses the toilet and about 200 customers are buying 200 jerry cans (each 20 to 22 litres) of water from the water kiosk.

[7] The main donors are currently e.g. BMZ through KfW and GTZ, SIDA, DANIDA, UNICEF and World Bank

Table 1: Average annual operating costs and revenue from public toilet facility and water kiosk **for the operator** (based on 300 toilet users and 200 water kiosk users per day).[a]

Average annual costs per annum for operation	**Expenses in EUR/a**
Salary of toilet/kiosk operator (220 EUR/month)[b]	2,640
Salary of toilet assistant (110 EUR/month)[b]	1,320
Water for toilet – currently at 2.1 cbm per day or 7 liters per customer (water retail tariff of 0.80 EUR per 1000 liter); paid to WSP	613
Water for kiosk - average of 4 cbm per day (special subsidized tariff of 0.30 EUR per 1000 liter); paid to WSP	438
Meter rent (2x 50 KSh for nominal size of meter up to 20mm); paid to WSP	12
Sewer costs for toilet/digester effluent (75% of water retail tariff)[c]; paid to WSP	460
Rent of facility (50 EUR/month); paid to WSP	600
Electricity (2 KWh/day á 0.17 EUR/KWh)	124
Toiletries (toilet paper, mops, soaps etc.)	450
Painting (half-year) of toilet facility	200
Plants, greenery, staff uniforms	N/A
Coupons, tickets, cashbook and so forth	10
Electrical fixtures and minor plumbing like water taps etc. (replacement)	100
Mirrors and other equipment	25
Costs for disposing waste from dust bins	20
Average total operation costs	**7,012**
Average revenue per annum for operator	
User fee revenue (current average of 295 toilet user per day; 0.05 EUR per toilet use, 5 shower users; 0.10 EUR per shower use)	5,566
Selling of water (average 4 cbm[d] per day at 0.02 EUR/22 liter jerry can)[e]	1,327
Additional income through selling activities, shoe shining, credit etc. (10 EUR per month)	120
Average total revenue for operator	**7,014**

[a] The living costs in urban areas like Naivasha are estimated at EUR 100 per month

[b] The income increases with the revenue of the operator

[c] For future installations sewer fee could be reduced because of lower organic load

[d] Corresponds with 200 people using the water kiosk, if each person buys one jerry can of 20 L per day.

[e] Allowance for 20 litre containers that take 22-23 litres (standard expansion contingency in such containers)

The current opening hours are only during day time from 6:30 am to 7:00 pm.

Tariffs: The Naivasha Public Toilet charges for the use of the toilet 5 Ksh[8] (0.05 EUR), for use of the shower 10 Ksh (0.1 EUR) and for a 20-22 litre jerry can of water 2 Ksh (0.02 EUR). These tariffs were proposed by the WSP. The Water Services Board (asset holder) and the Water Services Regulatory
Board (regulator) can adjust these tariffs if required. The operator is not allowed to raise the price of water and sanitation services. The price setting is meant to be pro-poor.

The operator pays a subsidised water tariff to the WSP of 0.3 EUR per m^3. At the same time he/she makes 1 EUR per m^3 from the sale of water thereby making a profit of 0.70 EUR per m^3. For the water used in the toilets the operator pays the standard retail price of 0.8 EUR per m^3 since he/she collects a toilet user fee to cover his costs for toilet operation.

The calculation in Table 1 shows that a sufficient income for the operator is possible to cover the operation and maintenance costs. In case the facility gets connected to the electricity grid, the opening hours could be extended and more customers attracted. This could influence the economics of the facility positively. The same stands for increased numbers of customers.

Table 2: Annual operation and maintenance cost, revenue and profit of **Water Service Provider** (based on 300 toilet users and 200 water kiosk users per day).

Average operation and maintenance costs for the Water Service Provider	**Expenses in EUR/a**
Operation costs:	
Producing and distributing water (approx. 0.35 EUR per m3)	780
Employment costs for inspecting visits (quarter hour per week)	150
Maintenance costs:	
Replacement of equipment	500
Plumbing maintenance toilet	200
Miscellaneous	200
Yearly Desludging/maintenance costs for Waste Water Treatment (executed by WSP)	100
Annual O&M costs for WSP	**1,930**
Average revenue per annum for Water Service Provider	
Water revenue, Sewer fee, water rent (see table above)	1.523
Rent of facility (see table above)	600
Biogas revenue (approx. 10 EUR per month) - not yet utilized	-
Advertising revenue (approx. 20 EUR per month) - not yet utilized	-
Total revenue Water Service Provider	**2,123**
Annual total of Water Service Provider	**193**

The use of biogas will be charged by the WSP after the current trial period. The WSP plans to charge 10-15 EUR per month to cater for operation and maintenance costs for the biogas plant and a profit margin. This is less compared to the costs the café is currently paying for traditional charcoal costs. The café owner will sign a “Biogas Utility Management Contract” with the WSP which state roles and responsibilities of the two parties.

The Rift Valley Water Services Board aims at cost recovery only for operation and maintenance cost (but not re-investment costs). Approximately 1,930 EUR per year is necessary to cover operation and maintenance costs for WSP (see Table 2). The revenue for WSP is approx. 2,123 EUR which leads to a profit of 193 EUR. The cost figures in Table 2 are based on 300 visitors per day, but the capacity of the biogas plant is 1,000 visitors per day. If visitor numbers go up, the profit would also go up.

Re-investment costs are normally also part of an economic analysis, but in this case they are not considered because of the pro-poor approach of the WSTF funding policy. Future re-investments would have to be cross-subsidised via wealthier population segments.

10 Operation and maintenance

As mentioned above, the WSP licensed a private operator to run the facility as a business on a day-to-day basis. The operator can be either a private entrepreneur or a local Community Based Organisation (CBO). In Naivasha the CBO called Banda Livestock Self Help Group was selected and signed a renewable one year-contract with the WSP. Thus, the operator is not an employee of the WSP. The local authority is not involved in the management of the facility.

The operator and the staff of WSP were trained by the WSTF prior to commencement of operation. A facility management concept has been developed by the WSTF and is applied by the WSP.

The operator cleans, maintains, attends to, opens and closes the Public Sanitation Facility and carries out all other associated tasks to the satisfaction of the WSP. Customers pay on a pay-per-use basis. The operator has to be present during opening hours (currently 6:30 am to 7 pm), carries out minor repair works and provides for the safety of the users and facility day and night. The operator pays the water bill and rent to the WSP and also pays other operation costs (see Section 9). This is stipulated in the renewable one-year contract including penalties for bad performance. Currently two people work at the facility (one to deal with customers, one for cleaning).

The WSP is supervising the facility on a weekly basis in terms of technical conditions and operation quality. The maintenance of the toilet (beyond daily simple maintenance) is the shared responsibility of the WSP and the WSB. This includes major maintenance and repair works, which are not the result of normal wear and tear but are caused by accidents, improper use or acts of vandalism. The maintenance also includes the yearly sludge removal from the biogas plant as well as the maintenance of the biogas piping.

[8] Ksh is Kenyan shilling – approx. 100 Ksh equal 1 EUR (2009)

11 Practical experience and lessons learnt

After one year of operation, the toilet and water kiosk are delivering convenient, safe and affordable sanitation and water services. The new water kiosk and public toilet currently has approx. 9,000 visitors of the facility (for toilet, shower and/or water kiosk) per month, with 7,500 of these visits being from travellers and 1,500 visits from regular users. This is monitored through the book keeping of the operators.

On a daily basis an average of 300 users currently visit the public toilet, out of which are 250 travellers and 50 regular users from the businesses activities around the bus park. The new public toilet has drastically improved the hygienic conditions at the bus park. It also provides an income to the private sector (operator) and to the WSP.

The success factors of this project were:

- The pay-per-use concept is appropriate to supply convenient services to the user through an operator.
- The operators were trained on their job responsibilities before they were contracted.
- The facility was designed to generate enough revenue to make it attractive to the WSB and WSP.
- Best use of biogas is in small restaurants and cafés where food and hot drinks are prepared. The use of biogas for heating water for showers was initially planned but there was low demand by customers for hot showers; biogas use for lighting is considered too complicated (operation and vandalism issues)
- The management and ownership of public toilets were linked to the water sector institutions and the privatised Water Service Providers in order to enhance sustainability of service provision. Experience has shown that town and municipal councils in Kenya generally have difficulties in appropriately managing such facilities.

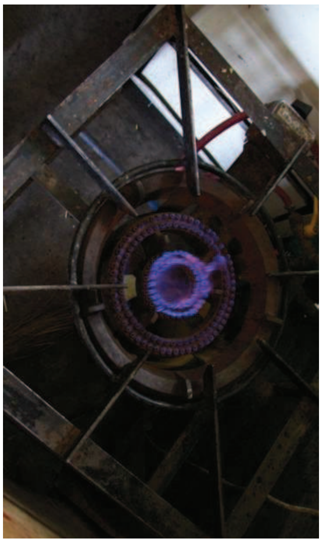


Fig. 12: Biogas is used to cook snacks and tea at the adjacent cafe.

Challenges for the project were:

- The development of a business plan and management concept for an intended project by WSP/WSB was not done in detail. It should be done at the project preparation phase. This way it prepares the WSP/WSB to fulfil their mandates and helps to ensure sustainable service provision.
- The coordination of supervision of the construction works was weak. The roles and responsibility must be better spelled out right from the start through the formation of a project task team. A standard implementation procedure is necessary.
- The WSB and WSP must work closely together during project preparation and implementation to enhance ownership (through a project task team)
- The WSP lacked capacity in project implementation and in operation and maintenance. There was a shortage in qualified personnel.
- The architectural design of the toilet building should be improved in terms of space use, efficiency, safety against vandalism (day/night) and user convenience. The WSTF has already developed an improved architectural design that will be implemented in Kenya from 2010 onwards
- The water consumption of conventional water flush toilets is very high (approx. 7-10 litres) and the cisterns regularly broke down due to misuse and/or vandalism. The experience often made in public toilets in Kenya is that the toilet cisterns fail to fill quickly enough (due to low pressure), so that users shift to pour flush system. This has a positive impact in terms of water conservation, but bears a higher risk of transmission of diseases if hand wash facilities are not working and not utilised by users.
- There is competition between the free (but unhygienic) council public toilets in walking distance from the bus park, or urination in the open, with the pay-per-use public toilet. Maybe the user fee should be lowered to attract more customers.

Fig. 13: Cistern after installation (left) and after vandalism/misuse and theft (right) a few weeks later. Repairs were undertaken by WSP, but the toilet operator now shifted to a pour flush system.

12 Sustainability assessment and long-term impacts

In Table 3 a basic assessment was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Public toilet with biogas plant and water kiosk Naivasha, Kenya

Table 3: Qualitative indication of sustainability of the system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X			X	
• environmental and natural resources		X			X			X	
• technology and operation	X				X			X	
• finance and economics		X			X		X		
• socio-cultural and institutional	X			X			X		

Sustainability criteria for sanitation:

Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.

Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.

Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.

Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.

Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see www.susana.org: the SuSanA Vision document "Towards more sustainable solutions"

With regards to long-term impacts of the project, the main expected impacts of the project are:

1. Demonstrate commercialisation of sanitation services within the institutional water sector.
2. Increased convenience for travellers and other clients.
3. Demonstrate that biogas can be produced from human excreta and used for cooking purposes.
4. Reduced organic load of the treated wastewater from this public sanitation facility discharged to the sewer (compared to the no-treatment option) and hence possibly a marginal improvement in final effluent from the wastewater treatment plant (monitoring of effluent quality is being undertaken, but data is not yet available).
5. A small contribution to improved public health (so far there are no plans to monitor the impact).
6. This was the first sanitation project of the WSTF. It served as a learning facility for various stakeholders and the improvement of facility design and implementation.

13 Available documents and references

The following documents are available:

Photos from this project are available on flickr:
- http://www.flickr.com/photos/gtzecosan/sets/72157623254082278/

Videos clips from this project are available on Youtube:
- http://www.youtube.com/user/susanavideos#p/a/u/1/Vc70xD8KoGk

Drawings:
- Drawings of biogas plant and public toilet (2007) http://www2.gtz.de/dokumente/oe44/ecosan/en-naivasha-drawing-ecosan-public-toilet-2007.pdf
- Drawings of new public toilet design (2009) http://www2.gtz.de/dokumente/oe44/ecosan/en-drawings-wstf-public-toilet-new-design-2009.pdf
- Drawings of fixed dome biogas plant for cow dung and agricultural waste (AKUT, 2007) http://www.susana.org/lang-en/cap-dev/visual-aids-drawings/technical-drawings

Publications:
- Poster on Naivasha, 5th World Water Forum in Istanbul, (GTZ, 2009) http://www2.gtz.de/dokumente/oe44/ecosan/en-poster-naivasha-worldwaterforum-wwf-istanbul-2009.pdf
- Public sanitation concept of WSTF (WSTF, 2009) http://www2.gtz.de/dokumente/oe44/ecosan/en-wstf-public-sanitation-concept-2009.pdf
- Public toilet management guideline of WSTF (WSTF, 2009) http://www2.gtz.de/dokumente/oe44/ecosan/en-wstf-public-toilet-management-guideline-2009.pdf
- Water and sewer tariffs from NAIVAWASS (NAIVAWASS, 2009) http://www2.gtz.de/dokumente/oe44/ecosan/en-naivawass-water-and-sewer-tariffs-june-2009.pdf
- Case Study: Water Kiosks (GTZ, 2009) http://www.gtz.de/en/dokumente/gtz2009-0193en-water-kiosks.pdf
- Flyer Water Kiosks http://www2.gtz.de/dokumente/oe44/ecosan/en-gtz-flyer-waterkiosk-2009.pdf

The WSTF with the support of GTZ is providing design and management guidelines for water kiosks and water supply related infrastructure called “water supply toolkit” and for public sanitation called “sanitation toolkit”. These documents as well as additional documents on the project are available from the WSTF (as DVD).

14 Institutions, organisations and contact persons

Owner of the facility:

Rift Valley Water Services Board (RVWSB)
Chief Executive Officer Mr. Mutai
P.O. Box 2451, Nakuru, Kenya
Tel: +254-51-2213557

Implementation/Facility Management:

Naivasha Water and Sanitation Company (NAIVAWASS)
Managing Director Mr. James Gichana
P.O. Box 321, Naivasha, Kenya
Tel:+254-721-551991
E-Mail: jameskinyoko@yahoo.com

Water Services Trust Fund (WSTF)
Engineer Mr. John O. Orwa
GTZ Advisor Mr. Han Seur
P.O. Box 49699 – 00100, Nairobi, Kenya
Email: orwa@wstfkenya.org
Email: hanseur@hotmail.com
Web: www.wstfkenya.org

Technical Planning/Implementation Support:

EU-Sida-GTZ EcoSan Promotion Project (EPP)
Project Manager Mr. Patrick Onyango
Technical Manager Mr. Christian Rieck (main contact for this document)
Site supervisor Mr. Moses Wakala
Ministry of Water and Irrigation
Ngong Road, Maji House, Nairobi, Kenya
Tel: +254-721-172661
Email: patrick.onyango@gtz.de, onyangopadak@yahoo.com
Email: christian.rieck@gtz.de
Email: wakala.gtz@gmail.com

Supplier of biogas appliances

New World Stainless Steel (piping and stove)
Mr. J.K.Bhalla
P.O. Box 44922
Lusaka Road, Nairobi, Kenya
Tel: +254-737912081
Email: newworld@newworldss.com

Case study of SuSanA projects

***Public toilet with biogas plant and water kiosk
Naivasha, Kenya***

SuSanA 2010

Authors: Christian Rieck, Patrick Onyango (both GTZ-Kenya)

Co-authors: Roland Werchota (GTZ), Katrin Bruehbach, Tony Green, Soeren Bauer (all WSTF/GFA Consulting)

Editing and reviewing: Steffen Blume and Elisabeth v. Münch (GTZ ecosan programme - ecosan@gtz.de)

Urine diversion dehydration toilets for rural schools in Kenya – draft

Fig. 1 Project location

1 General data

Type of project:
Demonstration facilities at rural primary schools as part of the larger Ecosan Promotion Project (EPP)

Project period:
Start of construction: August 2007
End of construction: May 2010
End of monitoring period: Nov 2010

Project scale:
70 schools with UDDTs (double vault system) - in most cases with 2 toilets for boys and 2 toilets for girls per school
263 toilets in total and 8,000 children (approx.) served based on 30 students per toilet

Address of project location:
Lake Victoria region with Nyanza, Western and Rift Valley province; Eastern, North-Eastern and Central Provinces in Kenya

Planning organisation:
EU-SIDA-GTZ Ecosan Promotion Project (EPP), Kenya (embedded in the GTZ Water Sector Reform Program)

Executing institution:
- GTZ
- School administration and boards
- Various Water Services Boards
- Water Services Trust Fund (WSTF)

Supporting agency:
- European Union (EU): ACP EU Water Facility (60 %)
- Swedish International Development Agency (SIDA) (30 %)
- German Technical Corporation (GTZ) on behalf of German Federal Ministry for Economic Cooperation and Development (BMZ) (10 %)

Note: since 1 January 2011, GTZ is called GIZ, after the merger with DED and Inwent

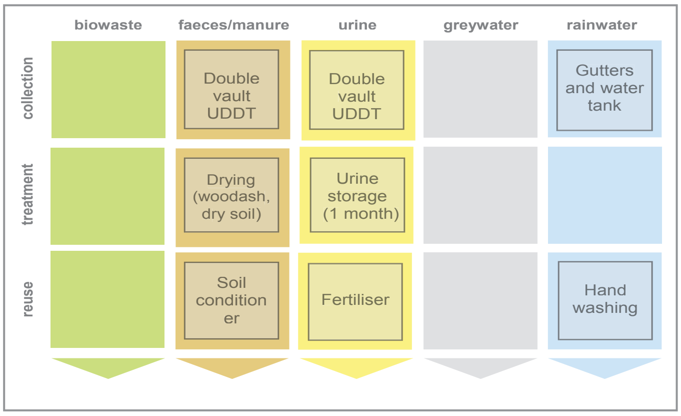


Fig. 2 Applied sanitation components in this project (UDDT stands for urine diversion dehydration toilet).

2 Objective and motivation of the project

The Ecosan Promotion Project (EPP) implemented a number of UDDTs in schools as part of the project. The focus on school sanitation in general had several long-term objectives:

- To improve the learning conditions of the students through improved sanitation facilities and accompanied hygiene education. The sanitation solutions had a focus on the reuse of human excreta as a resource. This concept is also known as ecological sanitation (ecosan).
- To engage a wider audience of schools and the surrounding households, so called clusters in order to support, stimulate and create demand for ecosan in the area.
- To engage the children as effective agents of change. Children pass on their knowledge of better hygiene practices and improved facilities from school to their parents and thus influence the communities.
- The toilets built under this program mainly served as an entry point for promotion and awareness raising only. The number built per school (usually four cubicles) was too few to have a real impact on the everyday life of the pupils.

Fig. 3 School UDDT block with two cubicles for boys with urinal on the right and hand washing station in the centre on top of the urine collection chamber at Mwala Primary School near Machakos (source: Johannes Orodi, GTZ-Kenya, Oct. 2009).

Urine diversion dehydration toilets for rural schools in Kenya – draft

Ecological sanitation offers an alternative sanitation solution for many schools in Kenya as it has various advantages to conventional pit latrines and as it generates products that can be used as fertiliser to grow crops in school gardens and thus can improve food security or generate additional income.

The focus of this document is on urine diversion dehydration toilets (UDDTs) for schools implemented under the EPP. The EEP also built household UDDTs, biogas and DEWATS systems. For more information on the EPP see Rieck (2010c) and the blog of the Ecosan Kenya Network[1]. The project's aim was to develop, test and promote the reuse orientated sanitation concepts for large and small-scale applications in mostly rural areas of Kenya.

3 Location and conditions

In many schools in Kenya, basic sanitation and hand-washing facilities are not provided or are in a very poor condition. Schools are often unable to provide a healthy environment mostly due to the lack of political motivation and attention for sanitation and hygiene. This generally leads to[2]:

- Schools with inappropriate, poorly managed and insufficient sanitation facilities for children, especially for children with physical disabilities, girls and small children (under the age of eight years old).
- A lack of financial resources for cleaning and maintaining toilet facilities in schools.
- Lack of proper hand washing facilities (including water and soap) and anal cleansing material (such as toilet paper or water).
- Lack or poor enforcement of regulations and guidelines related to school sanitation and keeping the premises clean.
- Insufficient or non-existing budgets and financing for sanitation for new facilities and also operation and maintenance of existing facilities.

Fig. 4 Old pit latrines at Muslim Primary School, Mumias in Western Province (source: Laura Kraft, GTZ, June 2010).

Girl students are especially affected by lack of facilities due to their special needs during menstruation. They fear to use toilet facilities that are situated in an isolated location or mixed facilities for boys and girls due to the risk of harassment or rape[3]. For example more than 500,000 Kenyan girls stay at home during their menstrual cycle missing out on approx. 90 school days a year (Onyango et al., 2009). It is recommended to provide separate sanitation facilities for boys and girls and appropriate space for changing and washing of sanitary pads as that can help to keep girls in school more consistently and longer.

Fig. 5 Newly finished block of two school UDDTs in Western Province. Old pit latrines are visible in the background (source: Moses Wakala, GTZ, April 2009).

Usually pit latrines are used in Kenyan schools which are often inappropriate due to risk of groundwater pollution and flooding. Flooding is a common problem during heavy rains and can cause the destruction of the toilets and also the flushing out of the human excreta into rivers, wells and other drinking water sources. This is often the cause for outbreaks of cholera and other water borne diseases. In some cases, schools have "grave yards" of old, filled pit latrines that cover large parts of the entire compound and will eventually limit digging of new pits.

Occasionally pits are lined on the side with masonry in areas with unstable soils or a conservancy tank is installed underneath the toilets, which are then emptied by a pump. The sludge is then often disposed unsafely in nearby ditches or water bodies if available.

Apart from the space limitation many schools face the challenge of rocky grounds, unstable soils and high groundwater levels that make the construction of pit latrines very expensive and hardly possible.

Most pilot projects were realised in rural primary schools located near the Lake Victoria in Nyanza and Western Province of Kenya. This part of Kenya is characterised by high population density, regular outbreaks of cholera and intensive agricultural activities. The sandy and loamy clay soils found around Lake Victoria are used for farming activities as the main source of income for the population. Generally, the greater Lake Victoria area is characterised by sufficient rainfall for agricultural production. The rainy period is April/May and October/November.

A few toilets were also built in Rift Valley and Central province and the semi-desert areas of Eastern and North-Eastern (near Wajir).

---

[1] http://ecosankenya.blogspot.com/

[2] See also SuSanA factsheet on school sanitation: http://www.susana.org/lang-en/library/rm-susana-publications?view=ccbktypeitem&type=2&id=1188

[3] African Population and Health Research Center (APHRC) http://aphrc.org/download/?id=99

In 2010, the under-five child mortality rate was at 85 children per 1000 in Kenya, and is has been decreasing during the last twenty years.[4]

4 Project history

The Ecosan Promotion Project (EPP) was an EU-funded and SIDA and GTZ co-funded project embedded in the larger Water Sector Reform Program of GTZ in Kenya. The project started in November 2006 and ended in May 2010. Within the project period 263 double vault Urine Diversion Dehydrating Toilets (UDDTs) were constructed in 70 schools by the EPP and also a certain (still unknown) number of school UDDTs via the WSTF. More than 600 UDDTs were constructed in households (Rieck, C. 2010c) and flushed based systems with DEWATS and biogas systems were installed in various schools and public places (see map in Fig. 6).

The EPP has constructed UDDTs in 62 primary and 8 secondary schools in mostly rural areas of Kenya. The list and detailed maps of schools is found on the ecosan network Kenya blog[5]. Beginning from mid of 2007 the first toilets were constructed in schools. Main target areas were Nyanza and Western Province.

Partners

The EPP offices were located at the Ministry of Water and Irrigation in Nairobi who was the main local partner. In the beginning of the project in 2007 the project assigned three sanitation officers, so called regional site managers (see contacts in Section 14), who were coordinating the implementation work directly with the communities, community based organisations (CBOs), schools, local administration, NGOs and artisans.

In schools the EPP worked with the school administration and parents-teachers associations. Initially also NGOs with experience in ecosan implementation were engaged to support the process and provide capacity building for the EPP sanitation officers. These NGOs were KWAHO (Kenyan Water for Health Organisation)[6] and ALDEF (Arid Land Development Focus). The local community based organisations (CBOs) were also involved in the school projects since at the same time household toilets were implemented in the surrounding community as part of the cluster approach (see below). Often the schools were also used for meetings and trainings of the community.

After initial contact with the school administration the project team usually received an official request for support. After agreeing to the terms, the school and EPP signed an MoA stating roles and responsibilities of each partner (see example of Memorandum of Agreement in Section 13). Generally the school contributed mainly by participation in trainings but rarely in material, cash or labour contributions. The "sanitation project cycle" and implementation program of WSTF give an overview of the participatory process that was applied (Rieck, 2010).

Between 2007 and 2010 more than 30 local masons were trained in building the toilets and were later contracted by the EPP to carry out the construction process in the communities.

Beginning of 2010 also the Water Services Trust Fund (WSTF) in collaboration with the water sector institutions of the Water Services Boards (Lake Victoria South and North in Western und Nyanza Province, Athi in Central Province and Tana Water Services Boards in Eastern Province) started to implement UDDTs in clusters following the established approach. The EPP acted as a support organisation to the institutions in project preparation, implementation supervision and training activities.

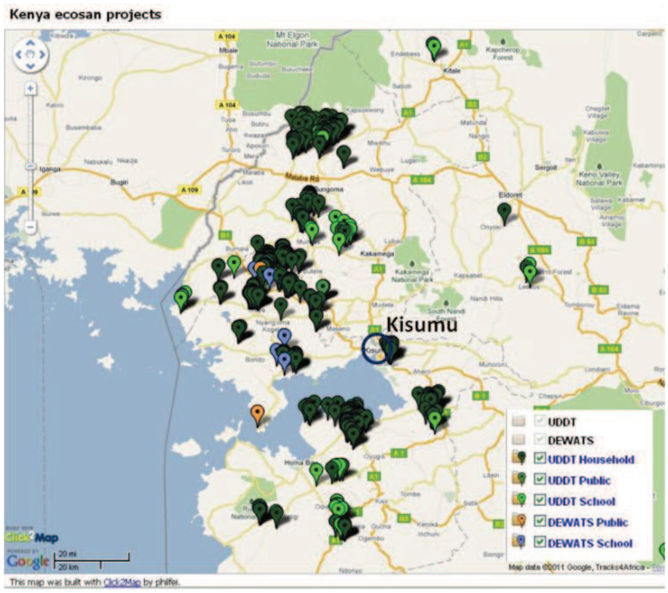


Fig. 6 View of Nyanza Province in the South and Western Province in North along Lake Victoria where most units were constructed. The light green dots mark UDDTs in schools.

Cluster approach

The approach was to always set up a cluster of 10 to 15 UDDTs at households and 4 at one local primary or secondary school. A walking distance of less than 20 minutes between these toilets was envisaged but not always achieved. The idea was to include both households and a school as they form one community. This should provide more momentum for sanitation improvements instead of focusing only on households or schools individually or by providing only one or two toilets per community. Ideally neighbours shall become encouraged to replicate the toilets as there are trained masons in the locality. However sufficient replication rates have not happened as monitoring suggests (see Section 11 on lessons learnt and Rieck, C. (2010c) for more info).

Schools should also promote good hygiene behaviour to children who then can pass this on to their families at home. If there are also adequate sanitation facilities at the households of the children as well, the desired behaviour change from schools to households is more likely to happen. However due to the small number of provided UDDTs and low replication rates (see paragraph above) this effect was likely to be only minimal. 10-15 UDDTs would serve about 100-200 people in a community which consists in general of far more than 500 people.

[4] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childmortality.org and http://www.childinfo.org/).

[5] http://ecosankenya.blogspot.com/p/projects.html

[6] www.kwaho.org

Urine diversion dehydration toilets for rural schools in Kenya – draft

5 Technologies applied

Urine diversion dehydration toilets (UDDTs) with a double vault system were constructed, because it is a robust, safe and user friendly technology. In comparison single vault urine diversion toilets require regular emptying of vaults and handling of partly fresh faeces which less acceptable to users. Usually two separate "blocks" of toilets for boys and girls were constructed; one "block" consisted of two cubicles only (see Wakala 2008). Boys urinals were also implemented in less than 10 schools, since usually urinals exist in sufficient numbers in schools. However the lack of new urinals has led to negative effects (see Section 11).

Fig. 7 Plastic urine diversion squatting pan with concrete footsteps inside a UDDT. Urine is collected in the centre; the two lids are covering the two faeces vaults (source: Laura Kraft, GTZ, June 2010).

Fig. 8 Faeces vault of UDDT with ash-covered dried faeces (source: Laura Kraft, GTZ, June 2010).

The plastic squatting pan separately collects faeces and urine. The urine is collected in containers located in an attached urine collection chamber (see Fig. 3). The faecal matter drops straight into the vault, where it is stored for a period of approx. six months under conditions that are intended to promote drying and reduction of pathogens to a resonable level for handling. When the first vault has been filled, the faecal waste is allowed to dry for the time which is required for the second vault to fill up (approximately six months). After each use, a scoop of ash is sprinkled over the faeces for improved drying, fly prevention, pH treatment (increase) and to cover the fresh faeces for aesthetic reasons.

6 Design information

Each school received 2 cubicles of UDDTs for boys and 2 cubicles for girls. In some cases also cubicles for teachers were constructed. Each cubicle will be shared by about 25 to 40 school children which depends on how the school is allocating the toilets to a certain group of classes or years. Therefore about 100 to 160 pupils were served per school.

Locally burnt bricks, concrete blocks or in some cases hydra-form blocks were used to build the masonry of the toilet structure. On the outside the masonry is keyed, on the inside plastered and painted in light colors. The toilet slab (floor) is made of cement, ballast, sand and twisted iron bars. For the storage of the faeces every toilet has two vaults that are connected to one vent pipe. The volume of the faeces chamber is 560 L with a length, width and height of 0.75 x 1.1 x 0.75 m.

About five steps are needed to reach the toilet door.

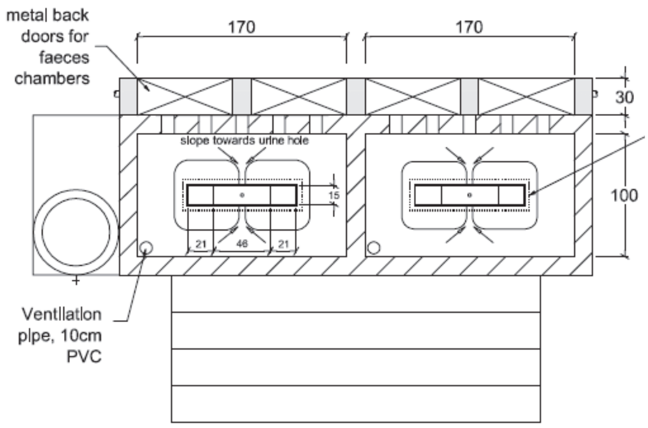


Fig. 9 Top view of toilet block with 2 UDDT cubicles and hand washing unit (source: Rieck, GTZ, January 2010)

The vault doors are made of metal sheets fixed on a wooden frame, painted black and are placed in a steep angle (inclined) in order to enhance solar heating. It was later realized that vertical vault doors are a better option (see Rieck et al., 2011 and Section 11). Firstly many times the toilets are not properly aligned towards the sun for many practical reasons and end up predominantly shaded thus are not serving the original purpose of solar absorption. In addition inclined vault doors face challenges with increased risk of rainwater leakage, vandalism (people sitting on it, placing or storing objects) and additional construction costs and complexity as compared to vertical doors.

The squatting pan for urine diversion is manufactured by a Kenyan company called Kentainers (see section 14) and was designed in cooperation with the EEP. It is made from plastic and has two faeces holes with a lid on each hole for a double vault system. While one lid has a handle for the vault which is in use, the other lid is without a handle and has a weight tied underneath to cover the hole of the inactive faeces vault (but this was too confusing for children, see technical lessons learnt in section 11). Each toilet cubicle has one ash container with a scoop and a laminated instruction poster.

The diverted urine is collected in two 20 liters plastic containers which are filled alternately. A flexible hose pipe (size 1 inch) connects the squatting pan's urine outlet with the container. The containers are stored in an attached urine collection chamber on which a 100 liter plastic water tank with a tap is placed for the purpose of hand washing. Soap is suppose to be provided by the school and usually placed next to the tank (see Fig. 1). The roof of the facility has a rainwater catchment system which directs rainwater into the water tank. In case there is not sufficient water available, the tank can be manually refilled with water from other water sources. The hand washing system is suboptimal as it provides no privacy (more infos in technical lessons learnt in Section 11).

Fig. 10 Rear view of 2 toilet blocks with inclined vault doors and ventilation opening which also provide additional light inside the cubicle (source: Paul Mboya, GTZ Kenya, Jan 2009)

The toilet design did not consider in detail issues of menstrual hygiene management. However sanitary bins were provided in each cubicle for the girls block.

Note: Design shortages are described in section 11.

7 Type and level of reuse

The students, teacher and partly staff of the schools were trained on how to use the UDDTs and the excreta products properly and safely (see Fig. 11Fig. 12). The urine is used after a short storage time in the containers as a fertiliser either on school gardens that are used for agricultural experiments of students or larger school farms if available. Not all schools did however venture into reuse and instead do dispose the urine at trees and bushes. For reuse the urine is diluted at a rate of 1:1 up to 1:5 before use in the school gardens. The gardener digs a small shallow trench next to the plant, pours the urine into the trench and covers the trench immediately with soil, so that nitrogen evaporation is minimised. Additionally the students and teachers were instructed that the last urine application should be at least four weeks before harvest.

The crops which have been fertilised with the urine in school gardens include kales, spinach, maize, mangos and bananas.

Fig. 11 Two 20 L urine containers with flexible hoses in a vault attached to the UDDT at Mwala Primary School, Ukambani (source: Johannes Orodi, GTZ Kenya, Oct. 2009).

The dried faeces are used directly on the school farms as soil conditioner after the second vault is full (approx. six months). No further treatment is applied but the users are advised to use the faecal matter for planting fruit trees like bananas and mangos and burying it. The school is strongly advised in trainings to apply health risk reduction measures like wearing gloves, rubber boots and washing hands with soap.

In terms of reuse of urine and faecal matter the follow up visits by consultants working for GIZ in mid 2010 showed mixed results (see Section 11). The majority of the schools do use the fertiliser for demonstration purposes but not food production. Often the school farms are small and not well managed, and the urine is mostly applied to trees or dumped on the ground. Certainly the lack of adequate and well timed training in reuse at the point of need resulted in these mixed results.

8 Further project components

Trainings and establishment of health clubs

In many Kenyan schools the project team observed that hygiene education is practically non-existent. Therefore all students, teachers and the parents were asked to participate in trainings with the main objective being to create awareness on sustainable operation and maintenance of school toilets and the link between sanitation, hygiene and health.

Furthermore in all schools a health or ecosan club was established or used if it already existed. The aim was to ensure a progressive, active and vibrant body of students who would mentor new members on the operation and maintenance of the UDDTs, the reuse of urine and dry faeces and the dissemination of information on ecosan and hygienic behavior.

Many students joined the clubs because they felt appreciated and had trust in the ecosan project. The schools usually provided a dedicated teacher as a patron to guide and oversee the clubs which usually had 20 to 40 members. The clubs were encouraged to network with other pilot ecosan schools in the same area in order to learn from one another. The effectiveness of clubs was not monitored, however a few problems were observed (see Section 11).

It was observed after the trainings that increasing knowledge on ecosan led to increased use and appreciation of facilities.

Fig. 12 Awareness creation and training in Mwala Primary School near Machakos in Eastern Province (source: Paul Mboya, GTZ Kenya, Oct. 2009).

9 Costs and economics

The investment costs per double vault UDDT with one cubicle are about KSH 50,000 (approx. EUR 500) as shown in Table 1. The school toilets of this case study usally had two cubicles (= one toilet "block"), see Fig. 3. The capital costs were thus about EUR 1000 for one toilet "block". Most schools obtained two toilet blocks, therefore the cost per schoo were EUR 2000 for hardware. The operation and maintenance costs are low as the school itself collects the products from the toilet and uses it directly in their farms.

Table 1 Cost breakdown for one cubicle of double vault UDDT (Blume, 2009). One toilet block with 2 cubicles costs about double.

Item category	Costs in Ksh	Costs in Euro
Foundation	4,525	45
Double vaults incl. doors	6,250	63
Toilet slab	3,789	38
Squatting plate (plastic)	3,500	35
Urine chamber with slab for water tank	3,900	39
Urine chamber doors	3,000	30
Ventilation	630	6
Steps	1,425	14
Walls with burned bricks	7,579	76
Doors	1,800	18
Painting	1,000	10
Roofing	3,268	33
Hand washing unit	800	8
Rainwater Harvesting	745	7
skilled labour costs	7,000	70
unskilled labour costs	3,000	30
Total	**52,211**	**522**

However the UDDTs can be made cheaper by using different materials, avoiding painting and other simplifications like omitting the rainwater harvesting system. See the study on costs and economics of UDDTs by Blume (2009).

Ideally, the contribution by the schools should be at least 20% of the total construction costs to ensure ownership. However in most cases the schools were not able or not sufficiently convinced to organise contributions from their own budget, the parents or the community.

The design used here is quite expensive making it hardly affordable for wide scale replications without state funding. The most significant cost items were cement and stones. The UDDTs were not built in the cheapest way but rather with high quality and appealing character making it a rather "fancy toilet" with high construction costs. It was the idea of the EPP team to market the UDDTs as modern and uplifting which in turn should create a positive mindset on development and instil pride. This approach has however not translated into broad replication of this technology in schools due to other underrated factors like high costs and donor dependency.

10 Operation and maintenance

As mentioned above, operation and maintenance of the UDDTs is done by the school itself, often the health or ecosan clubs (i.e. the students) but also by employed school staff (but not the teachers). It is not clear how the clubs created substantial incentives to students to clean the toilets (e.g. recognition, peer pressure, rules in the school etc.)

The club members and their patron participated in a special training on the use of urine as fertiliser and faeces as soil conditioner (operation). The club was provided with protection items and sanitary bins as well as T-shirts and base caps for individual members as incentive and motivation to participate as shown in
Fig. 13 .

Fig. 13 Health club members with protection items like cloves, mask, rubber boots and equipment like watering cans as well as sanitary bins that are given to the school and managed by the club, Mwala Primary School, Eastern Province (source: Paul Mboya, GTZ-Kenya, Oct. 2009).

The maintenance activities of the UDDTs includes cleaning, provision of wood ash, checking for blockages of the urine pipes, emptying full urine containers (every day) and full faeces vaults (every 6 months). It also includes minor repairs of the water tap (hand washing unit), chamber doors (due to rusting, termites), roofing, rainwater harvesting and occasional repainting.

11 Practical experience and lessons learnt

The major challenge in implementing sanitation facilities in schools is to create sustainable operation and maintenance systems within the school. This strongly relates to the level of ownership. Since the participation, financial and material contribution of the schools and surrounding community was very low in most cases, the ownership did not sufficiently develop. This has brought challenges to the cleaning and management of the toilets.

Due to challenges during planning and construction, some toilets were not yet finished when the trainings took place. The impact of the training without having the new toilets tends to be low as knowledge gets lost without application.

Furthermore many toilets started operation shortly before the end of the EPP project time in May 2010. Therefore the required trainings on reuse of urine and faeces could not take place. For the use of dry faeces it takes one year to "harvest" (filling half year and resting half year) thus many schools did not reach that stage during the time of EPP. Moreover simple operational problems like blocked urine pipes occurred only later when no direct support from GTZ was available anymore.

After the end of the EPP project the GTZ sustainable sanitation program in Germany funded some basic follow up of 45 schools with UDDTs and 12 schools with decentralized waste water treatment systems (DEWATS) including trainings and technical support until Nov. of 2010.

General observartions

- A generally high workload of teachers, overcrowded classrooms (high pupil/teacher ratios) and underpaid teachers indirectly affected the interest and motivation of teachers to engage in additional initiatives such as overseeing health or ecosan clubs.
- Since each school received only 4 toilets and school size ranges from 200 to sometimes 1,000 students not all students were allowed or able to use the new toilets. This resulted in overcrowding of the toilets which quickly led to uncleanliness and misuse.
- Misuse was also a problem, such as dumping of ash or even faeces in urine section. This led to blocking of the urine pipes and odour problems.
- The school management obviously did not manage or was not willing to unblock the urine pipes since this was an unexpected problem and an offensive (smelly) business. Sadly, the local artisans were not contacted by the schools for assistance even though they could have easily provided this service. It must be assumed that many or most of these schools were not able or willing to provide financial resources to maintain "donor-funded" toilets.
- Another big challenge was to enforce hand washing with soap after the toilet use. Most of the rainwater tanks could not be used properly as they were either stolen, not filled with water or damaged. Soap was usually not provided by the schools. Even after trainings with the aim of creating awareness on proper hygiene behaviors there was generally a lack of interest and finance (budget) for operation and maintenance of hand washing.
- In some cases the success of a project also depended on just one or two committed school directors and teachers. Once they left the schools the UDDTs quickly got misused and neglected resulting in closure of the facilities. This often happened once the urine pipe got blocked.

Software and project design lessons learnt

- Awareness creation and participation of all parents and other community members in the implementation process for school toilets is most important to make sure that UDDTs and reuse are accepted and well understood within the community.
- Contributions of parents and community members to the construction of the school toilets and the use of state funds in order to limit donor money dependency are important. This will build the crucial ownership needed for proper operation and maintenance.
- Training of local artisans on entrepreneurship that goes beyond construction alone is important, for example issues of operation and maintenance of the toilets so that they can provide support services to the schools. This would be a possibility for income generation, if the school agrees to sign a service contract e.g. services for emptying and management of excreta, reuse of fertiliser in agriculture etc.
- Always provide a sufficient number of toilets with the same standards for all students and teachers. Demonstration toilets seem to not lead to the replication of more toilets in schools. The Kenyan standard (Ministry of Education) requires a ratio of 1 toilet per 25 female students and 1 per 30 male students. Other standards call e.g. for a ratio of 1/50 for boys if urinals are provided. Also female urinals should be considered as it provides more hygienic conditions for girls.
- Build more affordable designs which are more likely to be replicated by schools for the cases that schools grow in students numbers and for the replacement of old facilities. Adapt local designs used for the school buildings and households.
- Provide a sufficient follow up and monitoring process over a time period of at least two years after the start of use that ensures trainings at all crucial stages after the start of operation (i.e. for unblocking of urine pipes, application of urine, closing of full vaults after 6 months, handling of dry faeces after another 6 months, repairs of vault doors, doors, water taps etc.).
- Make sure the school has a sufficient budget and available resources for toilet paper, soap and O&M activities such as replacement of water taps that will enable continuous hygienic practices and proper use of sanitation facilities.

Fig. 14 A urine pipe of a urine diversion squatting pans got blocked with ash at Muslim Primary School, Mumias. Faeces drop holes are covered with lids on the left and right in this photo (source: Laura Kraft, GTZ, June 2010).

- Make use of urine a simple activity or use soil infiltration (e.g. soak pit, infiltration trench) to fertilise trees instead of manual application which will lower work load.
- Ensure a continuous training and learning process at the schools on proper use and maintenance of the toilets. A good way might be to introduce specific hygiene curricula in the schools, use school competitions (award schemes) and other tools to motivate learning and keep engagement up.
- Making sure that menstrual hygiene management issues are included in design, implementation and trainings.

Technical design lessons learnt:

- No specific provision was made for menstrual hygiene management at the schools, except the allocation of sanitary bins. The project was not aware that teenage girls often use old cloth during menstruation as pads which need to be washed for the purpose of reuse. Hence girls might miss school when they are menstruating due to the fact that there was no space or water provided to change and wash their sanitary towels in privacy. However this could be done over the urine section of the squatting pan provided that the urine is not reused. Otherwise a separate drainage should be provided inside the toilet.
- In only a few schools the boy's UDDTs had urinals. Boys then often used the toilets for urinating instead of going to the existing old urinals, which led to splashing and urine entering the faeces vaults, since boys naturally stand during urination. This causes bad smell and unhygienic conditions.
- The system with two lids on the squatting pan confused some children in such a way that some students defecated into the urine section or tried to open the closed (resting) vault forcefully for defecation. Hence it is recommended to only cover the faeces hole of the resting vault and leave the "active" vault's hole uncovered (the children are used to one open hole in pit latrines).
- There were also problems with leakages of rainwater into the faeces vaults due to poor craftsmanship and insufficient material quality of the vault doors (e.g. untreated wood frame of the vault door was consumed by termites). In order to address this problem of rainwater leakage it was decided for future installation to use only straight vault doors with minimal risk of rainwater leakage and which is also cheaper and simpler in construction.
- The flexible hose pipes of 1 inch for urine collection have blocked very often due to accidental use of ash in the urine section, faeces and other obstructive materials. Many times the flexible pipe also developed sharp bends if bended too tightly e.g. in corners that can easily lead to blockages. Therefore it is recommended to use a bigger diameter of 2 or 3 inch and preferably standard PVC pipes. The school toilets should be retrofitted. The choice of flexible hose pipes was made on basis of similar designs worldwide, however these challenges were not documented prominently.
- The 20 liter urine containers are too small thus causing heavy work load due to contant exchange of containers. It would be better to provide 2 big alternating tanks that allow for treatment (short term storage) and bridging of times with no need for fertilization
- The plastic tank of the hand washing facility needs to be secured in a concrete ring to avoid theft. The tank can be permanently fixed. It was often witnessed that the tanks were missing or used for other purposes.
- The design with steps does not take into account pupils with disabilities etc., therefore sitting types like bench design should be considered (see Rieck et al., 2011)

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 2 Qualitative indication of sustainability of the system. A cross in the respective column shows assessment of the relative sustainability of project ("+" means: strong point of project; "o" means: average strength for this aspect and "–" means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X			X	
• environmental and natural resources	X			X			X		
• technology and operation		X		X				X	
• finance and economics			X		X		X		
• socio-cultural and institutional		X			X			X	

With regards to long term impacts of the project, the main expected impacts were (note: these impacts have not been verified yet):

- Students spread their knowledge about ecosan within their families and communities which results in a higher demand and awareness of improved sanitation.

- Higher awareness on proper hygiene practices like hand washing amongst the students.
- Reduction of investment cost for sanitation hardware do to longer life spans of UDDTs as compared to pit latrines
- Increased agricultural production of school farms through use of fertiliser from UDDTs. schools

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

13 Available documents and references

Photos from this project are available on flickr:
- http://www.flickr.com/photos/gtzecosan/sets/72157628127018213/ and other sets under Kenya

Videos:
- Promoting ecological sanitation in Kenya (01/2010) http://susana.org/lang-en/videos-and-photos/resource-material-video?view=ccbktypeitem&type=3&id=8
- Johannes Orodi Odhiambo explains the advantages of UDDTs at a new toilet in Ugunja (05/2009) http://susana.org/lang-en/videos-and-photos/resource-material-video?view=ccbktypeitem&type=3&id=15

Drawings:
- Drawings and BOQ of urine diversion dehydration toilet for households and schools (Kenya), April 2010 http://www.susana.org/lang-en/library/rm-technical-drawings

Publications:

Blume, S. (2009) Cost optimization of single door UDDTs in Kenya. GIZ Kenya, Nairobi, Kenya http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=513

Blume, S. and Rieck, C. (2010) Singing the Gospel of Ecosan – A Kenyan Toilet Preaching http://ecosankenya.blogspot.com/2010/06/sing-ing-gosp-el-of-ecosan-k-enyan.html

GTZ and SIDA (2007) Using the EcoSan toilet, http://susana.org/lang-en/library/rm-posters?view=ccbktypeitem&type=2&id=352

Kraft, L. (2010) Final sampling report for products from double-vault UDDTs (faeces and urine), GIZ Eschborn, Germany http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1026

Odhiambo, J.O. (2008) Example of a Memorandum of Agreement, GTZ-Kenya http://www2.gtz.de/Dokumente/oe44/ecosan/en-memorandum-of-agreement-2009.pdf (to SuSanA library?)

MWI (2009) The Water Sector Sanitation Concept – WSSC, Ministry of Water and Irrigation (MWI) Kenya http://www2.gtz.de/Dokumente/oe44/ecosan/en-mwi-kenya-sanitation-concept-2009.pdf (to SuSanA library? - are there any new WSTF materials which are now in the library?)

Onyango, P., Odhiambo, J.O. and Oduor, A. (2010) Technical Guide to EcoSan Promotion, GTZ-Kenya http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=710

Rieck, C. (2010a) Sanitation project cycle for rural areas, Kenya http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=812

Rieck, C. (2010b) Implementation programme of EPP/WSTF/WSB, http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=813

Rieck, C. (2010c) UDDTs implemented via CBOs and Water Services Trust Fund, Nyanza, Western and other provinces, Kenya, GTZ Kenya, Nairobi, Kenya, http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=129

Rieck, C., von Münch, E. (2011). Technology review of urine diversion dehydration toilets (UDDTs) - Design principles, urine and faeces management (draft). (GIZ), Germany. http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=874

Wakala, M. (2008) Construction work of two institutional UDDTs, household toilets and ferro-cement water tank – Butere Mumias http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1193

Continuous updates about the project sites on the Ecosan Kenya Network Blog: http://ecosankenya.blogspot.com/. More communication is available on the Kenya Ecosan Network facebook page: http://www.facebook.com/ecosan.kenya.

14 Institutions, organisations and contact persons

Technical Planning and Implementing Support

EPP (EU-SIDA-GTZ Ecosan Promotion Project), Kenya (during Nov. 2007 to May 2010); Ministry of Water and Irrigation (MWI), Maji House, Ngong Road, Nairobi, Kenya
T: +254-20 272 3353

Contact 1: Paul Patrick Onyango (project leader)
T: +254 721 172 661, E: onyangopadak@yahoo.com,
Contact 2: Odhiambo Johannes Orodi (communication officer)
T: +254 725 658 150, E: orodiodhiambo@yahoo.com
Contact 3: Eng. Moses Wakala (sanitation officer, Western)
T: +254 721 743171, E: wakala.gtz@gmail.com
Contact 4: Wycliffe Osumba (Sanitation officer, Nyanza)
T: +254 712 930 516, E: osumbawycliffe@yahoo.com

Partner organisation:
Ministry of Water and Irrigation, Nairobi, Kenya
Contact: Eng. Ombogo, E: patrick_ombogo@yahoo.com
Contact: Rose Ngure, E: ngure_rose@yahoo.com

Executing organisation:

Primary and secondary schools
http://ecosankenya.blogspot.com/p/projects.html
KWAHO (NGO) http://www.kwaho.org/
ALDEF (NGO) aldef@nbnet.co.ke
Various Community Based Organisations (CBOs) and private construction companies (e.g. Comila in Kisumu) and masons

Executing institutions:
Lake Victoria South Water Services Board, Kisumu (http://www.lvswaterboard.com/)
Lake Victoria North Water Services Board, Kagamega (http://www.lvnwsb.go.ke/)
Athi Water Services Board (http://www.awsboard.go.ke/)
Tanathi Water Services Board (http://www.tanathi.go.ke/)

Financing agencys:
Water Services Trust Fund (WSTF)
Engineer Mr. Macharia
Han Seur
P.O. Box 49699 – 00100, Nairobi, Kenya
Email: macharia@wstfkenya.org
Email: hanseur@hotmail.com
Web: www.wstfkenya.org
T: +254 20 713020

Supplier of sanitary ware:
aquasantec (Kentainers Kenya)
Embakasi Office, Off Airport North Rd, Nairobi, Kenya.
T: +254 20 2519098/99 E: info@aquasantec.com
Contact: Paul Madoc, E: paul_madoc@kentainers.com
Web: http://www.kentainers.com/kent/kentainers.html

Case study of SuSanA projects
Urine diversion dehydration toilets for rural schools in Kenya
SuSanA 2011

Authors: Laura Kraft (formerly consultant for GIZ) (kraft_laura@yahoo.de), Christian Rieck (christian.rieck@giz.de)(GIZ)

Editing and reviewing: Elisabeth von Münch (ecosan@giz.de)

Case study of sustainable sanitation projects

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya

Figure 1 Project location

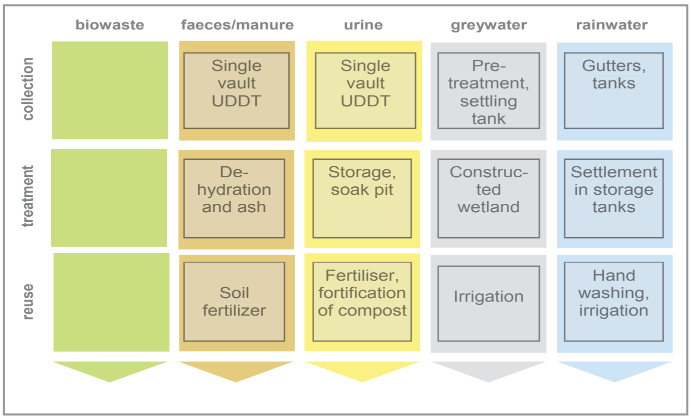


Figure 2 Applied sanitation components (UDDT stands for urine diversion dehydration toilet)

1 General data

Type of project:
Full-scale pilot project for a school in Nakuru, Kenya

Project period:
Start of construction: June, 2008
End of construction: May, 2009
Start of operation: September, 2009
Monitoring period planned for: one year
Project end: 31 March 2010

Project scale:

Total investment: EUR 8, 473

Total number of users: 223

1. Design and construction of a school UDDT with 3 toilets and 9 urinals for boys, 5 toilets and 4 urinals for girls, urine storage tank, roof water harvesting for a population of 200 students at a cost of EUR 5,135
2. Design and construction of a greywater treatment system for kitchen and dish washing effluents at a cost of EUR 1,500
3. Design and construction of a faeces drying shed at a cost of EUR 857
4. Workshops and training at a cost of EUR 981

Address of project location:
Crater View Secondary School,
Prisons road, off Eldama Ravine Highway
Nakuru, Kenya

Planning institution:
Egerton University/Rosa Project, Egerton-Kenya

Executing institution:
Nakuru Municipal Council/ ROSA project, Nakuru-Kenya

Supporting agency:
European Union

The work was carried out within the project ROSA (*Resource-Oriented Sanitation concepts for peri-urban areas in Africa*; Contract No. 037025-GOCE; duration: 1.10.2006 – 31.3.2010), a Specific Target REsearch Project (STREP) funded within the EU 6th Framework Programme, Sub-priority "Global Change and Ecosystems".

2 Objective ad motivation of the project

The objectives of this project which was part of the much larger ROSA project were mainly to:

- Introduce concepts of resource oriented sanitation and present a change of paradigm from the conventional waste oriented to beneficial reuse oriented sanitation.
- To improve on sanitation by establishing a urine diversion dehydration toilet system that is free of flies and odour.
- To reduce groundwater pollution and health risks associated with pit latrines.
- To demonstrate that faeces and urine collected from the UDDTs can be safely sanitised and utilised as soil conditioner and as fertiliser respectively.
- To demonstrate that greywater can be effectively treated and used as for irrigating crops.

The motivation was to contribute towards achieving the MDGs by promoting productive sanitation.

3 Location and conditions

Figure 3 The UDDT facility at Crater View Secondary School two years after construction (Source: L.Kraft, May 2011)

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya

Crater View Secondary School is a government school located in the north-western part of Nakuru municipality. Nakuru Municipality is a mid-sized town, the fourth largest town in Kenya after Nairobi, Mombasa and Kisumu. The current population is estimated at 500,000 people with a growth rate of 4.5% per year (MCN, 1999). The soils are mainly volcanic loose soils ranging from moderate occurrence of surface rock to very shallow soils with surface rocks rendering the area unsuitable for digging pit latrines. In Kenya, the under-five child mortality rate is currently[1] 84 children per 1,000 (compared to 99 per 1000 in 1990)

The piloting area is London estate in Nakuru and has little or no connection to the main sewer line. It is an area inhabited by low income earners and thus, poverty levels are very high. Furthermore, it is densely populated (2000-4500 persons/km^2). Crater View secondary school in London area is strategically located to serve children from the poor neighbourhood. It is a day school, but lunch is served to the entire school population.

The school population is made up of 200 students (120 girls and 80 boys), 16 teachers and 7 workers. Previously, the students were served by 3 pit latrines for the girls and 2 for the boys. The condition of the latrines was poor and characterized by pungent smell and flies. The new UDDT's has improved the students/toilets ratio to 24 for the girls and 26 for the boys and hence conforms to the recommended ratio of one toilet to 25 girls and one toilet to 35 boys (GOK, 2007). Furthermore the four urinals installed for the girls have reduced the demand for the toilets to approximately one half while the ratio for the boys urinals is 9 boys per urinal. The project did not make any provision for anal cleansing since majority of the students (95%) who are between 14 to 18 years old are Christians and use toilet paper for anal cleansing.

Greywater from kitchen and dish washing was disposed into the open resulting in ponds of wastewater that caused a major public health threat since the site acted as breeding grounds for flies.

Figure 4 Left: The old pit latrines at Crater view secondary school (Source: Muchiri, 2008) Right: Greywater from kitchen and dish washing was disposed in open drains prior to the project (Source: Raude, 2009)

4 Pilot project history

In 2007, the ROSA project (Resource-Oriented Sanitation concepts for peri-urban areas in Africa) carried out a survey to investigate the status of sanitation in Nakuru. The results showed that only 19% of the built-up area was sewered and in the high-density areas, sanitary facilities were poor and inadequate. The study identified the following as some of the main problems of onsite sanitation in Nakuru: collapse of pit latrines due to weak soils, flooding of pit latrines during heavy rainfall, smell and flies in pit latrines, contamination of groundwater, and inadequate water supply for basic hygiene. In some areas shallow soils and rocky grounds made it difficult to dig pit latrines and poor handling and disposal of greywater.

The school was selected due to: the poor condition of the existing pit latrine that was inadequate, smelly and with a lot of flies, the school lacked adequate and reliable water supply, there was no municipal sewerage system in the vicinity, and the school had a garden on which the urine and treated feacal matter could be used and lastly the principal and the school management were ready to take up the new system and were willing to collaborate accordingly.

Intensive awareness creation and demonstration workshops were later carried out to educate the students and teachers on the ROSA systems and particularly on the UDDT technology and greywater management. Five awareness creation and demonstration workshops were conducted in the school, the first one was before the construction commenced in April 2008, the second was during the ground breaking and foundation stage and the other two were demonstration on how to use the facility in June and September 2009. In January 2010, another demonstration was conducted for the new students.

The design and costs of the pilot units were developed and discussed with the users. A memorandum of agreement between the school management and ROSA was signed by both parties. The school is responsible for the management of the facilities. The pilot project construction phase started in May 2008 to June, 2009 and the ROSA project ended in March (2010).

Monitoring in May 2011:

A monitoring of the ROSA projects in and around Nakuru was done in May 2011 by the consultant Laura Kraft (e-mail address: kraft_laura@yahoo.de) on behalf of GIZ sustainable sanitation program (Kraft, L. 2011). The overall objective of the monitoring was to update the SuSanA case study in regard to present status and lessons learned from the project.

For monitoring and evaluation three methods were used to gather information:

- Desk review, field observations and interviews

During the desk study different online documents were reviewed to understand the project approach and to access the latest information on the project status. This knowledge was used to prepare monitoring sheets and questionnaires for interviews with UDDT users, related service providers for excreta management and other relevant stakeholders.

The ROSA project sites described by SuSanA case studies were visited to assess the status of the UDDTs and other related facilities within the ROSA project. Interviews were conducted with teachers, students, landlords, CBO/ NGO leaders and the Municipal Council. For documentation purpose digital pictures were taken during the monitoring and uploaded on flickr (see link in Section 13).

[1] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before the age of five if subject to current age-specific mortality rates.(http://www.childinfo.org/mortality.html and http://www.childmortality.org/)

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya

During the visit of Crater View Secondary School interviews were conducted with students and the teacher who is in charge of the environment. The state of the toilet facility and the greywater system were assessed using the monitoring sheet.

Based on the resultant information, the case study was updated. The original text referring to the project state in 2009 was maintained with minimal alterations in addition to the new observations added under the headings “Project update May 2011”.

5 Technologies applied

After consideration of options, the urine diversion dehydration toilet (UDDT) was chosen due to its advantage of not requiring water for use as flush toilets do and for not having to dig pits in the hard rock as the pit latrines require. The greywater treatment method used was the sub-surface flow constructed wetland system. The project consisted of the following components:

Urine diversion dehydration toilets (UDDTs)

Figure 5 New school toilet implemented by ROSA project (Source: Muchiri, 2009)

A masonry block consisting of eight cubicles of single vault UDDTs was constructed. The girls section was provided with 5 cubicles (25 students per toilet), 4 urinals and a space for changing menstrual pads and school uniform into sportswear. On the other side the boys were provided with 3 cubicles and 9 waterless urinals.

Figure 6 New waterless girls’ urinals (squatting) inside the girls’ toilet block (Source: Muchiri,2009)

Each side has two hand washing basins located strategically at the entrance of the facility.

Figure 7 Inside of the UDDT, showing urine diversion squatting pan and bucket of ash (Source: Muchiri, 2009)

Figure 8 Inside the boys’ toilet - 3 cubicles (left) and 6 waterless urinals (right) made of plastic buckets (Source: Muchiri, 2009)

Greywater treatment

The greywater treatment system consists of a collection trough (dish washing facility), a settlement tank of 250 litres and greywater collection tank of 750 litres. The development of a greywater treatment system involved consideration of institutional and social issues in addition to technical factors.

A horizontal subsurface flow constructed wetland (HSSF CW) system was chosen with a water surface maintained at 15-30 cm below the ground level.

Drying shed for faeces

To ensure a closed loop sanitation system in the school, a drying shed was constructed where faeces from the UDDTs will be stored for further drying and treatment.

6 Design information

UDD toilets

The overall dimensions of the UDD toilet block are 13 m length by 3.6 m width, housing eight UDDT cubicles, space for urinals and an area for changing uniform into games kits is provided adjacent to the urinals.

The superstructure is constructed of masonry stone which is locally available and the roofing is made of timber trusses (75 mm by 50 mm) and gauge 30 corrugated iron sheets. Standard size doors and frames (1.98 m by 0.9 m) made of Cyprus timber was used for each toilet cubicle. To save on cost, each toilet area (1.1 m x 0.9 m) was designed to meet the minimum toilet floor area requirement of approximately 1 m^2 (Harvey et al., 2002).

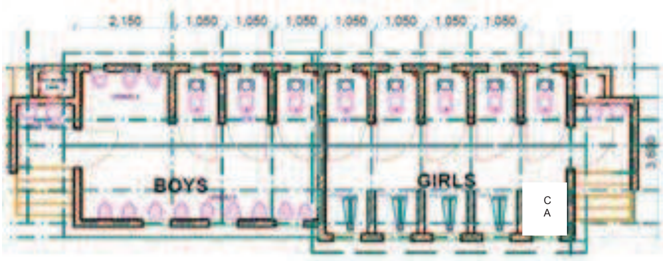


Figure 9 Floor plan for the toilet block at Crater View School (Source Muchiri. 2009)

The faeces are collected in single vaults below a 75 mm thick reinforce concrete floor slab fixed with a plastic urine diversion squatting pan called ``eko plate´´ (Product of Kentainer Ltd.). The faeces vaults are 1.1 m x 0.9 m x 0.75 m (LxWxH), with enough space to hold three 50 litre containers for the faeces and adequate room for the attendant to remove and replace the containers. This reduces the need to frequently empty the buckets and allows pathogen die off for at least six months (WHO, 2006). Once a container fills after approximately 30 to 45 days, it is pushed aside to allow an empty bucket to be placed below the hole.

Vault doors (0.9 m x 0.75 m) are large enough to allow removal and replacement of the containers at ease. They are made of galvanised steel for durability, painted to prevent rusting and tightly fixed to prevent entry of flies.

In each cubicle a bucket of ash and a scooping cup is provided for use after defecation.

Figure 10 Interior of a faeces collection vault with a 50 litre container to collect the faeces (Source: Muchiri, 2009)

Other toilet components

To supplement the inadequate water supply in the school, rainwater is harvested from the roof into two 250 litre plastic water tanks and the water is connected to hand washing basins.

To overcome the problem of foul smell, vent pipes are installed in each vault and rise 1.00 m above the highest point of the roof to enable draft action to suck the foul air from the chamber. Flies are prevented from getting into the faeces vault by gauze mesh wire fixed at the top of the vent pipe. The interior of the toilet is well ventilated and lighted by glazed windows both in the front and in the rear as shown in figure 12 below.

Figure 11 Ventilation pipes and windows for each UDDT collection vault and cubicle respectively (Source: Muchiri, 2009)

Underground urine tank

Urine from the waterless urinals (4 for girls, 9 for boys) and from the UDD toilets is collected and stored in a 2000 litre masonry underground tank. The tank is large enough to hold urine for approximately 2 months assuming a generation rate of 0.20 l/student /day (a day is from 8.00 am to 5.00 pm since it is a day school). The total amount generated by 200 students will be 40 litres per day amounting to 2000 litres in 50 working days (2 months). To minimise odour, the urine drain pipe is submerged into the collection tank to provide a basic water seal. An overflow connected to a perforated 50mm drain pipe is buried along a plantation of trees in the garden. Provision for installation of a hand pump is fitted, however the school is yet to install the pump.

Figure 12 Urine collection tank (2000 L) at Crater View secondary school (Source: Muchiri, 2009)

Drying shed

The area of the drying shed is 22 m^2 and the dimensions are 6 m x 3.6 m. The shed is constructed of cedar poles and wire mesh on the sides and the roof is covered with corrugated iron sheets.

The amount of faeces generated by the students was calculated based on an annual generation rate of 50 litres per person. However, since the school is closed for 3 months per year for holidays, the toilets are only in use for 9 months of the year. The amount generated per student during school sessions was estimated to be 37 litres in 9 months.

Furthermore the school is a day school and it is reasonable to assume a half rate generation at the school and half at home reducing the amount to 19 litres/student and this works out to approximately 4000 litres (4 m^3) per year. If faecal matter is spread over ¾ of the shed area (to allow working space) at a minimum depth of 0.5 m, it can hold 8.25 m^3 of material from the UDDT (the volume of ash and toilet paper is not included in these calculations). The drying shed is therefore designed to accommodate faecal matter generated in the UDDT for at least 2 years.

The floor is made of concrete and a 500 mm stone wall is constructed along the four sides of the floor slab to prevent surface runoff from entering the shed. The roof slopes from 2.4 m at the ridge to 1.5 m at the sides. Gutters for rainwater harvesting are fitted.

Figure 13 Drying shed for processing faecal matter from the UDD toilets (area 6 m x 3.6 m) (Source: Muchiri, 2009)

Rainwater harvesting for hand washing

Rainwater from the roof is collected in gutters and harvested in two 250 litre capacity plastic tanks. The water is then piped to two hand washing basins inside the toilet both on the girls' and the boys side. When there is no rain or when the tanks run dry, they are refilled by the students on a weekly basis. The water was drawn from a tap within the school (50 m from the toilet) in 20 litre containers. It takes 20 trips (20 minutes) to fill the two 250 litre tanks.

Figure 14 Roof water harvesting system and students washing their hands after visiting toilet (Source: Muchiri, 2009)

Greywater treatment system

The greywater treatment system was designed for the treatment of greywater generated from preparing food and washing dishes at Crater View secondary school. The system also receives water from hand washing basins in the kitchen area. The project aimed at treating greywater generated for reuse or safe disposal. This was achieved by gravity flow, single pass treatment of greywater through a pre-treatment followed by a horizontal sub-surface flow constructed wetland (HSSF CW) with vetiver grass (*Chrysopogon zizanioides L*) as aquatic plants. The pre-treatment chamber was connected to the wetland through a 610mm long, 50mm diameter pipe.

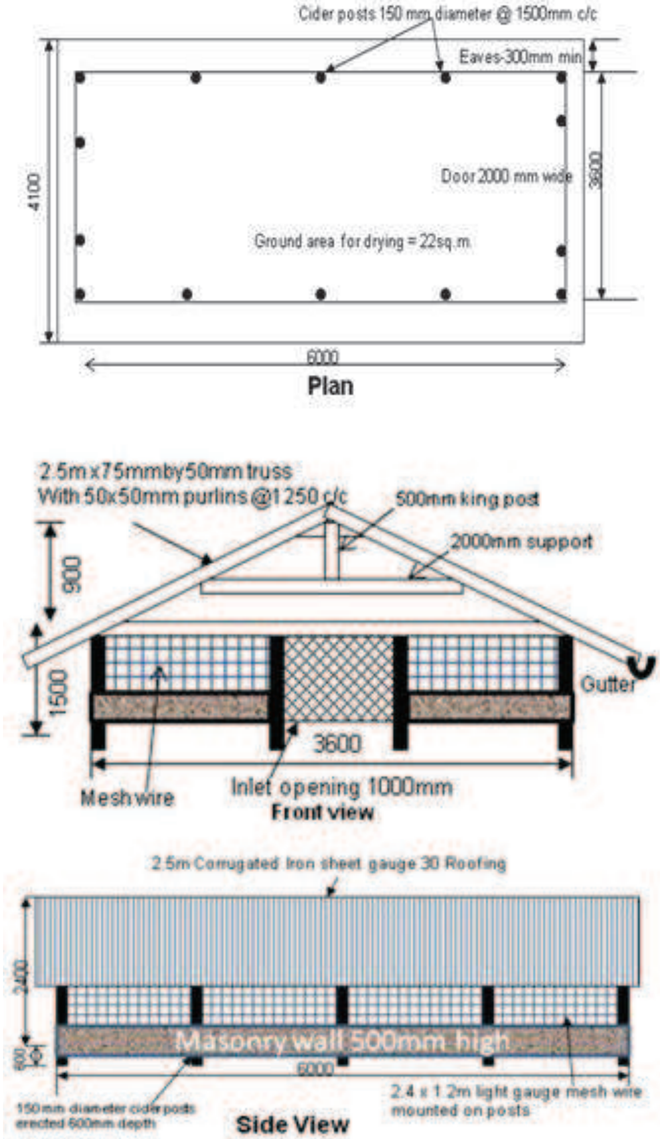


Figure 15 Plan, front section and side view of drying shed for faeces from UDDTs at Crater View Secondary school (Source: Muchiri, 2009)

Figure 16 Greywater treatment system at Crater View Secondary School (Source: Laura Kraft, 2009)

Table 1: Grey water treatment system design details

No	Name	Description
1	Pre-treatment	Two chamber (0.25 & 0.75 m³) litter trap for settling of coarse organic matter and grease trap; cleaning interval not more than 4 times/yr
2	Constructed wetland surface area	Horizontal sub-surface flow constructed wetland (HSSF CW); length = 2 m, width = 1 m (area 2 m^2)[2]
3	Inlet to constructed wetland	Stone distributor; slotted pipe for greywater distribution, inlet depth = 0.86 m
4	Treatment volume	Fine gravel (D60 = 3.5 mm, Cu = 1.8); initial porosity = 40%; with an average wetted depth of 0.875 m; Hydraulic conductivity was 17 m/day
5	Outlet	Outlet depth = 0.8 m; variable effluent outlet height
6	Flow	Flow rate is set at 1 m^3/day; hydraulic loading rate (HLR) is 500 mm/day
7	Other design considerations	Bottom slope of 1-2%; gravel media; geo membrane liner of 1 mm thickness
8	Materials	Building sand is locally available (3-8 mm in size)
9	Retention period	2 days
10	Cost	Treatment system including hand-wash facility EUR 1.500

Monitoring outcomes from May 2011:

Urine diversion dehydration toilets (UDDTs)

The superstructure was generally in good condition without visible damage beside one broken glass-window at the boys' side. On the inside walls were some signs of vandalism mainly on the boys' side. The walls have foot- and handprints and there some writings on the wall.

All toilet cubicles and urinals were in use, but one urine pipe was blocked on the girls' side. According to the teacher, blockage of urine pipes was a common problem before. Therefore the school exchanged the old pipes with new pipes having a wider diameter and sieves.

Underground urine tank and drying shed

It was observed that the urine tank got filled up and urine might overflow and infiltrate in the soil. The drying shed is in good conditions without any visible damage. Gutters for rainwater harvesting are fitted but not connected to a rainwater harvesting tank. Faeces in the drying shed were very dry, not smelling and ready for reuse. Despite a container for sanitary pads the faeces at the drying shed still contain not degradable material like plastic bags, sanitary pads and degradable material like paper (Fig.17).

Figure 17 Dried faeces mixed with not degradable materials inside the drying shed (Source: L.Kraft, May 2011)

Rainwater harvesting for handwashing

The handwash facility was in place and functioning but water was only in the boys' section available. The gutter for rainwater collection was blocked which could be the cause of water shortage. If there is no water available, the rainwater tank cannot easily be refilled manually due to its high position. There is another handwash facility which is connected to pipe water but as it is far from the toilet it is usually not used by the students.

Greywater treatment system

As observed the amount of treated water discharged from the greywater treatment system was very little. The pre-treatment containers were filled up with water and most probably the problem was either a blockage with overflow within the system or leakage at the point of the filter or piping.

Figure 18 Greywater treatment system with settlement tank (Source: L.Kraft, May 2011)

[2] This equates to 0.009 m^2 per person (223 people at the school), which is very small. (question: why is it so small?)

7 Type and level of reuse

Urine and dried faeces

After several awareness and sensitisation workshops on the reuse of the products from the UDDTs, the school is willing to use the urine as a fertiliser and the dried faecal matter as a soil conditioner. The school has a small farm on which they plan to grow crops and Napier grass using the products. The student environmental club has embarked on growing trees and is willing to use the UDDT products to grow the trees.

Greywater reuse

Water is a scarce commodity in this area and any available extra drop is critical to the survival of the agro-forestry activities in the school. Crater View Secondary School is currently involved in a tree planting program in line with the Kenya Government policy on stimulus package and employment creation through "Kazi Kwa Vijana (KKV)"- "Jobs for the youth".

KKV aims at employment creation by encouraging the Kenyan youth to deal with environmental issues with schools and public institutions being the main targets. The greywater is reused in the school for the agro-forestry activities. This pilot has a great potential for possible future up-scaling since Kenya is a water scarce country. Demand for greywater treatment system is high in the Municipality due to its ability to compliment on the scarce water. However, the systems require space, flowing water and are relatively capital intensive.

Monitoring outcomes from May 2011:

According to the teacher the urine was not reused and the urine tank has not been emptied yet. The faeces have been collected in the drying shed for one year but have not been reused, too. It is planned to reuse treated faeces for trees and crops planted in the school compound however there was a concern that the students react negatively when faeces are reused. Also greywater has not been used as the outlet is insufficient.

8 Further project components

The following activities are in progress at Crater View Secondary School in respect to the pilot project:

- Monitoring operation and maintenance of the facilities
- Research on urine and faecal matter treatment, management and utilization.

Initial results for the operation and maintenance can be found in http://www.ecosan.at/ssp/issue-2-operation-maintenance/article-4/view

9 Costs and economics

The bill of quantity and construction cost for the school UDDT, the drying shed and the greywater treatment systems are given below. ROSA project covered 90% of the total cost while the school contributed 10%.

Equivalent cost for single UDDT cubicle would be EUR 639. This is because it is built in a professional way for demonstration purpose. The price includes architectural set up and it is completely roofed toilet block for boys and girls.

Table 2: Cost for construction (labour inclusive) of UDDT block at Crater View Secondary School. Current exchange rate 1 EUR =104.32 KES (Kenyan Shillings)

Item	Description	Amount (EUR)
1	Excavation and earthworks	194.53
2	Concreting	812,44
3	Walling	1248,58
4	Roofing	640,54
5	Doors	825,12
6	Sanitary installations	634,09
7	Finishes	764,23
	Total	**5119,54**

Table 3: Cost for construction of drying shed at the school

Item	Description	Amount (EUR)
1	Cedar posts and poles	22,81
2	Timber	202,74
3	Iron sheets and nails	140,91
4	Gutters and holders	19,17
5	Cement	76,69
6	Sand	47,93
7	Aggregate	134,20
8	Building stones	50,61
9	Wire mesh	63,27
10	Labour	95,86
	Total	**854,19**

Table 4: Cost for construction of greywater treatment system at the school.

Item	Description	Amount (EUR)
1	Mobilization and sensitisation	195,55
2	Foundation footing	14,95
3	Slab	82,92
4	Support pillars	173,51
5	Trough	103,14
6	Plumbing works trough	38,10
7	Plumbing works - wetland	97,73
8	Liner	49,85
9	Wetlands construction	261,50
10	Transport	134,20
11	Labour	133,24
12	Vetiver grass	38,34
13	Fencing materials	110,24
	Total	1433,29
	School contribution	666,42
	ROSA Project contribution	766,87

Table 5: Total cost for construction and implementation of ROSA project at Crater View Secondary School

Item	Description	Amount (EUR)
1	Construction of UDDT block	5119,53
2	Construction of drying shed	854,19
3	Construction of greywater treatment system	1433,29
4	Workshops and training	450,54
5	O&M basic tools	95,86
6	Monitoring exercise for 26 wks	498,47
	Total	**8446,89**

10 Operation and maintenance

The entire project is managed by the school after being handed over on 24th September 2009. However, as long as the ROSA project was running (until March 2010) the ROSA team continued with back-stopping when needed. To ensure sustainability, after mobilisation and sensitisation, the school nominated a care-taker who was actively involved during and after construction. The day to day cleaning of the toilet is done by an employee of the school who is paid a monthly salary of EUR 45.

It is planned that collection, transportation and emptying of the faeces chambers will be done once every three months during the holidays. The urine tank may be emptied as soon as there is demand for fertiliser. These activities will require additional labour to assist the care taker. It will cost approximately EUR 2 to empty the containers once per month amounting to a total of EUR 24 per year.

Monitoring outcomes from May 2011:

There was ash available in 7 out of the 8 toilets however not one of the fresh faeces were covered with ash. There were no posters or explanations on the right use of the toilet therefore it might still be lack of knowledge.

Figure 19 Left: In the boys section piled up faeces are visible as containers are filled up, fresh faeces are not covered with ash, signs of cross-contamination in the front part. Right: Blocked urine pipe in the girls section (Source: L.Kraft, May 2011)

On the boys' side a strong urine smell emitted from the urinals, there were signs of faecal cross-contamination in the urine section of the toilet slab, the faeces containers were already filled up and flies were observed. The girls' side was generally cleaner and better maintained however one urine pipe was blocked and urine stagnated in the front part of the UDDT slab (Fig.18).

11 Practical experience and lessons learnt

Crater View Secondary School is normally used for other social activities over the weekends and during holidays when students are away. In one such meeting, the school allowed a Christian function to take place that saw the school host over two thousand people. It was during this time that the vetiver grass was up-rooted from the constructed wetland out of curiosity by the participants. It is interesting to note that the students requested the principal to close the UDDT facility fearing that the visitors would misuse the toilets.

For the greywater system, the actual influent flow rate is higher than what was assumed in the design. The school is close to Nakuru GK prisons and the prison authorities sunk a borehole that offers continuously supply of pumped groundwater to the school. Hence, the system now occasionally experiences an overload of greywater and clogging. However, the system is designed with an overflow pipe that takes care of shock loads. As a result, the effluent quality is not affected.

The UDDTs received acceptance by the students due to lack of smell and lack of flies. A majority of the students found the UDDTs attractive when interviewed. Since completion of the pilot, both local and international visitors have visited the school to see and learn about the sustainable sanitation system. The main repairs and overall management is the responsibility of the school principal assisted by two members of staff who are patrons of the student's environmental club.

The UDDT's are fully operational and are kept clean most times. Ash is always available, while water for hand washing is 90% available. Further, 100% of the boys interviewed were satisfied with the UDDT and particularly the urinals, no blockage or damage was reported, however the girl's urinals were reported blocked but were unblocked by the caretaker with technical assistance from the ROSA team. It was learnt that the blockage was due to sand deposits from the foot-steps into the urinal channel. The drying shed does not produce neither odour nor flies.

Monitoring outcomes from May 2011:

There is still a challenge with the operation and maintenance and mainly with the reuse of the UDDT products. So far neither urine nor faeces have been reused by the school. There is the need of creating more awareness on the reuse of faeces and urine for teachers and students.

Majority of students prefer the UDDT to the pit latrines. Main reasons are that they are clean, build in a nice/beautiful way and the UDDTs offer more space and are therefore less congested. Some students prefer the pit latrines because they are less complicated to use and the management of the UDDT is sometimes poor therefore the toilets are dirty and smelly. Girls also often use the pit latrine to dispose their menstrual pads despite the fact that there are also containers for pads in the UDDT.

The students know the importance of handwashing and are aware that diseases can be prevented by washing hands. They wash their hands if water is available but they do not use soap as it is not provided by the school. Not all students believe that urine or faeces are a valuable fertiliser and some students believe there is a health risk especially if somebody is sick.

The teacher said the previous workshops were very useful and helped the staff and students to understand and use the UDDT toilets well. There is only a challenge when new students come as they did not participate in the workshop but they are usually guided by the older students. The project implementation team is still in touch with the school and comes for follow up visits. Generally the UDDT attracts many visitors who sometimes come from outside Nakuru district.

The monitoring showed clearly that another workshop needs to be undertaken that shall focus on the reuse of the UDDT products and proper O&M procedures and budgets e.g. provision of soap. Toilet facilities must be cleaned and emptied more regularly. This should ideally be integrated into the curriculum with materials provided to the teachers on the subject. Problems with proper use of the toilet could be supported by putting posters on how to use them in every toilet. To ensure that there is always water available for handwashing it would be preferable if the taps can be connected to the piped water.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 6) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 6: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria:	+	o	-	+	o	-	+	o	-
• health and hygiene	X				X		X		
• environmental and natural resources	X			X			X		
• technology and operation	X				X		X		
• finance and economics			X			X			X
• socio-cultural and institutional		X			X			X	

The UDDTs have attracted a lot of interest among the neighboring residential areas and schools. About sixteen landlords have constructed similar UDDTs in Nakuru and some secondary schools outside Nakuru have requested for similar designs and coasting. Learning from experience, the following recommendations are suggested for the long term sustainability of UDDT's:

- Strengthen the ownership concept among the students, teachers and workers to ensure proper use and maintenance of the facilities by continues education and sensitization on UDDT's.
- Encourage students to spread the knowledge of the sustainable sanitation system to the communities they live in.
- Sensitise all the stakeholders on the additional economic benefits arising from the utilisation of the products.
- Encourage the school to utilise the urine and the sanitised faecal matter in their farm and consider this as a potential business opportunity.

As the outcome of the monitoring crucial factors for sustainability are the proper operation and maintenance of the UDDT. This also includes the reuse or safe disposal of faeces and urine to avoid a scenario whereby the storage facilities will one day be full and the faeces and urine might be dumped in an inadequate way (see Section 11).

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

13 Available documents and references

The following documents are available:

Photos from this project are available on flickr:
http://www.flickr.com/photos/gtzecosan/sets/72157624069945409/with/4666056056/

Publications:

- Sustainable Sanitation Practice "Operation and Maintenance – Successful models for O&M of sanitation systems, Issue 2. (2010)
http://www.ecosan.at/ssp/
- Manual how to use urine as natural fertilizer in Kiswahili
http://rosa.boku.ac.at/images/stories/Public%20Docs/urine_use_kiswahili.pdf
- Manual how to use urine as natural fertilizer in English
http://rosa.boku.ac.at/images/stories/Public%20Docs/urine_use_english.pdf
- ROSA IEC Posters Kenya
http://rosa.boku.ac.at/images/stories/Public%20Docs/nakuru_iec_posters.pdf
- ROSA Brochure Kenya
http://rosa.boku.ac.at/images/stories/Public%20Docs/nakuru_brochure.pdf

- Further information is available from ROSA homepage
  http://rosa.boku.ac.at/index.php?option=com_frontpage&Itemid=1
  http://rosa.boku.ac.at/index.php?option=com_content&task=view&id=10&Itemid=11
- Baseline study for Nakuru
  http://rosa.boku.ac.at/index.php?option=com_remository&Itemid=5&func=fileinfo&id=187
- Kraft, L. (2011) Monitoring and evaluation of ROSA projects in Nakuru. Results of field observations and questionnaires, GIZ
  http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1196

References:

- GOK (2007) Kenya Vision 2030. Ministry of planning and development, Government of Kenya
  http://www.planning.go.ke
- MCN (1999) Municipal Council Nakuru Strategic Structure Plan. Action Plan for Sustainable Urban Development of Nakuru town and its Environs, Volume 1.
- Harvey, P. Baghri, S. and Reed, B. (2002) Emergency Sanitation: Assessment and programme design. Water, Engineering and Development Center (WEDC), Loughborough University, UK
  http://wedc.lboro.ac.uk/
- WHO (2006). Guidelines for safe use of wastewater, excreta and greywater, Volume IV: Excreta and greywater use in agriculture, World Health Organisation.
  http://www.susana.org/docs_ccbk/susana_download/2-1004-summary-of-whoguidelines-for-the-safe-use-of-wastewater-excreta-and-greywater-vol4-part1.pdf

14 Institutions, organisations and contact persons

Planning, design, construction and supervision:

Edward W. Muchiri* (edmuchiri@yahoo.com)*
Tel: +254722605569
James Raude (ramesso@yahoo.com)
Bennedict Mutua (bmmutua@yahoo.com)
*Author for correspondence

ROSA Project/Egerton University,
Faculty of Engineering & Technology
P.O. Box 536, Egerton 20115, Kenya.
Tel: +254722605569; +254722617042/+254733857805
Website of the institution: www.egerton.ac.ke

Contacts:

Municipal council of Nakuru
P.O. Box 124, Nakuru, Kenya
(Pilot city and end-user in which the strategic sanitation and waste plan will be developed and where the ROSA project is implemented)

Crater View Secondary School
P.O. Box 13184, Nakuru, Kenya
Tel: +254 210264

Kentainers Ltd,
Nairobi, Kenya
info@kentainers.co.ke
Suppliers of Urine diverting Eco-plates

Case study of SuSanA projects

UDD toilets and greywater treatment at Secondary School, Nakuru, Kenya

SuSanA 2010

Authors: Edward W. Muchiri (Egerton University), James Raude (Egerton University), Bennedict Mutua (Egerton University)

Editing and reviewing: Norbert Weissenbacher (BOKU Vienna), Christian Rieck (GIZ, christian.rieck@yahoo.com), Elisabeth von Muench (GIZ, ecosan@giz.de), Laura Kraft (kraft_laura@yahoo.de)

Case study of sustainable sanitation projects

UDDTs at a church and nursery school Nakuru, Kenya

Fig. 1 Project location

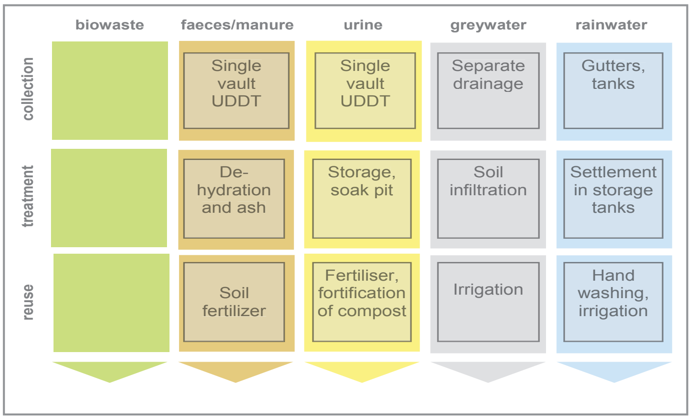


Fig. 2 Applied sanitation components

1 General data

Type of project:
Urine diversion dehydration toilets (UDDTs) at a church and nursery school in Nakuru, Kenya

Project period:
Start of construction: April 2008
End of construction: June 2008
Start of operation: September 2008
Monitoring period planned for: one year
Project end: 31st March 2010

Project scale:
1. Design and construction of a masonry toilet block consisting of 2 single vault UDDTs, one double vault UDDT and a urinal for a population of 50 church members and 25 children at a cost of EUR 1,788,
2. Workshops and training on basic knowledge of ROSA concepts, demonstration on usage, operation and maintenance of the system at a cost of EUR 212

Total investment of the project described: EUR 2,000

Address of project location:
House of fire ministry church,
Nakuru London Estate
Nakuru, Kenya

Planning institution:
Egerton University/Rosa Project, Egerton-Kenya

Executing institution:
Nakuru Municipal Council/ ROSA project, Nakuru-Kenya

Supporting agency:
European Union

The work was carried out within the project ROSA (*Resource Oriented Sanitation concepts for peri-urban areas in Africa*; Contract No. 037025-GOCE; duration: 1.10.2006 – 31.3.2010), a Specific Target REsearch Project (STREP) funded within the EU 6th Framework Programme, Sub-priority "Global Change and Ecosystems".

2 Objective and motivation of the project

The objectives of this project were to improve on sanitation by establishing a urine diversion dehydration toilets system that provides a fly and odour free environment and that reduces groundwater pollution and health risks associated with pit latrines.

The motivation was to contribute towards achieving the MGDs and Kenya Vision 2030 (GOK, 2007) by promoting sustainable sanitation.

3 Location and conditions

House of fire ministry is a small community church located at London estate in the North-Western part of Nakuru town. The church is lying at the foot of the extinct volcano Menengai Crater. Nakuru is a cosmopolitan town that gained its municipal status in 1952, and hosts people with different cultures, ideologies, religious, political, social and economic aspirations. It is the fourth largest town in Kenya, with a population of approximately 500,000 people and is located 160km North-west of Nairobi (MCN *et al.*, 1999).

Fig. 3 The front view of the UDDT with the men/boys side on the left and the ladies/girls on the right side (Source: S. Blume, 2008).

The church members are coming from the neighbouring middle to high density settlement (2000 – 4500 persons/km^2) characterised by low income earners and thus, poverty levels are high. The church and the majority of the other residents have no piped water supply and no access to water borne sanitation. The main sanitation system used in this area is onsite sanitation with 85% of the population including the church using pit latrines.

Fig. 4 Existing pit latrines

Due to the soil conditions of Nakuru that are mainly volcanic loose soils, ranging from moderate occurrence of surface rock to very shallow soils, there is a high possibility of liquid content in the pit leaking to the underground and transported to the lake along geological fault lines, that may cause contamination to the ground and surface water.

4 Project history

In 2007, when ROSA project carried out a survey to find the status of sanitation in Nakuru, and to identify an entry point of a ROSA system (Resource-Oriented Sanitation concept for peri-urban areas in Africa), House of fire ministry church was selected as one of the pilot sites due to the following reasons:

- The church was a good entry point into the community because it was attended by various people from the community.
- Existing pit latrines were of poor quality, smelly and posed health risk to the users especially the nursery school children.
- Possibility of the pit latrine polluting ground water.
- Opportunity of having a closed loop ROSA system since the church has a garden and is practicing urban agriculture within the compound.

The most important factors considered were that the bishop was willing to adopt the UDDT (which was the first project of its kind) and to reuse the products on the farm. It was also expected that the church members would be effective ambassadors to disseminate the ROSA concept and therefore support up-scaling.

Fig. 5 Urban agriculture practice within the church plot

The implementation of the ROSA UDDT pilot at the church involved four main stages. The initial stage was a needs assessment carried out to identify the existing situation, introduce the ROSA concept and technologies involved and to identify an entry point. This was followed by workshops with stakeholders to create awareness on the ROSA concept, promote the need for ownership and to determine their views, roles and responsibilities and to confirm agreement on the need to proceed with implementation. The third stage was the design and construction of the UDDTs. The final stage was commissioning of the facility and demonstration of proper use of the UDDT, education on basic knowledge on O&M, and utilisation of urine and dried faecal matter from the UDDTs.

The pilot UDDT facility proposed was to serve the church congregation of about 50 members and a pre-primary nursery school with an enrolment of 25 children aged between 3-7 years.

Fig. 6 Inside the single vault toilet at the church showing the urine diversion pedestal and a container of ash.

Design and costing of the pilot UDDT was developed and discussed with the church management and agreed upon. The school and church community contributed unskilled labour and water during the construction. A memorandum of agreement between the church management and ROSA was drawn and signed by both parties. Construction commenced in April 2008, completed in June and commissioned in September, 2008.

Fig. 7 Inside the men's urinal showing the fabricated plastic containers urinal for the kids and standard ceramic urinals.

Monitoring in May 2011:

A monitoring of the ROSA projects in and around Nakuru was done in May 2011 by the consultant Laura Kraft (e-mail address: kraft_laura@yahoo.de) on behalf of GIZ sustainable sanitation program (Kraft, L. 2011). The overall objective of the monitoring was to update the SuSanA case study in regard to present status and lessons learned from the project.

For monitoring and evaluation three methods were used to gather information:

- Desk review, field observations and interviews

During the desk study different online documents were reviewed to understand the project approach and to access the latest information on the project status. This knowledge was used to prepare monitoring sheets and questionnaires for interviews with UDDT users, related service providers for excreta management and other relevant stakeholders.

The ROSA project sites described by SuSanA case studies were visited to assess the status of the UDDTs and other related facilities within the ROSA project. Interviews were conducted with teachers, students, landlords, CBO/ NGO leaders and the Municipal Council. For documentation purpose digital pictures were taken during the monitoring and uploaded on flickr (see link in Section 13).

During the visit of the church and nursery school interviews were conducted with the bishop of the church and the head teacher of the school. The state of the toilet facility was assessed by use the monitoring sheet.

Based on the resultant information, the case study was updated. The original text referring to the project state in 2009 was maintained with minimal alterations in addition to the new observations added after the headings "Project update May 2011".

5 Technologies applied

The various sanitation options including Arboloo, Composting toilet, Urine diversion dehydration toilets with both single vault and double vault were considered. The Urine diversion dehydration toilet (UDDT) was chosen due to its advantage of separately collecting the urine and faeces such that the treatment for each fraction can be specific as required. Single and double vaults were constructed to compare their performance.

The facility is divided into two sections, the female and the male section. The female side has two units; one single vault UDDT and a double vault UDDT with solar drying cover at the back. The men's section consists of one single vault UDDT and a urinal cubicle with five waterless urinals in the men's section. Two of the urinal bowls are standard ceramic urinal bowls while the other three are specially designed for children out of 5 litre plastic containers and fitted lower to the floor level (300 mm compared to standard level of 600 mm) to allow ease of use by the boys.

Due to the stigmas on handling faeces, it was agreed that the faeces will be collected in containers for ease of collection, instead of allowing it to drop on the floor of the chamber.The faeces are collected in 50 litre plastic containers placed in the single vault underneath the toilet slab. Smaller containers of 20 to 30 litres were placed in the double vault chambers which are smaller in size. Once the containers are full, they are transferred to the solar drier in the double vault and remain there until they are completely dry and odour free before they are emptied into the garden and applied around banana plants.

Urine is collected in a 100 litre plastic tank, whose overflow discharges into a soak pit; urine can be collected easily from the tank for agricultural use.

Rainwater is harvested from the roof into a 250 litre tank which is connected to ceramic hand washing basins in both the female and the male sections. The greywater from hand washing is drained into a crop field.

Fig. 8 Roof water harvesting system for hand washing at the new UDDT.

6 Design information

The overall dimensions of the UDD toilets block are 6.9 m long by 2.3 m wide. The block is housing two single vault UDDTs of 0.9 x 1.1 meter, one urinal room of the same size and a double UDDT with a floor space of 1.35 x 1.1 meter.

To save on costs, the floor area for each single toilet was designed to meet the minimum but adequate toilet floor area requirement of approximately 1m^2 (Harvey, 2002).

A firm foundation wall was constructed to hold the substructure including the chambers and the superstructure. A 75mm thick base concrete slab was provided over which the vaults were constructed. The designed vault size is 1.1 x

0.9 x 0.75 meter which can receive 0.6 m^3 (600 litres) of faecal matter when 80% full. The use of containers for collection of faeces reduces this capacity to between 150 – 200 litres depending on the number and size of containers used.

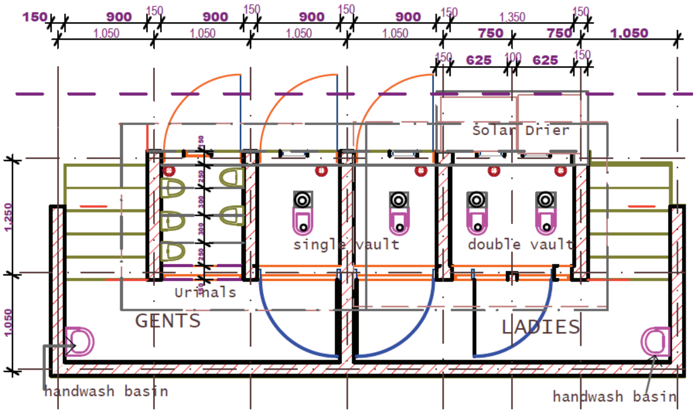


Fig. 9 Floor plan of church toilet

Fig. 10 On the right 20 liter container in a single vault (2009). Left: 70 liter container used during the field visit in 2011 (L.Kraft, May 2011)

It was estimated that 25 kg of faeces were generated per week which totals to 1300 kg per year. The vaults are large enough to hold faecal matter in 50 litre containers for at least six months before withdrawal. This reduces the need to frequently empty the containers and allows pathogen die off for within the six months (WHO, 2006).

The vault doors (0.9 m x 0.75 m) made of metal are tightly fixed to avoid flies and painted to avoid rust. The doors on the double vault are fixed at a slope to drain off the water and are painted black for best solar adsorption.

The general design was kept attractive to display dignity and hence overcome stigmas that users may have about the UDDTs. The roof is made of timber trusses and covered with galvanized corrugated iron sheets gauge 30. Three standard size doors and frames (1.98m x 0.9m) made of cyprus timber were fixed on each toilet cubicle.

The interior of the toilet is well ventilated and lighted by vent space above the door that are covered with gauze wire to avoid flies, while each vault has a vent pipe that rises 1m above the roof for effective draft of odour from the vault.

Fig. 11 The rear of the UDDT showing the single vaults and the solar drier for the double vault

Monitoring outcomes from May 2011:

The superstructure was in good conditions without visible damages. The rainwater harvesting system was in place and connected to the water tank. All collection chambers were well functioning and had containers for faeces inside. The urine tank was well connected and not overflowing but had a small leakage in the connection pipe to the soak pit (Fig.12).

The hand wash facility was in good conditions but there was no water available as the rainwater harvesting tank cracked. According to the teacher interviewed the children carry water to wash their hands. Toilet paper and soap is provided by the school and was available on both sides (male/female).

Fig. 12 50 liter urine tank with small leakage in pipe (L.Kraft, May 2011)

7 Type and level of reuse

Once dry faecal matter from the UDDT is removed, it is emptied at one spot in the farm and allowed to aerate and disintegrate. Paper and other non-decomposing materials are removed and burned while the faecal matter is mixed with soil and applied around banana plants and trees.

The containers are cleaned by scrubbing ash or soil inside them and then returned into the vaults as shown in Fig. 13.

Urine from the facility was used to grow corn and vegetables on an experimental basis and the results were very encouraging since the crop looked healthy and stronger than the crops without. More research is required to determine the effect of urine on the crops and the pathogen die-off in the faeces before reuse on the farm.

Fig. 13 Containers are placed in the solar drier of the double vault compartment (Source: Steffen Blume, 2009)

Monitoring outcomes from May 2011:

According to the bishop neither urine nor faeces are reused at the moment. Urine goes to a soak pit and the faeces are buried on-site. The reason given by the bishop was that there is no treatment facility (drying shed) on-site therefore faeces are not yet dry and suitable for reuse. For him it was not practical to transfer the full containers to the double vault to let them dry there as there was not enough space and there were no additional containers for exchange.

The bishop and the teacher would prefer to reuse UDDT products in the school garden and therefore want to construct a drying shed for on-site treatment. They believe urine and treated faeces are valuable fertilizers and that there is no health risk after proper treatment.

8 Further project components

Apart from the normal use of the toilet, it also serves as a research and demonstration facility. The ongoing activities include monitoring operation and maintenance (O&M) and research on O&M and the involvement of private sector service provider in the UDDT business. It also serves as a training point where visitors and prospective owners of UDDTs come to visit.

9 Costs and economics

The bill of quantity and construction cost for the church UDDT is given below:

Table 1: Cost for construction of UDDT at house of fire church approx. 1 EUR =100 KES (Kenyan Shillings)

Item	Description	Amount (KES)
1	Excavation and earthworks	11.000
2	Concreting	45.300
3	Walling	47.700
4	Roofing	16.800
5	Doors	22.800
6	Sanitary installations	21.300
7	Finishes	21.000
	Total (KES)	**185.900**
	Total (EUR)	**1.859**

A comparison of the capital construction cost of this UDDT and a similar design of a pit latrine or a flush toilet was done to confirm the differences. The results showed that the construction cost variance was not significant. However the operation cost of these options varied significantly, with the flush toilet leading followed by the UDDT (Table 3).

Table 2: Calculated construction cost for alternative options for the church toilet

Item	Description	UDDT	Pit latrine	Flush toilet
1	Excavation and earthworks	11.000	31.039	11.039
2	Concreting	45.300	39.843	35.455
3	Walling	47.700	43.065	38.565
4	Roofing	16.800	16.800	16.800
5	Doors	22.800	10.830	16.830
6	Sanitary installations	21.300	13.300	37.300
7	Finishes	21.000	21.023	21.023
	Total (KES)	185.900	175.910	177.022
	Total (EUR)	**1.859**	**1.759**	**1.770**

Table 3: Estimate operation and maintenance cost for three options

Description	UDDT	Pit latrine	Flush toilet
Emptying faeces	1.600	0	0
Emptying urine	1.600	0	0
Emptying latrine	0	720	0
Sewage fee	0	0	6.000
Cleaner expenses	12.000	12000	18.000
Washing detergents	600	600	1.200
Disinfectant	0	50	0
Annual cost (KES)	15.800	13.370	25.200
Annual cost (EUR)	**158**	**133**	**252**

If recycling and reuse of products from the UDDT is done, earnings from the sales of the product of EUR 0.03 per kg may reduce the overall expenditure hence making the UDDT more profitable.

10 Operation and maintenance

The UDDT project is managed by the House of Fire church bishop and management after being handed over. However, the ROSA project has continued to intervene as and when need arises especially on technical matters. The day to day cleaning of the toilet is done by the 3 nursery school teachers and a family living in the compound also using the facility.

To ensure proper use and basic operation and maintenance of the UDDT, occasional training and demonstration is conducted by the ROSA team to the users.

It is planned that the collection, transportation and treatment of the faeces from this church will later be done by a service provider every three to six months, depending on the filling rate and the number of people using the toilet. The urine tank may be emptied as soon as there is market or when locally required.

Monitoring outcomes from May 2011:

The double vault UDDT on the ladies side was not in use. According to the teacher there are only few people using the toilet therefore they closed one toilet. The single vault UDDTs on both sides are in use.

On the male side the bucket with ash was empty therefore fresh faeces were not covered properly. As observed the person using the toilet last tried to cover the faeces with toilet paper instead. There were no instructions on usage in or outside the toilets.

The smell in the toilets was tolerable but the one used by men was not well cleaned. As shown in the picture below (Fig.14) there was urine on the floor and also signs of faecal cross-contamination in the urine section of the toilet pan. The toilet used by women was cleaner and ash was available.

Fig. 14 On the left, inside view of toilet used by men with empty ash container, urine on the floor and signs of faecal cross-contamination. Right: Inside view of toilet used by women (Source: L. Kraft, May 2011)

The teachers are cleaning the toilet when need arises and additionally a person is employed for cleaning the toilet once a week. The emptying of containers is done by a church elder for free. The containers are emptied after every three month when the school is closed.

The main challenge was the reuse of the faeces and urine as described in Section 7. The handling of fresh faeces puts the service person, who might not be sufficiently trained, in risk. A instruction poster would be helpful as well as a training on handling, reuse and disposal (see also Section 11).

The handwash facility was in good conditions but there was no water available as the rainwater harvesting tank cracked. According to the teacher interviewed the children carry water to wash their hands. Toilet paper and soap is provided by the school and was available on both sides (male/female).

11 Practical experience and lessons learnt

The UDDT is generally well maintained most of the time. The teachers mop the toilets at least 3 times per week and/or when need arises. Majority of the children were trained to use the toilets correctly and the very small ones are accompanied by the teacher to the toilet.

Once in a while the toilets are misused by visitors and neighbours who do not know how to use them. The smell is usually caused by blockage of the urine pipes or leaking urine from the storage tank. When both the faeces and the urine are mixed, the faeces remain wet and produce pungent odour. The remedy to this is to act immediately and unblock the pipes, empty the wet faeces or if wetness is not significant, cover with more ash.

Fig. 15 A community based organisation from the area learning about the ROSA system at the church with an aim of providing collection and transporting service

When flies are noticed, it means the faeces are not covered properly by the users, the faeces are wet or the facility is generally dirty.

Continuous monitoring is required by the ROSA team in order to ensure the facility is operating properly and the management is committed to its success.

Monitoring outcomes from May 2011:

The teacher explained that generally the user acceptance of the UDDT is high. Most of the users feel comfortable in using it and think the design is attractive. They feel that the UDDT is more hygienic and cleaner than the pit latrines used before.

The teachers train the children on the use of the UDDT and therefore the facility is usually used by all children without problems. Sometimes the new pupils block the urine part as they accidentally pour ash there. The children are also taught about the importance of hand washing and soap is provided by the school.

According to the teacher the training and workshops done by the ROSA team were very useful as the explanations were very clear and it enabled toilet users to operate and maintain the toilet by themselves. There is still regular contact with the project implementation team and the school is very happy about the support given to them.

It is either recommendable to construct a small drying shed for on-site treatment in order to enable use for maize and bananas planted in the school/church compound. The bishop and teachers are interesting in the reuse of dried faeces. Alternatively a training on safe reuse and disposal strategies for the untreated faeces can be organised. The objective would be to showcase burial of faeces in a productive and safe way e.g. burial close to existing fruit or timber trees or for the purpose of planting such trees. Other crops would not be recommendable. The reuse of urine could be another topic as it is more safe to use.

Fig. 16 Handwash facility was in good conditions. Toilet paper and soap is provided by the school Source: L. Kraft, May 2011)

12 Sustainability assessment and long-term impacts

A basic assessment (Table 4) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 4: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project ("+" means: strong point of project; "o" means: average strength for this aspect and "–" means: no emphasis on this aspect for this project).

	collection and transport			**treatment**			**transport and reuse**		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	x					x		x	
• environmental and natural resources	x				x			x	
• technology and operation	x				x			x	
• finance and economics		x			x			x	
• socio-cultural and institutional		x			x			x	

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

Results from monitoring done for one year have showed that the project has had a positive impact. The church receives many visitors that are interested in adopting the UDDT. There is a great potential for up-scaling the pilot project in Nakuru and other areas in Kenya in the future. Already many people have shown interest and about sixteen households in London estate have started to construct similar UDDTs.

For long term sustainability and for economic sanitation, the following is recommended:

- Encourage the church management to have a sense of ownership and to ensure good operation, maintenance and management
- Encourage users to spread the knowledge of the ROSA system to the communities they live in, so as to create a critical mass.
- To demonstrate the additional economic benefits arising from the utilisation of the products.
- To test the health effect of handling faeces and urine during collection, transportation, treatment and reuse

meant to serve as a source of researched information that can be used in the decision making on utilisation of products.

13 Available documents and references

The following documents are available:

Photos from this project are available on flickr:

- http://www.flickr.com/photos/gtzecosan/sets/72157626748894341/ (Church and Nursery school)

Publications:

- Sustainable Sanitation Practice "Operation and Maintenance – Successful models for O&M of sanitation systems, Issue 2. 01/2010 http://www.ecosan.at/ssp/
- Manual how to use urine as natural fertilizer in Kiswahili http://rosa.boku.ac.at/images/stories/Public%20Docs/urine_use_kiswahili.pdf
- Manual how to use urine as natural fertilizer in English http://rosa.boku.ac.at/images/stories/Public%20Docs/urine_use_english.pdf
- ROSA IEC Posters Kenya http://rosa.boku.ac.at/images/stories/Public%20Docs/nakuru_iec_posters.pdf
- ROSA Brochure Kenya http://rosa.boku.ac.at/images/stories/Public%20Docs/nakuru_brochure.pdf
- Further information is available from ROSA homepage http://rosa.boku.ac.at/index.php?option=com_frontpage&Itemid=1
- Kraft, L. (2011) Monitoring and evaluation of ROSA projects in Nakuru. Results of field observations and questionnaires, GIZ http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1196

References:

- GOK, (2007) .Kenya Vision 2030. Ministry of planning and development, Government of Kenya http://www.planning.go.ke;
- MCN, (1999). Municipal Council Nakuru Strategic Structure Plan. Action Plan for Sustainable Urban Development of Nakuru town and its Environs, Volume 1. GOK
- Harvey, Peter, Baghri, Sohrab and Reed, Bob. (2002) Emergency Sanitation: Assessment and programme design. Water, Engineering and Development Centre (WEDC), Loughborough University, UK.
- WHO (2006). Guidelines for safe use of wastewater, excreta and greywater, Volume IV: Excreta and greywater use in agriculture, World Health Organisation. http://www2.gtz.de/ecosan/english/

14 Institutions, organisations and contact persons

Planning, design, construction, supervision and implementation

ROSA Project/Egerton University,
Faculty of Engineering & Technology
P.O. Box 536, Egerton 20115, Kenya.
Edward W. Muchiri - (edmuchiri@yahoo.com)
Bennedict Mutua - (bmmutua@yahoo.com)

Municipal council of Nakuru
Sammy N. Kimani (Director of Environment)
Town Hall
P.O. Box 124, Nakuru, Kenya

House of fire ministry
P.O. Box 3170, Nakuru, Kenya

Email: edmuchiri@yahoo.com;
Tel: +254722605569
Website of the institution: www.egerton.ac.ke

Case study of SuSanA projects

UDD toilet at a church and nursery school, Nakuru, Kenya

SuSanA 2010

Authors: Edward Muchiri (Egerton University), Bennedict Mutua (Egerton University)

Editing and reviewing: Norbert Weissenbacher (BOKU Vienna) norbert.weissenbacher(at)boku.ac.at, Laura Kraft (kraft_laura(at)yahoo.de), Christian Rieck (GIZ sustainable sanitation program) christian.rieck@giz.de

This document is available from:
www.susana.org