sustainable sanitation alliance

Compilation of 27 case studies on sustainable sanitation projects from Sub-Saharan Africa

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Left column:
1 Uganda, 2007 (I. Jurga)
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Right column:
3 Namibia, 2010 (S. Berdau)
4 Zimbabwe, 2009 (P. Morgan)

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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 **sub-Saharan 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 27 case studies in sub-Saharan 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, 5 July 2011

partner of
sustainable
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alliance

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Case study of sustainable sanitation projects

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

Fig. 1: Project location

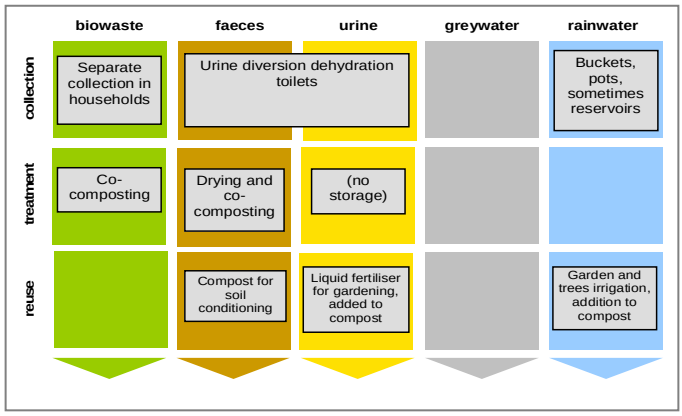

Fig. 2: Applied sanitation components in this project

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.

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

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.

In Botswana, the under-five child mortality rate is currently **57 children per 1000**, which is high but at least there is currently a downward trend towards fewer child deaths.[1]

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[2]. The project was funded by GTZ (on behalf of the German Federal Ministry BMZ), coordinated by IUCN

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

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

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.

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.

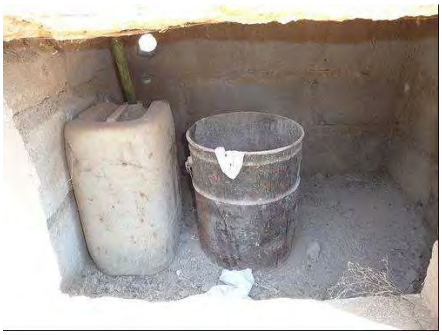

Fig. 6: Collection chamber under a properly working ecosan UDD toilet (left: urine container, right: faeces bucket) in Paje.

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.

Composting boxes

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 m^3 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 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 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 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).

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/

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14 Institutions, organisations and contact persons

Note: IUCN office in Botswana no longer exists.

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Case study of SuSanA projects

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

SuSanA 2010

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Case study of sustainable sanitation projects

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

Fig. 1: Project location

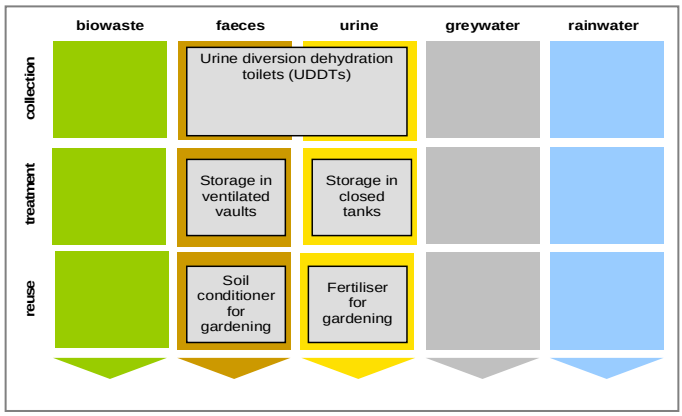

Fig. 2: Applied sanitation components in this project

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
GIZ-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) 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]

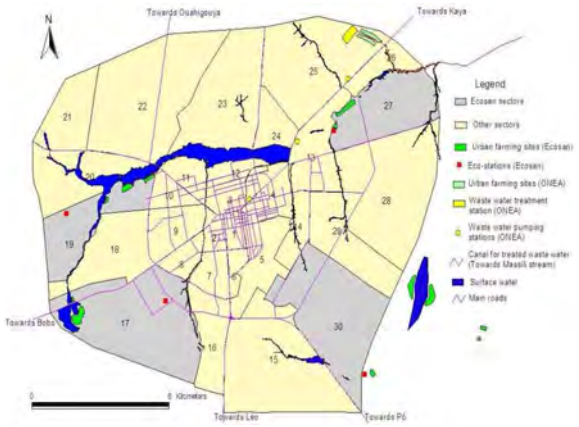

Fig. 4: UDDTs are located in four sectors (here in grey) out of the 30 sectors in Ouagadougou city map (total diameter of the city is approx. 18 km) (source: CREPA, 2008).

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

[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/).

[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)

community-based organisations were supported in setting up collection and transport businesses (associations).

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.

To increase acceptance 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 the costs with the costs of the ONEA latrines, particularly the VIPs (see section 13: document on study for financial and economic analysis – What is its title?)

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 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	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.

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- 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)
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ONEA (role: Planning, co-financing and technical support)
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DGAEUE (role: National ecosan coordinator)[13]
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Direction Générale de l'Assainissement, des Eaux Usées et des Excréta (sanitation, wastewater and excreta)

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- **ACONA-Z** for sector 27
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- **RATAMANEGRE** for sector 30
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Case study of SuSanA projects

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

SuSanA 2011

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[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

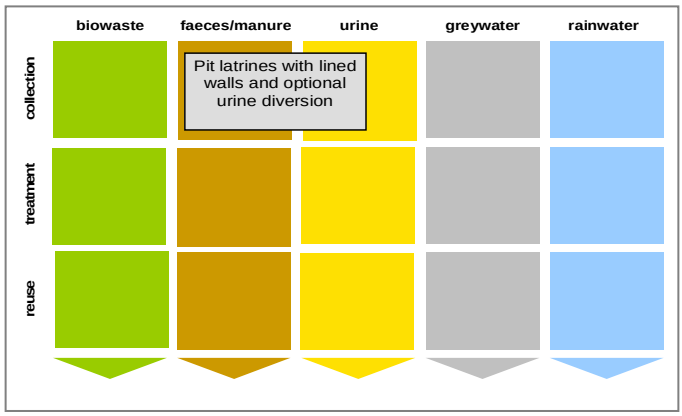

Fig. 2: Applied sanitation components in this project

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.

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

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

[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/).

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).

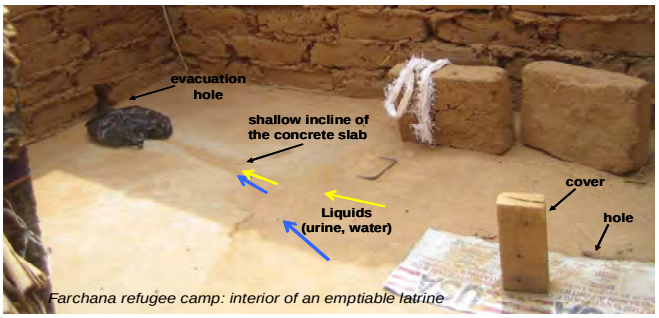

Fig. 5: Single pit family latrine (source: J. Patinet (2009) Groupe URD). Where is the faeces drop hole?

[3] Earth bricks fired in a kiln.

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

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).

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

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

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 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 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

Household pit latrines with urine diversion Farchana refugee camp, Chad (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).

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

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14 Institutions, organisations and contact persons

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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

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Case study of sustainable sanitation projects

Arborloo for household sanitation Arba Minch, Ethiopia (draft)

Fig. 1: Project location

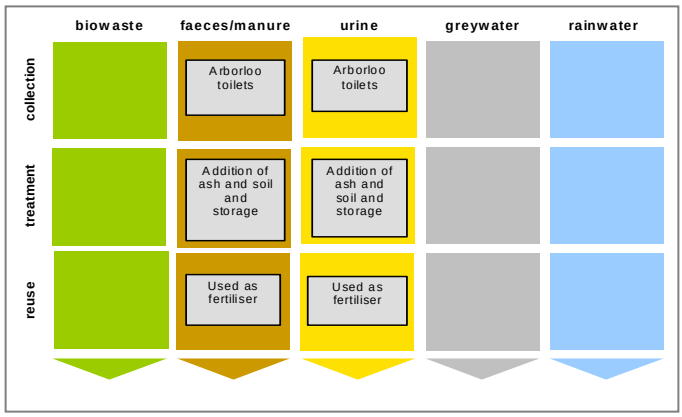

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Arborloo as resource-oriented household sanitation

Project period:
October 2006 - March 2010

Project scale:
Number of arborloos constructed: 9
Number of inhabitants covered: 33
Total investment: 347€

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)
'Idget' construction SME

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.

Arborloo is one sanitation option which is easy and affordable for many inhabitants of Arba Minch. Such construction would provide improved sanitation in places where there is sufficient space in the compound.

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 grow even worse with rapid population growth. The town does not have pit desludging services forcing residents to dig another pit, or manually desludge the pit, which is an unacceptable practice from the health and hygienic point of view.

Fig. 3: Typical Arborloo toilet house (source: ROSA Project Arba Minch, 2007)

Arborloo for household sanitation Arba Minch, Ethiopia (draft)

10% of the population practice open defecation. There are portions of the town that are congested settlements with rented houses in which land is not available for digging pits and people either share a single latrine, defecate in the open or use flying toilets. 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 achieved the following aims:

- conducting research including a baseline study and demand assessment on sanitation,
- identifying different sanitation options (involving safe disposal and re-use) through research conducted by Arba Minch University and other international partners,
- discussing and prioritising feasible options with active involvement of the local administration and community groups,
- undertaking pilot experiments of the different options and disseminating them through practical demonstration,
- providing support in scaling-up implementation in the local community,
- and providing 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 unit, biogas unit and composting schemes. At the moment there are 15 urine-diversion dry toilets (UDDT), 30 Fossa alternas, 9 Arbor loos, 9 greywater towers, 1 biogas unit and more than 5 composting schemes.
In this case study Arborloos are focused. There are nine Arborloos in Arba Minch. The total number of users is 33 out of which 15 are male and 18 female.

6 Design information

Arborloo, a single simple pit compost toilet, is made up of 4 parts (Peter Morgan, 2007):

- A pit
- A sheet metal or a half barrel to protect the pit
- A concrete slab
- A toilet house

Fig. 4: Portable toilet house (source: ROSA Project Arba Minch, 2008)

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. When the Arborloo pit is full, the parts of the toilet are moved to another place, rebuilt and used in the same way again (refer Fig. 3). A thick layer of soil is placed over the filled pit. A young tree is planted in this soil and is watered and cared for (refer Fig. 4). The content will decompose by different biological processes over time and utilized by the planted tree.

Fig. 5: Papayas grown on filled Arborloo pit (source: ROSA Project Arba Minch, 2008)

<u>The pits</u>
The pit dug for Arborloo is shallow and has a depth of 1.2m. It is circular and has a diameter of 80cm.

[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 pit protection
To prevent a pit from collapsing, a sheet metal or a half barrel is used (refer Fig. 5). In stable soils protection was not used.

Fig. 6: Arborloo pit protection (source: ROSA Project Arba Minch, 2008)

The concrete slab
The slab used for the Arborloo is made of concrete and has a dome shape as shown in Fig. 6. The slab has 1m diameter and 5cm thickness. A pile of sand is used to create the dome shape and a 5cm wide sheet of metal is used as a mould. Reinforcement was not used. Three slabs are cast from 50 kg of cement.

Fig. 7: Arborloo slab construction (source: ROSA Project, 2007)

The toilet house
Easily movable shelter is placed on top of the pit. In most of the Arborloos, the material used for the superstructure is a locally available and cheap material called 'karta' which is made of woven bamboo (refer Fig. 1).

7 Type and level of reuse

The nutrients from the urine and faecal matter are directly used by the plants which are grown on the filled arborloo pit.

If plants are not grown on the filled arborloo pit, it is possible to allow the pit contents to turn into compost and dig the compost out, 6 to 12 months later, for use on the garden or for fertilizing trees.

8 Further project components

The absence of credit facilities for households which are interested to construct the demonstrated innovative toilet option has constrained efforts for further up-scaling 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 Euros and this money will be used as a revolving fund.

9 Costs and economics

The details on investment cost for constructing one Arborloo is given in table 1. The total costs include both the material and labor cost.

Table 1: Bill of quantities of one Arborloo

Item no.	Description	Unit	Qty.	Unit price in Birr	Total Amount in Birr	Total Amount in Euro
A. Substructure						
1. Excavation and Earth work						
1.1	Clear the site to remove top soil to an average depth of 20 cm.	m^2	4.00	2.50	10.00	0.54
1.2	Pit excavation in ordinary soil to an average depth of 1.20 m and a radius of 0.3 m.	m^3	0.60	25.00	15.00	0.81
B. Super structure						
2. Concrete Work						
2.1	Provide and fix 1m diameter concrete dome slab	pcs	1.00	86.00	86.00	4.65
3. Carpentry and joinery						
	All structural members and wall materials should be free from harmful defects					
3.1	Eucalyptus diameter of 60 mm	m	28.78	4.00	115.12	6.22
3.2	Eucalyptus diameter of 80 mm	m	6.34	6.00	38.04	2.06
3.3	Eucalyptus diameter of 120 mm	m	9.54	10.00	95.40	5.16
3.4	Wooven Bamboo ('Karta') for wall	m^2	9.90	3.51	34.75	1.88
3.5	Supply and fix 'Karta'	pcs	1.00	10.00	10.00	0.54

Arborloo for household sanitation Arba Minch, Ethiopia (draft)

Item no.	Description	Unit	Qty.	Unit price in Birr	Total Amount in Birr	Total Amount in Euro
	Door Size 600x1500 mm², including all nailing and accessories.					
4. Roofing						
4.1	Supply and fix corrugated iron sheet G-32 for roof cover including all nailing and fixing accessories.	m^2	3.80	81.52	309.78	16.74
Total					**714.09**	**38.60**

	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).

10 Operation and maintenance

The operation and maintenance of the Arborloo toilets is simple and can be carried out by the user. When the Arborloo pit is full, the superstructure parts of the toilet are moved to another place, where a pit needs to be dug and used in the same way again. A thick layer of soil (min. 0.4m) is placed over the filled pit. A young tree is planted in this soil and is watered and cared for. The household may only pay for a daily labourer to dig the new pit and move the slab and the shelter.

11 Practical experience and lessons learnt

- Some users do not like the toilet because of the shallow depth of the pit and may not add ash and soil after defecation fearing that the pit may get filled in short period of time. From observations made up to now, people are interested in toilets which can be used for a long time i.e. about two years and above.
- Getting seedlings (young trees) may be difficult.
- Most of the times there is a chance of not taking care of the plants planted on the filled Arborloo pits and the plants may die and hence the composted excreta may not be utilised.
- No practical experiences with new income generation by arborloos so far.

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 emphasized (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)..

Health and hygiene: The technology reduces odour and flies.
Environment and natural resources: The excreta collected is used by the seedlings which improves the crop yield, natural resources yield and modify the very warm weather.
Technology and operation: The technology is accpeted even by small kids and rural residents who did not use any toilets before. But to construct the whole structure trained local mason is needed.
Financial and economic issues: The toilet owners have farmland and have started reusing excreta. The inhanced fruit yield increases their income.
Socio-cultural and institutional aspects: The toilets are accepted by male and female users. There are no complaints and it is expected that the users will inform their extended families residing in different parts of the zone. The Arba Minch health bureau needs excreta to be treated and safe for handling and as they assured of that, they may accept and institutionalize it. However, this takes time.

With regards to long-term impacts of the project, the main expected impact of the project is improved public health.

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14 Institutions, organisations and contact persons

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Case study of SuSanA projects

Arborloo for household sanitation

SuSanA 2010

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Case study of sustainable sanitation projects

Fossa alterna for household sanitation Arba Minch, Ethiopia (draft)

Fig. 1: Project location

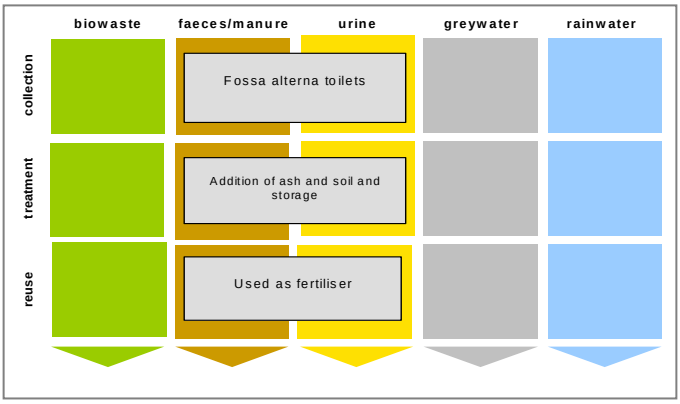

Fig. 2: Applied sanitation components in this project

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) xxx

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.

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

Fossa alterna for household sanitation Arba Minch, Ethiopia (draft)

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 feaces. 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.).

Fig. 4: Fossa alterna ring beams (source: ROSA Project Arba Minch, 2007)

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)

[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).

Fossa alterna for household sanitation Arba Minch, Ethiopia (draft)

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

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 (how? After how many 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

S. No.	Item	Unit	Qty	Unit Price in Birr	Total in Birr	Total in Euro
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
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 use as a fertiliser.(who does she pay?) 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. (so what was the solution)

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 is improved public health. It is planned to assess this at the end of the project in late 2009. Has the impact been assessed yet, as the project has ended since 2009? If it has, then what was the impact?

13 Available documents and references

- 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
- 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
- Baseline study for Arba Minch?

14 Institutions, organisations and contact persons

Planning, design, construction and supervision
Arba Minch Town Water Supply and Sewerage Enterprise
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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), Rahul Ingle(GIZ)

Editing and reviewing: Norbert Weissenbacher (BOKU norbert.weissenbacher@boku.ac.at), Elisabeth von Muench (GIZ, ecosan@giz.de)

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Case study of sustainable sanitation projects

Greywater tower for peri-urban areas Arba Minch, Ethiopia (draft)

Fig. 1: Project location

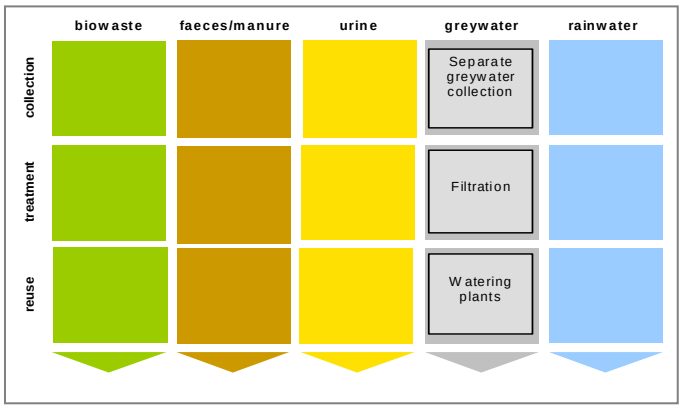

Fig. 2: Applied sanitation components in this project

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 inhabitants covered: 47

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.

Greywater tower for peri-urban areas Arba Minch, Ethiopia (draft)

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.

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

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

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).

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

Steps followed for the construction

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.

[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).

Greywater tower for peri-urban areas Arba Minch, Ethiopia (draft)

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.

Greywater tower for peri-urban areas Arba Minch, Ethiopia (draft)

- 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 emphasized (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, 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).

With regards to long-term impacts of the project, the main expected impact of the project is improved public health. It is planned to assess this at the end of the project in late 2009.

13 Available documents and references

- 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
- General project information: http://rosa.boku.ac.at

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I: http://www.amu.edu.et/rosa.shtml

Case study of SuSanA projects

Greywater tower, Arba Minch; Ethiopia

SuSanA 2010

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Case study of sustainable sanitation projects

Urine diversion dehydration toilets for private school Arba Minch, Ethiopia (draft)

Fig. 1: Project location

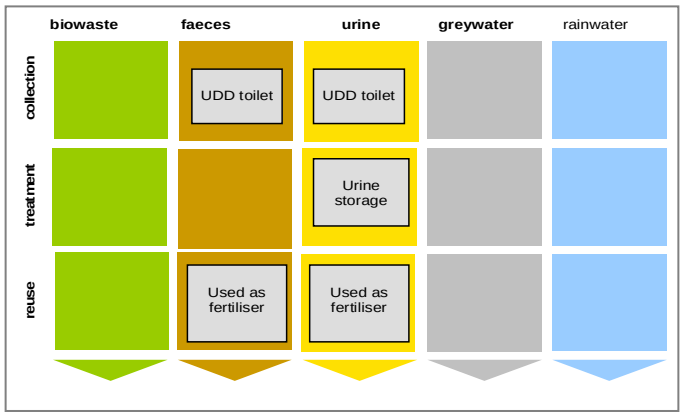

Fig. 2: Applied sanitation components in this project (UDD stands for urine diversion dehydration)

1 General data

Type of project:
Replacement of pit latrines with a urine diversion dehydration toilet block (UDDT) for Nelson Mandela School

Project period:
Start of construction: August 2008
End of construction: December 2008
Start of operation: December 2008
Ongoing monitoring period planned for: December 2008-March 2010
Project end: March 2010

Project scale:
Number of people covered: about 200 students and teaching staff

Address of project location:
Secha kifleketema, kebele chamo
Arba Minch, Ethiopia

Planning institution:
Nelson Mandela School

Executing institution:
ROSA Arba Minch

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 Nelson Mandela School had problems of frequent collapses of pit latrines and the school approached ROSA Arba Minch for a solution. So, the objectives of the project were:

- To reduce the repeated pit collapses and to have a sustainable toilet condition.
- To improve the toilet conditions with less odour and flies.

3 Location and conditions

Nelson Mandela School is a private school from grade 1 to 9 with a total number of 200 students and teachers. The school is located in Arba Minch in the southwest of Ethiopia. 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. The region is characterised by floods during rainy season and unstable soil conditions. There is also a shortage of water all over the town. The nature of the soil is loose and the water table is high during rainy season. So, in the rainy season groundwater enters the pit latrines.

The School had two pit collapse problems in past since its establishment and the last pit latrine collapsed completely before the construction of the UDDT. The students and their families were anxious and the administration was worried of losing their students to another school. So, the administration approached ROSA Arba Minch for a solution. Initially, the UDDTs were constructed for girls, but later on boys were also given three cubicles.

4 Project history

The project came into existence since Arba Minch is one pilot city of the EU funded project “Resource-Oriented Sanitation concepts for peri-urban areas in Africa (ROSA)”, which took place in four countries in East Africa. ROSA provided options and advice so the school administration decided to construct a UDDT block. The students are very happy and created a theater play about the toilets’ proper use.

Recently, the school in cooperation with ROSA has established an environmental club to promote reuse of excreta and proper toilet use besides other environmental issues. ROSA monitors the use of the toilet and the students

Urine diversion dehydration toilets for private school Arba Minch, Ethiopia (draft)

are coming to the ROSA crop trial site to see urine fertilised crops which is located about 2 km from the school. The trial site was used as demonstration site for those people who are not convinced of the use of urine as fertiliser.

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

5 Technologies applied

The urine diversion dehydration toilet has six vaults and six toilet cubicles which were planned for girls first. Later on 3 of them were used for boys. The toilet type was chosen because they do not collapse and the school has enough space to take care of their toilet products.

6 Design information

The floor was made by masonry and the superstructure was made of corrugated iron as a hollow block wall which was very expensive. PVC pipes were used for urine collection and as vent pipes while a 250 litre storage tank is used for storage of urine.

The UDD toilets are built in such a way that the operator can empty them from the back side of the toilet. Each toilet has an elevated concrete floor with plastic squatting pan produced in Addis Ababa by AQUASAN. The squatting pan leads to a vault for dehydration along with the anal cleansing material except water. Every user will apply ash on the faeces after use. Urine is led to a tank which is situated behind the toilets in the vaults.

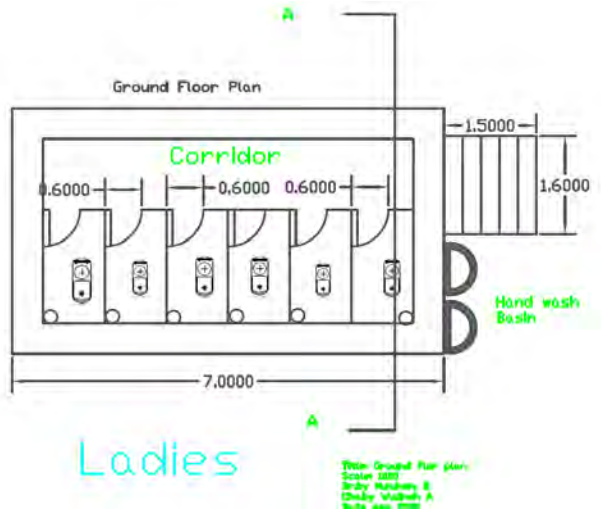

Fig. 3: Floor Plan of the UDDT (source: ROSA Arba Minch; 2009)

7 Type and level of reuse

The possibility of reuse was one of the main motivations of the ROSA project. The team supports the school administration in reusing the toilet products. One of the possibilities was to use the urine directly for the plants in the school compound. They have applied doses of urine for the seedlings. The dried excreta were co-composted along with organic solid waste material.

8 Further project components

The construction of this UDDT is only one part of several interventions towards improvement of sanitation in Arba Minch. Solid waste like green plants is also used by the school for co-composting. Research on operation and maintenance of the toilets, handling, reuse of the toilet products for crop trial and transporting is ongoing on 15 UDD toilets in the town. (Needs to be updated). Women groups organised to collect town solid waste are also involved in collecting and transporting the excess urine from the school to the co-compost producing youth group which is located in a distance of about 5 km.

9 Costs and economics

ROSA paid labour cost and advice while the school administration purchased all the construction materials. Local masons constructed the toilet.

Table 1: Material costs for six UDDT cubicles at Nelson Mandela School

Description	Price in Euro
1. Excavation and Earth work	56
2. Concrete work	652
3. Walling	1083
4. Carpentry and Joinery	182
5. Finishing	8
6. Roofing	212
7. Sanitary Installation	172
Total	**2365**

10 Operation and maintenance

ROSA is assisting the school staff in maintenance of all the components of the toilets. The operation of the toilets are done by the staff of the school (storage conditions of excreta, urine, hand washing facilities, cleaning of toilets, provision of drying agent like ash). The school janitor who is cleaning class rooms is also responsible for providing drying material in the toilets.

[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).

Urine diversion dehydration toilets for private school Arba Minch, Ethiopia (draft)

11 Practical experience and lessons learnt

All the students like the toilet type and the concept of reusing which is seen by their positive response. Such new concepts like UDDT may be successful if started with students for attitude change compared to grown-ups. Students have complained that hand washing water is not regularly kept nearby. Some of the students are complaining of ash blowing on their clothes while applying on faeces hole after defecation. Thus, orientation of the vault and wind blowing direction should be considered while constructing UDD toilets.

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).

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• 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: The technology reduces odour and flies when properly handled.

Environment and natural resources: The excreta is collected and urine shall be reused for fertilising the seedlings which improves the natural resources yield.

Technology and operation: The technology is accpeted even by 8 year old kids who can use the toilet. Construction of a whole structure needs trained local masons. It is being copied by the local masons.

Financial and economic issues: The school do not have farmland now but the ornamental seedling trees might pay back the school by beautifying the compound and attracting more students (increase income).

Socio-cultural and institutional aspects: The toilets are accepted by male female students from age 7 to 16. There are no complaints and it is expected that students will inform their family about this sanitation technology. The Arba Minch health bureau needs excreta to be treated and safe for handling and as they assured of that, they may accept and institutionalized it. However, this takes time.

With regards to long-term impacts of the project, the main expected impact of the project is improved public health and good condition of toilets. It is also possible to say that students disseminate the knowledge about the technology and concept to the society in the town and other towns.

13 Available documents and references

- 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
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I: http://www.amu.edu.et/rosa.shtml

Squatting UDD toilet pans producing companies in Ethiopia

- AquaSan Manufactuiring Ethiopia PLC. for UDDT pan made of plastic
- Ethio Fiber Glass Factory- Ethiopia for UDDT pan made of fiberglass
- Hawassa Tabor ceramic Factory Ethiopia- UDDT pan made of ceramic
- Locally produced by Masons from cement.

sustainable sanitation alliance

Case study of sustainable sanitation projects

Urine diversion dehydration toilets for private school Arba Minch, Ethiopia (draft)

Case study of SuSanA projects

UDDT for Nelson Mandela School

SuSanA 2010

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Case study of sustainable sanitation projects

Urine diversion dry toilet for one household Arba Minch, Ethiopia (draft)

Fig. 1: Project location

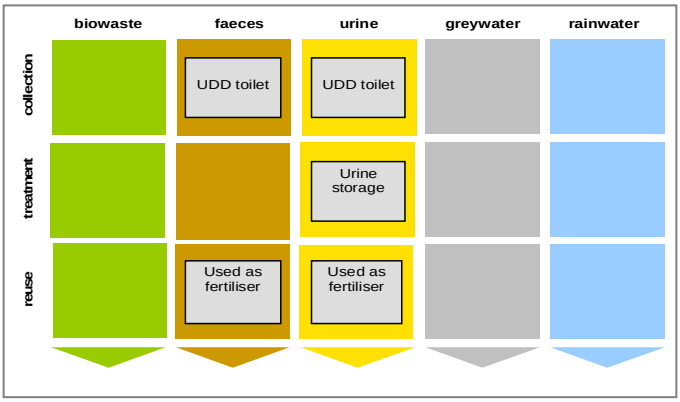

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Replacement of pit latrine with urine diversion dry toilet (UDDT) for one household in Arba Minch, Ethiopia

Project period:
Start of construction: June 2007
End of construction: July 2007
Start of operation: August 2007
Ongoing monitoring period: the following 3 months
Project end: completed

Project scale:
Number of inhabitants covered: 10 persons use the UDDT and on average, 30 donkey owners spend a night in the compound.
Total investment: EUR 325

Address of project location:
Abaya kifleketema, kebele Dilfana, nearby the big market and the River Kulfo, Arba Minch, Ethiopia

Planning institution: ROSA, Arba Minch

Executing institution: ROSA, Arba Minch

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

A household had a problem of repeated collapses of the pit latrine. The owner approached ROSA, Arba Minch for a solution. So the objective of the project was

- to reduce the repeated pit collapse and solve the toilet problem and
- to replace the toilet conditions with low odour and flies.

Fig.3: Mr. Agafari's new urine diversion dehydration toilet (source: Wudneh Ayele, 2007)

3 Location and conditions

The UDDT is located in Arba Minch, Ethiopia. The town has a total population of 75,000 and is characterised by flood during rainy season and unstable soil conditions. There is also a shortage of water all over the town. The head of the family has an irrigation farm more than half a hectare at the bank of the River Kulfo. The river is flowing cutting the town in two parts.

Urine diversion dry toilet for one household Arba Minch, Ethiopia (draft)

The owner's compound is more than 1000 m^2 in size, and most of the area is covered by mud houses. The remaining space is left for keeping donkey, mules and horses during the night for rural merchants. A lot of dung is collected from the animals every morning which the owner is accustomed to take to his farm as fertiliser. The rent is 1 birr per night per animal. The nature of the soil in the compound is loose soil.

In Ethiopia, the under-five child mortality rate is currently[1] **104 children per 1000**, and this is a significant change, since in 1990 the value was 210 child deaths per thousand.

4 Project history

The house owner approached ROSA which is working in Arba Minch in resource oriented sanitation. ROSA provided him several options and he decided to have a UDD toilet. This toilet was among the first demonstration toilets in Arba Minch. ROSA paid full cost and trained local masons in the mean time. Local masons constructed the toilet. The owner was very happy and applied the urine and faeces after composting in his farm which is located by the side of his compound. ROSA still monitors the activity of the toilet and reuse activity.

5 Technologies applied

The urine diversion dehydration toilet constructed has 1 vault where faeces are collected in a half cut 200 litre barrel. ROSA Arba Minch followed up on the planning and engineering construction and also paid the labour charges and the cost of construction materials. The sub-structure is built in masonry while the superstructure with corrugated iron sheets. PVC pipes are used for urine collection and vent pipes while plastic water storage tanks are used for storage of urine.

6 Design information

The UDDT toilets are built in such a way that the operator can empty them from the rear side of the toilet (Figure 3). The toilet has an elevated concrete floor with plastic squatting pan produced in Addis Ababa by?. The squatting pan leads to a vault for dehydration along with the anal cleansing material. Every user applies ash on the faeces after use. Urine is led to a subsurface tank which is situated behind the toilets in the vault.

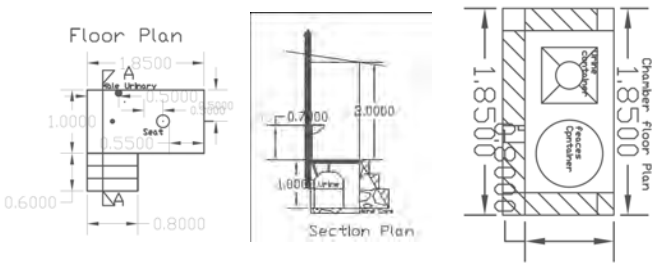

Fig. 4: the floor and section plan for Agafari´s UDDT (source: ROSA Arba Minch; 2009)

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

7 Type and level of reuse

The possibility of reuse was one of the main motivations for ROSA (Figure 4). The team supports the toilet owner in reusing the toilet products in his farm irrigated by a river called Kulfo. He has applied doses of urine for the banana, mango and lemon plants and the dried excreta were co-composted along with the organic material in his farm land. The yield was not estimated and the preparation of the compost was as the faeces container fills.

Fig. 5: Maize fertilised with urine (source: ROSA project in 2007)

8 Further project components

This project is a one amongst the other components of the ROSA project. Solid wastes like green plants and animal wastes are also used by the owner for co-composting. Research on operation and maintenance are being done for 15 UDDT toilet products in the town like crop trial and reuse aspect.

9 Costs and economics

Table 1: Bill of quantities for UDDT for Agafari´s household

Description	Price in Euro (2007 price)
1. Excavation and earth work	1.6
2. Superstructure	138
3. Concrete work	24
4. Carpentry and joinery	64
5. Roofing	33
6. Sanitary Installation	64
Total in Euro	**325**

10 Operation and maintenance

Up to now ROSA has been assisting the owner for the maintenance of any of the damaged components of the toilets. The owner operates and maintains storage of excreta, urine, hand wash, cleaning of toilets and provision of drying agent like ash.

11 Practical experience and lessons learnt

All the family members and the tenants admire this new toilet type and the concept of reusing which is observed from their positive response. During visit ROSA staff complained that hand washing water is not regularly kept nearby the toilet.

Urine diversion dry toilet for one household Arba Minch, Ethiopia (draft)

Guests, who do not have any knowledge about toilets at all, visit the house every day and tend to misuse the toilet holes.

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 emphasized (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: The technology reduce odour and flies.
Environment and natural resources: The excreta collected and reused for watering the seedlings which improves the crop yield, natural resources yield and modify the ver warm weather.
Technology and operation: The technology is accpeted even by small kids and rural residents who are not used any toilets before but construction the whole structure need trained local mason. It is being copied by the local mason.
Financial and economic issues: The toilet owners has farmland and he has started reusing excreta, fruit yield increase his income.

Socio-cultural and institutional aspects: The toilets are accepted by male and female users. There is no complaints and it is expected that they will inform their extended families residing in different part of the zone. The Arba Minch health bureau needs excreta to be treated and safe for handling and as they assured of that, they may accept and institutionalized it. However, this takes time.

With regards to long-term impacts of the project, the main expected impact of the project is improved public health and good condition of toilets. As a lot of guests visit the toilets it is also possible to say that tenants and landlords disseminate the knowledge, technology and concepts to Arba Minch town and other towns.

13 Available documents and references

- 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
- General project information: http://ROSA.boku.ac.at http://www.amu.edu.et

14 Institutions, organisations and contact persons

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Case study of SuSanA projects
Urine diversion dry toilet (UDDT) for Agafari´s household
SuSanA 2010
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Case study of sustainable sanitation projects

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

Fig. 1: Project location

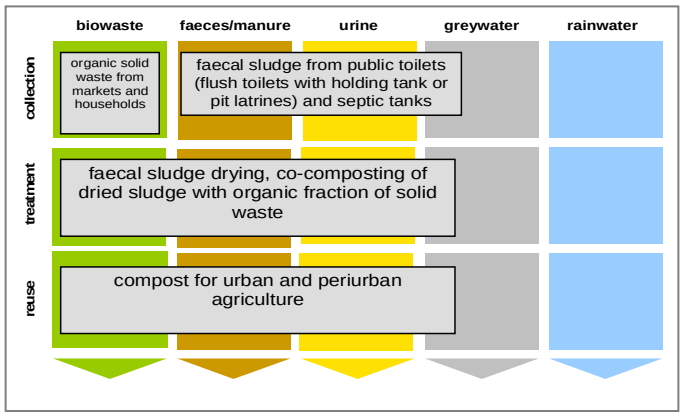

Fig. 2: Applied sanitation components in this project (urine and faeces are mixed with some flush water from pour flush toilets and with some anal washwater).

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).

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

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 faecal sludge & organic solid waste Kumasi, Ghana

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 m^3 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 m^3/month = 1.5 m^3/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 m^2
- 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 m^3/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/m^3)

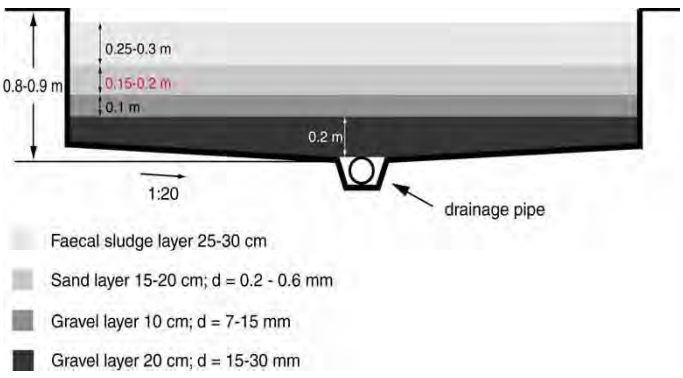

Fig. 5: Structural principle for a drying bed profile (for faecal sludge dewatering).

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

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

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

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.

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

[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.

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).

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[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

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- 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
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14 Institutions, organisations and contact persons

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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)

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[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).

Case study of sustainable sanitation projects

Public toilet with biogas plant and water kiosk Naivasha, Kenya

Fig. 1: Project location

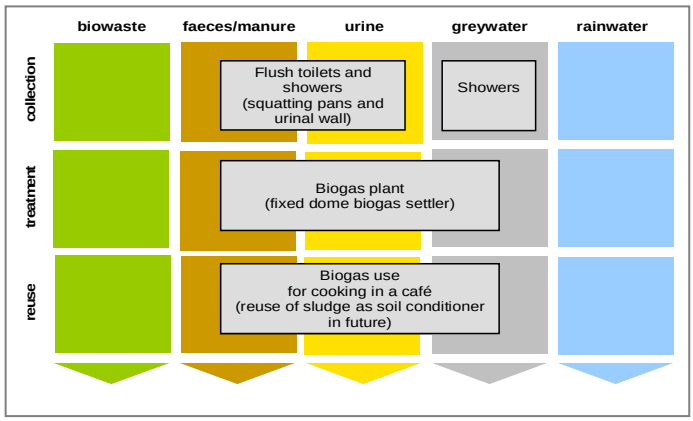

Fig. 2: Applied sanitation components in this project

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-GIZ EcoSan Promotion Project, Kenya
(supported by the EU, SIDA, GIZ 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)
- GIZ 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 (GIZ) in 2008/2009.

Public toilet with biogas plant and water kiosk Naivasha, Kenya

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. GIZ is supporting the Kenyan Water Sector Reform Program through its Water Program which has five components. One component is the **EU-SIDA/GIZ 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), GIZ-Kenya Water Program (EUR 100,000) and GIZ-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/).

Public toilet with biogas plant and water kiosk Naivasha, Kenya

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 GIZ 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 m^3 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

Public toilet with biogas plant and water kiosk Naivasha, Kenya

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.

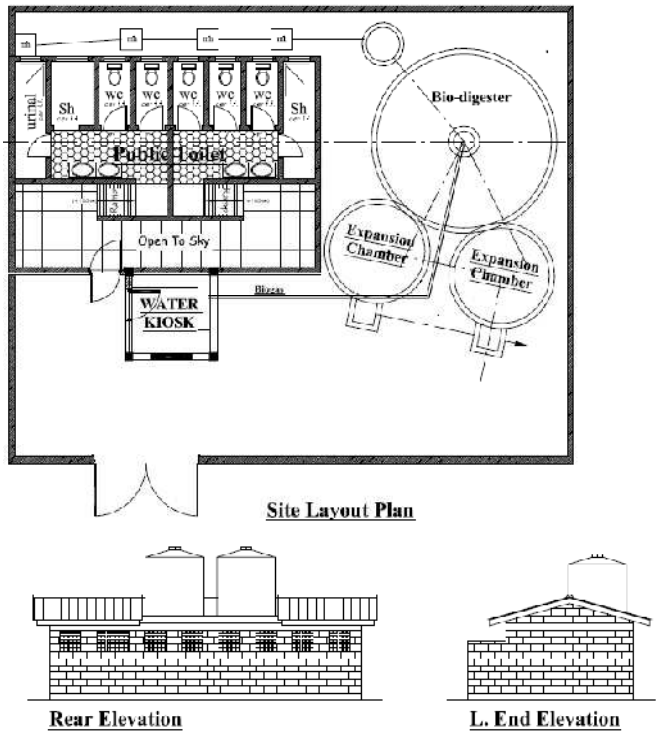

Fig. 9: Technical drawing of the facility and biogas plant (source: EPP). Space requirement for toilet and biogas plant is approx. 10 x 15 m.

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 GIZ-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.

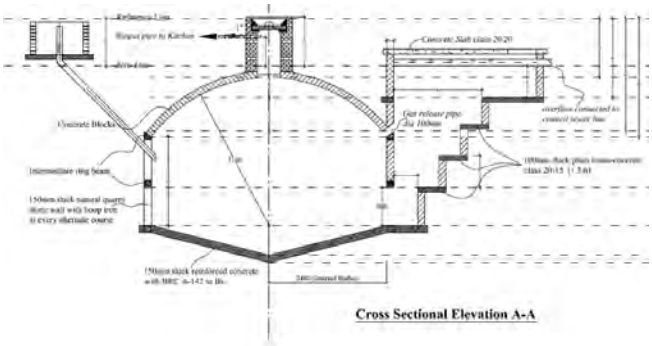

Fig. 10: Technical drawing of the biogas plant (built completely underground). Diameter of dome-shaped digester is 5 m. See section 13 for links to further drawings (source: EPP).

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.
- 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.

[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.

Public toilet with biogas plant and water kiosk Naivasha, Kenya

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.

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.

[7] The main donors are currently e.g. BMZ through KfW and GTZ, SIDA, DANIDA, UNICEF and World Bank

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.

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

[8] Ksh is Kenyan shilling – approx. 100 Ksh equal 1 EUR (2009)

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 GIZ 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

Public toilet with biogas plant and water kiosk Naivasha, Kenya

Implementation/Facility Management:

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Supplier of biogas appliances

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Email: newworld@newworldss.com

Case study of SuSanA projects

Public toilet with biogas plant and water kiosk Naivasha, Kenya

SuSanA 2010

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Case study of sustainable sanitation projects

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya (draft)

Figure 1 Project location

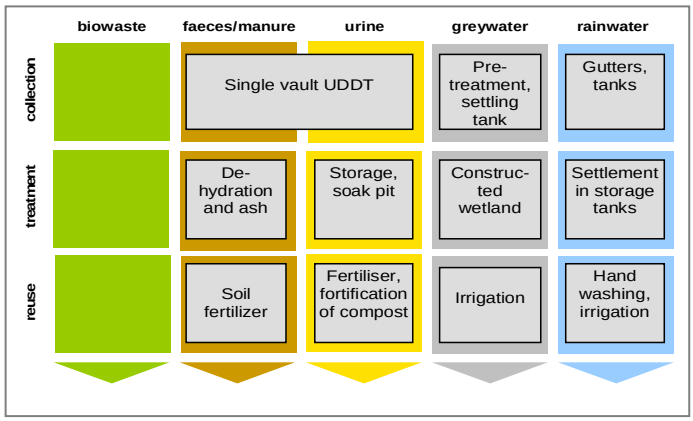

Figure 2 Applied sanitation components (UDDT stands for urine diversion dehydration toilet)

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
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
Design and construction of a greywater treatment system for kitchen and dish washing effluents at a cost of EUR 1,500
Design and construction of a faeces drying shed at a cost of EUR 857
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)

Crater View Secondary School is a government school located in the north-western part of Nakuru municipality.

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya (draft)

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 Laura Kraft 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 Crater View Secondary School interviews were conducted with students and the teacher who is in

[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/)

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.

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya (draft)

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).

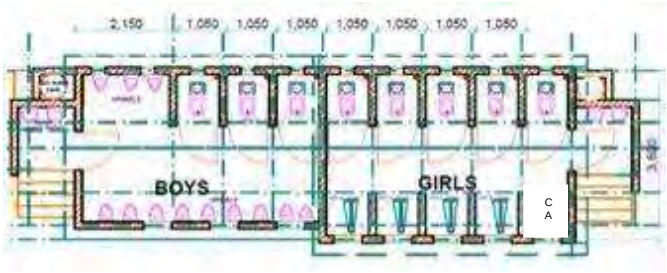

Figure 9 Floor plan for the toilet block at Crater View School (Source Muchiri. 2009)

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.

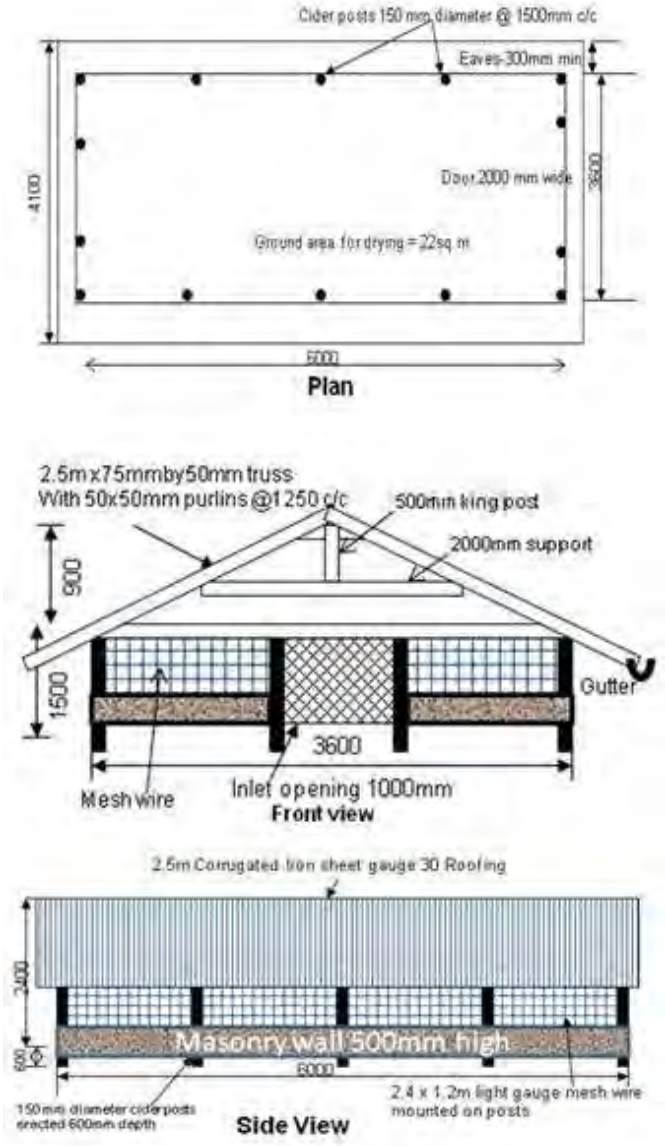

Figure 15 Plan, front section and side view of drying shed for faeces from UDDTs at Crater View Secondary school (Source: Muchiri, 2009)

Figure 16 Greywater treatment system at Crater View Secondary School (Source: Laura Kraft, 2009)

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya (draft)

Table 1: Grey water treatment system design details

No	Name	Description
1	Pre-treatment	Two chamber (0.25 & 0.75 m^3) 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?)

UDDTs and greywater treatment at Secondary School, Nakuru, Kenya (draft)

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

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- 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

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Contacts:

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(Pilot city and end-user in which the strategic sanitation and waste plan will be developed and where the ROSA project is implemented)

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Suppliers of Urine diverting Eco-plates

Case study of SuSanA projects

UDD toilets and greywater treatment at Secondary School, Nakuru, Kenya

SuSanA 2010

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Urine diversion dehydration toilets for schools Nyanza, Western and other provinces in Kenya (draft)

Fig. 1 Project location

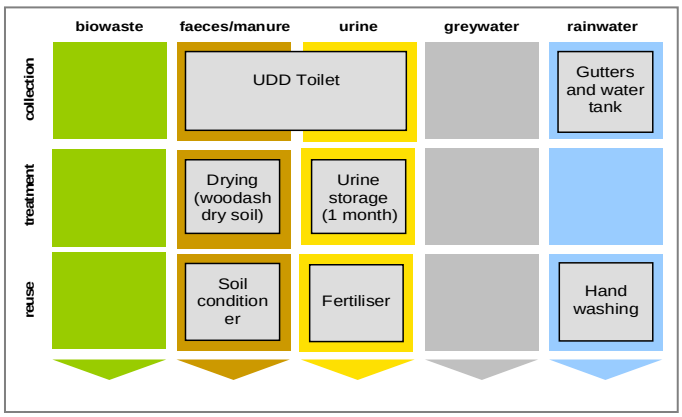

Fig. 2 Applied sanitation components in this project

1 General data

Type of project:
School based sanitation as part of the larger Ecosan Promotion Project (EPP)

Project period:
Start of construction: October 2008
End of operation: May 2010
Ongoing monitoring period until Nov 2010

Project scale:
Number of UDDTs at schools: 263 toilets
Number of schools with double chamber UDDTs: 70
Number of UDDT users: approx. 10,000 children

Address of project location:
Lake Victoria region with Nyanza, Western and Rift Valley province; Eastern, North-Eastern and Central Provinces in Kenya, East Africa

Planning organisation:
EU-SIDA-GTZ EcoSan Promotion Project (EPP), Kenya (Supported by the EU, SIDA, GTZ and embedded in the GTZ Water Sector Reform Program)

Executing institution:
Sanitation officers from EPP
School administration and boards
various Water Services Boards
Water Services Trust Fund

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 Promotion Project (EPP) implemented a number of UDDT facilities in schools as part of their project activities. The focus on school sanitation had various objectives being:

- 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 the human waste as a resource (ecological sanitation or 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.

Fig. 3 School UDDTs for boys with urinal at Mwala Primary School near Machakos (source: Johannes Orodi, GTZ-Kenya, Oct. 2009)

Ecological sanitation offers an alternative 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 fertilizer 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. Other implemented technologies

in schools being DEWATS are described in a different case study[1].

3 Location and conditions

In many schools in Kenya, basic sanitation and hand-washing facilities are not provided or are in 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 facilities for children, especially for children with physical disabilities, girls and small children (under the age 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.

Often the schools have a very high population above design capacity of the sanitation facilities, so that unhygienic practices prevail and open defecation is quite common. This is leading to sickness and absence from school. In an atmosphere of poor health children are unable to fulfill their education potential. Therefore safe water and adequate sanitation in schools are very important for education like books and pencils.

Fig. 4 Old pit latrines at Muslim Primary School, Mumias (Source: Laura Kraft, GTZ, June 2010)

The World Health Organisation states that half the consequences of malnutrition worldwide and 9.9 percentage of the total deaths in Kenya are related to inadequate water, sanitation and hygiene[3].

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 rape4. For example more than 500,000 Kenyan girls stay at home during their menstrual cycle missing out on approx. 90 school days a year[5]. Therefore 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 longer.

Fig. 5 Newly finished block of 2 school UDDTs. 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 that cause the destruction of the toilets and also the flushing out of the human waste into rivers, wells and other drinking water resources. 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 lined pits are used in schools, which are emptied by pump. The sludge is often disposed unsafely in nearby ditches or water bodies.

Besides the area 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 achievable.

Most pilot projects were realised in primary schools located near the Lake Victoria in Nyanza and Western Province of Kenya. This part of Kenya is characterised by symptomatic outbreaks of cholera, high population 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 characterized by sufficient rainfall for agricultural production. The rainy period is April/May and October/November.

[1] http://susana.org/lang-en/case-studies

[2] SuSanA factsheet on school sanitation

[3] Prüss-Üstün, Annette et al (2008) http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1135

[4] African Population and Health Research Center (APHRC) http://aphrc.org/download/?id=99

[5] Onyango, P. et al. (2009) http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=710

Other areas of implementation were in Rift Valley and Central province and the semi-desert areas of Eastern and North-Eastern (near Wajir).

4 Project history

The EcoSan Promotion Project (EPP) was an EU-funded and SIDA and GTZ co-funded project component embedded in the Water Sector Reform Program of GTZ water program. The project started in November 2006 and ended in May 2010. Within the project period 263 double vault Urine Diverting Dehydrating Toilets (UDDTs) were constructed in 70 schools and also a certain (still unknown number) via the WSTF. More than 600 UDDTs were constructed in households[6]. The EPP also demonstrated ecosan approaches with waste water based sanitation systems (flush toilets with Decentralised Wastewater Treatment Systems - DEWATS) in schools and public toilets[7]. The project's aim was to develop, test and promote the reuse orientated sanitation (ecosan) concepts for large and small-scale applications in mostly rural and peri-urban areas of Kenya.

The EPP has constructed Urine diversion dehydration toilets in 62 primary and 8 secondary schools in mostly rural areas of Kenya. The list and maps of schools is found on the ecosan network Kenya blog[8]. Beginning of 2008 the first toilets were constructed in schools. Main target areas were Nyanza and Western Province. Usually 2 separate blocks of toilets for boys and girls with each 2 UDDTs were constructed (see report from Wakala, M. 2008). Boys urinals were also implemented in a few, but not all schools.

Partners

The EPP offices were located at the Ministry of Water and Irrigation in Nairobi as the main local partner. In the beginning of the project in 2007 the project assigned three sanitation officers and so called regional site managers (see contacts in Section 14) that were coordinating the implementation work directly with the communities, community based organisations (CBOs), schools, local administration, NGOs and artisans.

In schools 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) [9] and ALDEF (Arid Land Development Focus). The local Community based organizations (CBOs) were also involved in the school projects since at the same time household units were implemented in the surrounding community as part of the cluster approach. Often the schools grounds were used for meetings and trainings of the community.

After initial contact and awareness creation to the school administration the project usually received an official request for support. After agreeing to the terms the school and EPP signed a MoA stating roles and responsibilities of each partner (see example of Memorandum of Agreement in Section 13). Generally the school did contribute mainly in terms of participation in trainings but rarely in material, cash or labour contributions. The sanitation project cycle and implementation program of WSTF gives an overview of the participatory process that was applied (Rieck, 2010).

During the whole process local masons were trained on building the toilets, who were later on contracted by EPP to carry out the construction process. This was also agreed upon in the MoA.

At a later stage also the Water Services Trust Fund (WSTF) in collaboration the water sector institutions of the Water Services Boards (LVSWSB, LVNWSB, ATHI WSB, and TANATHI WSB) 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.

Cluster approach

The approach was to always set up a cluster of 10 to 20 toilets at households and one local primary or secondary school within one community - walking distance of less than 20 minutes to each other was envisaged but not always achieved. 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. Moreover "numbers also matter" to achieve behaviour change and to increase social acceptance of new development within a community.

Schools are also crucial for promoting good hygiene behaviour of children who then try to 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, thus the approach of clusters was central.

In Kenya, the under-five child mortality rate is currently[10] **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.

5 Technologies applied

Urine diverting dehydrating toilets (UDDTs) with double vault system were constructed.

Fig. 6 Plastic UDDT slab for separating urine and faeces inside a UDDT (Source: Laura Kraft, GTZ, June 2010)

[6] Rieck, C. (2010) http://www.susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=129

[7] http://susana.org/lang-en/case-studies (will be available soon)

[8] http://ecosankenya.blogspot.com/p/projects.html

[9] www.kwaho.org

[10] 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/).

Urine diversion dehydration toilets for schools Nyanza, Western and other provinces in Kenya (draft)

The plastic squatting pan separately collects faeces and urine. The urine is collected in a container located in an attached urine-collection chamber. The faecal matter drops straight into the vault, were it is stored for a period of approx. 6 months under conditions that are intended to promote drying (dehydration) for the inactivation of faecal pathogens to an acceptable 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 6 months). After each use, ash is poured over the faeces for improved drying, fly prevention, pH-treatment and to cover the fresh faeces for a more pleasant sight.

Fig. 7 Faeces vault with ash-covered dried faeces (Source: Laura Kraft, GTZ, June 2010)

6 Design information

Locally burnt bricks, concrete blocks or in some cases hydraform 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 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 a vent pipe. The volume of the faeces chamber is 560 Liter with a length, width and height of 0.75 x 1.1 x 0.75 m.

The vault doors are painted black and are fixed in a certain angle in order to enhance solar heating. The squatting pan for urine diversion is manufactured by the Kenyan company called Kentainers (www.kentainers.com) and was designed in cooperation with GTZ. It is made from plastic and has two faeces holes for a double vault system and have two lids. 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. Each toilet has an ash container with a scoop and a laminated instruction poster inside the toilet.

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 with the container. The containers are stored in an attached urine collection chamber on which a 100 liter plastic water tank with tap is placed on top for the purpose of hand washing. 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.

7 Type and level of reuse

All schools were trained on how to use the UDDTs and the excreta products properly and safely (see Figure 10). The urine is used as a fertilizer in the school farms after a short storage time in the urine collection chamber. Mainly the urine is diluted at a rate of 1:1 up to 1:5 before used in the school gardens. The user digs a small shallow trench next to the plant, pours the urine and covers the trench immediately with soil, so that nitrogen evaporation is minimised. Additionally the users were instructed that the last urine application should be four weeks before harvest.

Fig. 8 Urine containers at Mwala Primary School, Ukambani (source: Johannes Orodi, GTZ-Kenya, Oct. 2009)

The crops which have been fertilised using the urine in school gardens include kales, spinach, maize, mangos and bananas. The dried faeces are used directly on the school farm as soil conditioner after the second vault is full (approx. 6 months). No further treatment is applied but the users are advised to use the faecal matter for planting fruit trees like bananas and mangos thus burying it safely underground. The school is strongly advised in trainings to apply health-risk reduction measures like wearing gloves, rubber boots and washing hands with soap as shown in Figure 10.

8 Further project components

Trainings and establishment of health clubs

In many Kenyan schools the project observed that hygiene education is non-existent, irrelevant or passive. Therefore all students, teachers and the parents were participating in trainings with the main objective to create awareness on ecosan technology, sustainable operation and maintenance and the link between sanitation, hygiene and health.

Fig. 9 Awareness creation and training in Mwala Primary School near Machakos (Source: Paul Mboya, GTZ-Kenya, Oct. 2009)

Furthermore in all schools a health or ecosan club was established or if already existing used and trained to ensure a progressive, active and vibrant body of students who would mentor new members on the operation and maintenance, 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 has 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.

It was observed during the trainings that increasing knowledge on ecosan systems leading to increase use and adaptation of facilities.

9 Costs and economics

The investment costs per toilet are about KSH 50,000 (approx. EUR 500) as shown in Table 1. In most of the pilot schools two separate toilet blocks for girls and boys with two toilets each and a handwash facility were constructed for students and sometimes also one or two more toilets for the teachers. 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 The investment for one double vault UDDT (Blume, 2009)

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 the value of approx. 20% or above of the total construction costs for building ownership. However in most cases the schools were not able or not sufficiently convinced to organise contributions from own budget, parents and community.

10 Operation and maintenance

As mentioned above, operation and maintenance of the sanitation facility is done by the school itself, often the health or ecosan clubs but also employed school staff (not the teachers).

The club members and their patron were participating in a special training on the use of urine as fertilizer and faeces as soil conditioner (operation). The club members were also provided with protection items like overalls, gumboots, gloves and masks as shown in Figure 10.

Fig. 10 Health club members with protection items in Mwala Primary School, Ukambani (source: Paul Mboya, GTZ-Kenya, Oct. 2009)

The operation of the UDDTs includes cleaning, provision of wood ash, checking for blockages of the urine pipes, removal of urine and dried faeces. The maintenance is minimal with regard to minor repairs of the water tap (hand washing unit), chamber doors (due to rusting, termites), roofing, rainwater harvesting and repainting.

11 Practical experience and lessons learnt

The major challenge in implementing sanitation facilities in schools is to create sustainable operation and maintenance mechanisms within the school. This strongly relates to the level of ownership. Since the participation of the schools in implementation 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 did not get finished when the trainings took place. The impact of the training without having the new improved facility to learn on tends to be low as knowledge gets lost without application.

Furthermore many toilets started operation shortly before the end of the EPP project time. Therefore the required trainings on reuse of urine and faeces could not take place. For the use of dry faeces it takes 1 year to “harvest” thus many school did not reach that stage during the time of EPP. Moreover simple O&M activities like unblocking urine pipes did only happen only later when no direct support from GTZ was available. However after the end of the EPP project the GTZ sustainable sanitation program provided some basic follow up for the

schools with trainings and also technical support until Nov. of 2010.

Furthermore a generally high workload, 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.

During the project only a few toilets were installed in the pilot schools so not all students were allowed or able to use the new facilities. This resulted in overcrowding of the toilets which quickly led to uncleanliness and often misuse (dumping of ash or even defecation in urine section). This led to quick blocking of the urine pipes and odour problems. The schools were mostly not willing to unblock the urine pipes since this was an unexpected problem and an offensive (smelly) business. This means that the local artisans were obviously not contacted by the schools for assistance even though they could have provided the service. It must be assumed that the school was not able or willing to provide financial resources to maintain the "donor-funded" infrastructure.

Another big challenge was to introduce hand washing after the toilet use. Most of the hand wash tanks were not in proper use as they were 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 is a lack of interest and finance (budget) for operation and maintenance of hand washing.

In terms of reuse of urine and faecal matter the follow up in 2010 has showed mixed results. Most of the schools do not effectively use the fertiliser for food growing rather than for demonstration purposes. Often the school farms are small and not well managed, thus the urine is mostly applied to trees or dumped. Certainly the lack of adequate and well timed training at the point of need resulted in mixed results.

In some cases the success of a project also depended on the one or two committed school managers and teachers. Once they left the schools the UDDTs quickly got misused and neglected resulting in closure of the facilities. This also happened when the urine pipe got blocked.

Software lessons learnt

- Awareness creation and participation of all parents and other community members in the implementation process is most important to make sure that ecosan is accepted and well understood within the community
- Contributions of parents and community to the construction process and if available state funds in order to limit donor money dependency – this will build the crucial ownership needed for proper operation and maintenance
- Training of local artisans on entrepreneurship that goes beyond construction (sanitation marketing) like issues of operation and maintenance of the toilets so that they can provide support services to the schools. This would be an incentive for income generation e.g. 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 facilities with the same standards for all students as well as teachers. Demonstration toilets do not lead to the replication of more toilets in schools. The Kenyan standards require 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.
- Build more affordable designs which are more likely to be replicated by schools (just like with pit latrines) for the situation 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 1-2 years that ensures proper timing of trainings at all crucial stages after the start of operation (application of urine, closing of full vaults after 6 months, handling of dry faeces after another 6 months, maintenance issues like leakage of faeces vaults or breakage of doors or water taps etc.).
- Make sure the school has a viable 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 facilities.

Fig. 11 A urine pipe got blocked with ash at Muslim Primary School, Mumias (Source: Laura Kraft, GTZ, June 2010)

- Make reuse of excreta a simple operational activity such as underground irrigation of trees instead of manual application which will lower work load and risk of disease transmission. Alternatively a disposal system can be set up.
- Ensure a continuous training and learning process at the schools on sanitation, O&M and the link of excreta to agriculture in order for new students to use the facilities properly and understand the concept – a good way is to introduce specific curricula in the schools, use school competitions (award schemes) and other tools to motivate learning and keep engagement up

Technical design lessons learnt:

- Instead of disposable sanitary pads girls often use old cloth which is washed and reused. Hence girls might still 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. This could be done over the urine section of the squatting pan provided that the urine is not handled manually for cultural reasons – so either underground irrigation or disposal.
- Not in all schools the boy's UDDTs included urinals. Therefore boys seem to use the toilets also for urinating, which lead to splashing and urine entering the faeces vaults, thus cause bad smell and unhygienic conditions.

- The lids on the squatting pan confused some children in such a way that they 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 hole uncovered (the children are used to one open hole in pit latrines)
- There were also problems with leakages of rainwater into the vaults due to poor craftsmanship and insufficient material quality of the vault doors (e.g. untreated wood frame was consumed by termites). In order to address this problem it was decided for the future to use only straight vault doors instead of inclined ones which will also be cheaper in construction.
- The flexible hose pipes of 1" 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 that can easily block with the slightest occurrence of solids. Therefore it is recommended to use a bigger diameter of 2" or 3" and preferably standard PVC pipes.
- The plastic tank of the hand washing facility needs to be secured in a concrete ring to avoid theft and misuse by the school. It was often witnessed that the tanks were missing or used for other purposes.

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 impacts are:

- Students spread their knowledge about ecosan within their families and communities which results in an higher demand and awareness of improved sanitation
- Higher awareness on proper hygiene practices like hand washing amongst the students
- Increased agricultural production on school farms through use of fertilizer from UDDTs and effluent water from biogas plants by 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, 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

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:

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- 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 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), Maji House, Ngong Road, Nairobi, Kenya
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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 agencies:
Water Services Trust Fund (WSTF)
Engineer Mr. Macharia
GTZ Advisor Hans 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

Local organisations implementing UDDTs projects:
- 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) - Machakos
- 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 (orodiodhiambo@yahoo.com)

Case study of SuSanA projects
UDDT toilets for schools in Kenya
SuSanA 2011

Authors: Laura Kraft, Christian Rieck
(free lance consultant for GIZ – Sustainable Sanitation - ecosan programme ecosan@giz.de)
Editing and reviewing: Elisabeth von Münch (GIZ, ecosan@giz.de)

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www.susana.org

Case study of sustainable sanitation projects

UDDTs at a church and nursery school Nakuru, Kenya

Figure 1 Project location

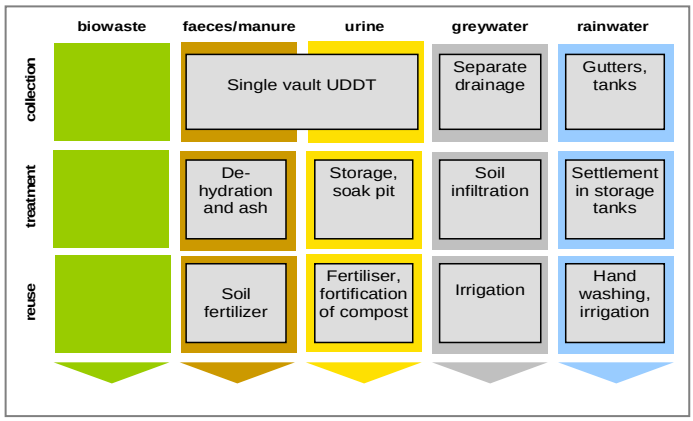

Figure 2 Applied sanitation components

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:
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,
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).

Figure 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).

UDDTs at a church and nursery school Nakuru, Kenya

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.

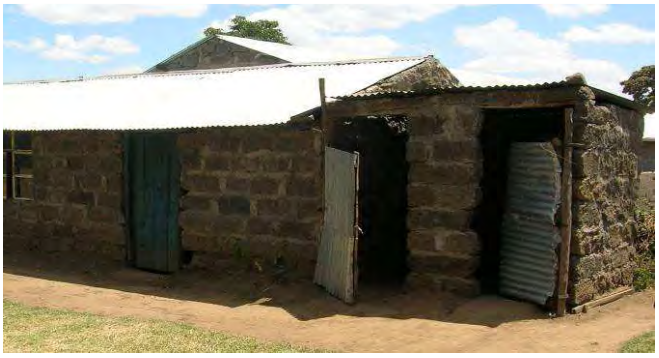

Figure 4 Existing pit latrines

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.

In Kenya, the under-five child mortality rate is currently[1] **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.

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.

Figure 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.

Figure 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.

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

Figure 7 Inside the men's urinal showing the fabricated plastic containers urinal for the kids and standard ceramic urinals.

Monitoring outcomes from 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.

Figure 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

UDDTs at a church and nursery school Nakuru, Kenya

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.

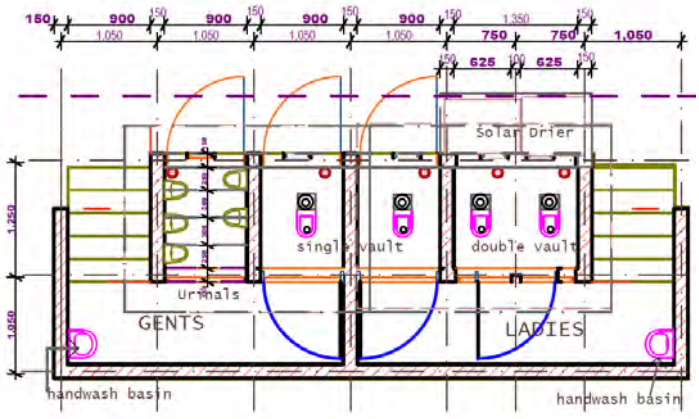

Figure 9 Floor plan of church toilet

Figure 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.

Figure 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).

Figure 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.

UDDTs at a church and nursery school Nakuru, Kenya

The containers are cleaned by scrubbing ash or soil inside them and then returned into the vaults as shown in Figure 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.

Figure 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.

Figure 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.

Figure 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.

Figure 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, 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).

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
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14 Institutions, organisations and contact persons

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Case study of SuSanA projects

UDD toilet at a church and nursery school, Nakuru, Kenya

SuSanA 2010

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Case study of sustainable sanitation projects

Urine diversion dehydration toilets at a residential plot Nakuru, Kenya

Fig. 1 Project location

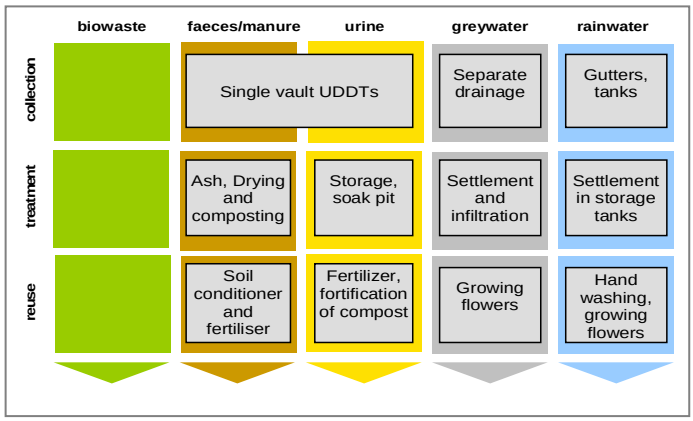

Fig. 2 Applied sanitation components

1 General data

Type of project:
Urine diversion dehydration toilets (UDDT's) in a residential plot in Nakuru, Kenya

Project period:
Start of construction: August 2008
End of construction: September 2008
Start of operation: December 2008
Monitoring period: Jan. 2009 – Dec. 2009
Project end: 31 March 2010

Project scale:
Design and construction of a masonry toilet block consisting of 3 single vault UDDTs for a population of 28 households (84 users) at costs of EUR 1,640
Total investment of the project described: EUR 1,940

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 mainly to improve sanitation by establishing urine diversion dehydration toilets thereby reducing groundwater pollution and health risks associated with pit latrines. The motivation was also to contribute towards achieving the MGDs and Kenya Vision 2030 (GOK 2007) by promoting sustainable sanitation.

3 Location and conditions

The residential plot is located in Hilton estate, a high density low income settlement in the North-Western part of Nakuru town.

The town 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 160 km north west of the capital Nairobi (MCN et al., 1999).

The pilot area has little or no connection to the main sewer line. Most of the tenants are unemployed and engaged in small scale enterprises of selling basic household goods and sorting waste in the dump site while others are artisans who are employed on temporary basis.

Fig. 3 Front view of plot-based UDDT for 28 households

Urine diversion dehydration toilets at a residential plot Nakuru, Kenya

The majority of the women are housewives. The residential pilot plot consists of 28 households with an average of 3 members per household.

Fig. 4 Nakuru-Hilton estate settlement. All photos in this document are from the ROSA project in 2008.

The main sanitation system used in this area is onsite sanitation where 85% of the population including the residential plot use pit latrines.

Fig. 5 Existing pit latrines (left) and a buried filled up pit latrine in the front on which the new UDDT was constructed

The geology of Hilton estate is characterised by very shallow soils and occurrence of hard rock on the surface. In some parts geological fault lines pass through the area. The site had hard rock outcrop and it was not possible to dig a deep pit latrine. Already the plot had a filled pit latrine and the one in use was also almost filling up. To create more volume for the pit, some residents constructed raised pits since it is more expensive to dig on rock.

In Kenya, the under-five child mortality rate is currently[1] **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.

[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 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

In a study carried out by the ROSA team in November-December 2007, it was observed that the main problem facing Hilton estate residents was lack of adequate water supply and lack of proper sanitation. Most pit latrines were very shallow and therefore filled up frequently costing the landlord a fee of Kenyan Shillings (Kshs) 3,500, about EUR 35, to exhaust the pit latrines. ROSA identified this plot as a pilot because its conditions were representative for the majority of the other plots and it is expected that the success of this pilot would lead to other landlords adopting the systems in their plots. The other factors that led to selecting this site were:

- The landlord was willing to experiment on the new sanitation concept.
- The plot was very close (less than 50m) to an organic composting shed which provided an opportunity to dry and treat the faeces from the UDDT.
- The landlord was a local leader, engaged in environmental management and together with a CBO known as MEWEREMA interested in providing collection services and co-composting the organic matter with compost.

Two awareness creation workshops were conducted in 2008 to sensitise the landlord, the tenants and local residents on ROSA systems (Resource-Oriented Sanitation concepts for peri-urban areas in Africa). Topics were the UDDT technology, utilisation of urine and dried sanitised faeces.

After discussion of the proposed design, the implementation commenced at the end of August 2008 and completed after one month at the beginning of October 2008. In November 2008, the tenants were trained on the use, operation and maintenance of the UDDTs which was later officially opened by the Treasurer to the Nakuru municipal council in December 2009.

Monitoring in May 2011:

A monitoring of the ROSA projects in and around Nakuru was done in May 2011 by Laura Kraft 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).

Urine diversion dehydration toilets at a residential plot Nakuru, Kenya

During the visit of the residential plot interviews were conducted with the landlord and chairman of the CBO MEWAREMA. The state of the toilet facility and the drying shed was 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

The various sanitation options including ArborLoo, composting toilet, urine diversion dry toilets (UDDTs) with both single vault and double vault were considered. The 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. UDDTs are dry sanitation systems that have two collection systems which separate and store the urine and the faeces fractions of the excreta at source in order to simplify their safe recycling and utilization of their nutrient content separately.

Due to the limited space available for construction, single vault UDDTs were chosen over the double vault UDDTs. During the training workshops, members opted for container collection arguing that it would be more hygienic to handle the faeces while contained, instead of allowing them to drop on the floor of the chamber.

The faeces are collected in 70 - 100 litre plastic containers placed in the vault underneath the toilet chamber. Once the containers are filled, they are pushed aside to place empty ones directly under the faeces hole. One of the toilets is assigned to men including a plastic waterless urinal installed at a corner. The other two are assigned for women and children, respectively.

Fig. 6 On the left: Inside the single vault UDDT showing the urine diversion pedestal, men’s urinal and a bucket for storing ash. On the right: greywater settling chamber

Urine is collected in a 50 liter plastic tank, when the tank is filled, the urine is discharged through an overflow pipe into a soak pit. Urine can be collected for agricultural use by removing the collection tank from the chamber behind.

Rainwater is harvested from the roof into a 100 liter tank which is connected to washing basin in front of the toilets. The grey water is directed to a flower bed after passing through a settlement tank.

6 Design information

The dimensions of the UDD toilets block are 3.3m length and 1.4m width, housing three single vault UDDTs.

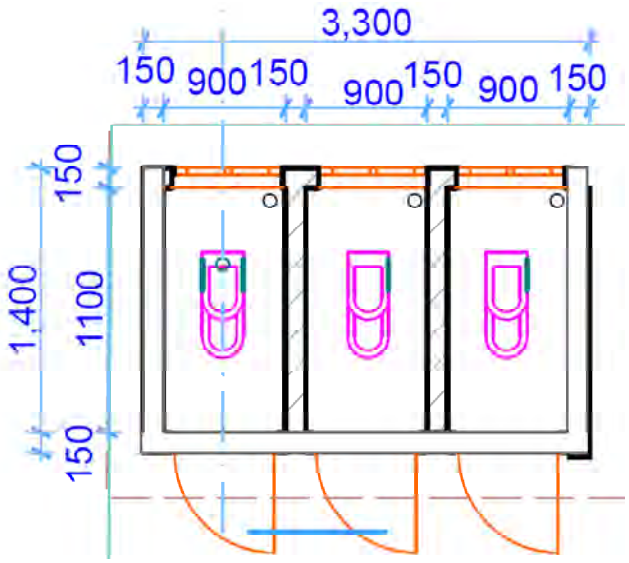

Fig. 7 Floor plan of the residential UDDT.

To save costs, the floor area for each single toilet (1.1m x 0.9m) was designed to meet the minimum but adequate toilet floor area requirement of approximately 1 m^2 (Harvey, 2002).

Fig. 8 Three dimensional view of the toilet block.

The toilet was constructed above an old pit that had been backfilled with stones and compacted. A 1m thick base concrete slab was placed over the compacted stones and the super structure constructed above this. The designed vault size is 1.1m x 0.9m x 0.75m which can receive 0.6 m^3 (600 litres) of faecal matter when 80% full. However, when using containers, only a maximum of 300 litres can be collected using 3 x 100 litre containers. It is calculated that it will take 45 days to fill one 100 liter container, hence three 100 liter containers last for 135 days, resulting that the faeces may be emptied every 135 days (4 ½ months).

Urine diversion dehydration toilets at a residential plot Nakuru, Kenya

Fig. 9 The rear of the UDDT showing vault doors and a shade for temporary storing the faeces for further drying before utilisation/disposal.

The interior of the toilet is well ventilated and lighted by a vent space above the door that is covered with a gauze wire to avoid flies, while each vault has a vent pipe that rises 1m above the roof for effective air circulation from the vaults to the atmosphere.

Monitoring outcomes from May 2011:

Generally the superstructure was in good condition only some of the stairs were cracked. The hand wash facility was in place, functioning and water was available.

There was only one cubical and one urinal in use, the other two toilets were locked as the containers were filled up (Fig.10).

Fig. 10 On the left, the old pit-latrines used by the tenants are located next to the UDDT facility with greywater settling chamber in front. Right: Only one cubical and one urinal of the UDDT are currently used by the landlord and his family (L. Kraft, May 2011)

7 Type and level of reuse

It is planned that the collection, transportation and treatment of the faeces from this plot will be done by a service provider. So far the faeces and urine produced in this UDDT have not been reused due to lack of demand. The plot area is covered with buildings and no space is available for urban agriculture. The dried faeces emptied from the vaults are disposed at a dump site that is only 50m from the plot, while the excess urine goes to a soak pit.

The local garbage compost company (MEWAREMA) will collect and transport the next load of dried faeces to the new drying shed which is located at the dump site for further treatment.

Fig. 11 Drying shed at the dump site for centralized composting (source: Sustainable sanitation Practice, Issue2. 01/2010, EcoSan Club)

The Initial cost estimates indicated that a charge of Ksh 100 to 400 for emptying service depending on the amount and the distance to the drying shed could be allocated.

Monitoring outcomes from May 2011:

Urine and faeces are not collected and reused. Urine overflows in the pit of the old pit latrine. The owner of the UDDT had exchanged the filled up container twice by himself as there was no collection service. The faeces were once disposed at the dumpsite and once the containers were exchanged and kept in one of the bathrooms next to the old pit toilet (Fig.12).

Fig. 12 Old, filled up faeces container stored in the bathroom next to the pit-latrine (Source: L. Kraft, May 2011)

Collection, transport and treatment service (MEWAREMA)

The Menengai Waste Recycling Management (MEWAREMA) is a CBO and licensed as operator for solid waste collection within the peri-urban areas Hilton and London. They are also experienced in organic compost production which was done by a women group collecting biodegradable waste from the dump site and supported by Practical Action.

Urine diversion dehydration toilets at a residential plot Nakuru, Kenya

During the ROSA project they agreed to offer a collection, transport and treatment service for the faecal matter from UDDTs. Unfortunately since the end of the project no collection of faeces was done by MEWAREMA.

The following challenges were identified:

a) No market for urine and faeces or co-compost
b) High investment cost in the beginning
c) No access to loans as they do not have enough capital
d) No profit will be made in the first years of operation
e) There are no subsidies available for supporting the collection service in the beginning before it can make profit.

MEWAREMA is still willing to do the collection, transport and treatment of the faecal matter but the challenges mentioned above seem hard to overcome. They had a donkey cart (financed by Practical Action) and two donkeys which the group bought for the collection although the drying shed (provided by ROSA) was destroyed during a storm (Fig.13).

Fig. 13 Drying shed was destroyed during a storm (Source: L. Kraft, May 2011)

Marketing and selling of co-composted faeces and urine (NAWACOM)

According to the ROSA operation and maintenance strategy MEWAREMA should sell the co-compost to NAWACOM (Nakuru Waste Collectors and Recyclers) who should be responsible for marketing and compost selling.

Challenges:

a) Marketing is a challenge as people value chemical fertilizer more than organic fertilizer

b) Many people believe that chemical fertilizer is having a better effect than organic fertilizer

c) Compost containing urine and faeces cannot be marketed openly but can be used as long as customers do not know (compost from “organic waste”)

d) Doubts if produced co-compost is “safe”, they would only buy when lab tests are done and prove that it has no high amount of heavy metals, pathogens or other harmful substances

8 Further project components

The following activities are in progress at the residential plot UDDT:

- Monitoring O&M of the facilities
- Research on O&M and the involvement of private sector in the business of collection, transport, treatment and marketing of compost
- Construction and management of drying shed

9 Costs

The cost of construction of the 3 single vault residential plot UDDTs is shown in Table 1.

Table 1: Construction costs for the 3 single vault UDDT (all provisional inclusive of labour).

Item	Description	Amount (EUR)
1	Excavation and earthworks	74
2	Concreting	238
3	Walling	474
4	Roofing	160
5	Doors	252
6	Sanitary installations	252
7	Finishes	188
	Total	**1.638**

A comparison of the operation and maintenance cost for three types of toilets namely: UDDT, pit latrine and flush toilets are given in Table 2.

Table 2: Comparison of estimated costs of operation and maintenance for three different sanitation options (annual costs in Euro)

Description	UDDT	Pit latrine	Flush toilet
Emptying	12	12	-
Empt.Urine	12	-	-
Service charge for sewer/water?	-	-	120
Cleaning	52	52	120
Disinfectant	-	24	10
Income from product	(36)	0	0
Total	**76**	**88**	**250**

The table shows that the operation and maintenance cost of flush toilet is much higher compared the other two. The operation and maintenance (O&M) costs for the UDDT and pit latrine show no significant difference. However, if recycling and reuse of products from the UDDTs is realised, earnings from the sales of the product (1200 kg at EUR 0.03 per kg = EUR 36) may reduce the overall expenditure hence making the UDDT more profitable. The costs for awareness creation workshop and training were EUR 300.

10 Operation and maintenance

It was the sole responsibility of the landlord to manage the UDDT implemented by ROSA in his plot. A memorandum of understanding was signed by the ROSA project and the landlord that he takes over all responsibilities after ROSA project ends. The ROSA project, however, has continued

helping and backstopping as and whenever need arose especially on technical matters. The landlord's wife and some female tenants were responsible for the daily cleaning and operation of the toilets. They cleaned the toilet floor regularly and ensured that there is ash available.

The landlord on the other hand was supposed to arrange collection and transportation of the faecal matter, to do repair work and general maintenance when need arises.

Fig. 14 A mother assisting her kid on using the UDDT.

To ensure proper use and basic operation and maintenance on the UDDT, occasional training and demonstration was conducted by the ROSA team to the users. The main activity of emptying the containers by a private provider/CBO will be done once per 4 months or earlier if the containers are full or have been mixed and therefore emitting smell.

Fig. 15 A community based organization (MEWAREMA) from the area that is in the process of acquiring a cart and two donkeys for providing collection and transporting service.

Monitoring outcomes from May 2011:

The toilet in use was clean but there was no ash inside the toilet, ash was stored outside under the sink. Therefore fresh faeces were not covered, looked wet and flies were observed in the toilet. There were no instructions on the right use of the UDDT in or outside the toilet.

11 Practical experience and lessons learnt

The UDDT was generally well maintained most of the time. Smell was detected and flies noticed 4 times of the 20 times visited by project staff. The main operation problem observed was the misuse of the toilets by visitors and strangers who were not familiar with the proper use, leading to mixing of urine and faeces. The children were also reported to put ash into the urine hole occasionally leading to blockage of the system.

To solve these problems, a new toilet management system has been put in place where the 3 UDDTs are divided among the 28 households, who are supposed to take care and maintain the toilets. The toilets are now closed and each group has their own keys.

The frequency of the 100 litre container filling with faeces was observed to be 45 days with an average of 20 people using the toilet per day.

Approximately 100 litres of urine is collected per week into the 50 litre container with an overflow that discharges into a soak pit. No market is available for the urine or the faecal matter from this toilet at the moment. It is realised that a proper re-use concept must be in place prior to operation of toilets or a safe disposal option being available as an alternative.

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.

Up-scaling of UDDT implementation is in progress and approximately 15 landlords/landladies have benefited the loan and constructed improved sanitation facilities.

Monitoring outcomes from May 2011:

Different households with UDDTs were visited within the peri-urban areas London and Hilton. Many people said the UDDT superstructure is of good quality and they like the design. The underground is very rocky in the area therefore people prefer the raised UDDT because digging a pit is expensive. UDDTs were also preferred as they do not fill up and are easily emptied.

Many people took a loan from Family Bank to finance a UDDT[2] but since there was no collection service most of this UDDTs are not in use anymore. Many users shifted back to the pit latrines after the containers filled up.

The main challenges are faced with the lack of a functioning collecting, transport, treatment and marketing system of urine and faeces as well as minor operation and maintenance:

- The responsible and licensed waste collector and processor is MEWAREMA that has not ventured into the business of human excreta since there is no market for the end product compost. The purchased transport equipment was donated in vain.
- NAWACOM as a local NGO that sells organic fertilizer called "MAZINGIRA" currently see no potential in fertiliser containing urine and faeces

[2] More information on this financing option can be obtained from WASTE – contact: Gert de Bruijne – WASTE advisor gdebruijne@waste.nl

- Usage of ash is not practised by all users therefore faeces are often wet and smell

The key constraint is the lack of marketing of the UDDT products as an organic fertilizer. It is crucial to invest in different marketing strategies to increase the demand on organic fertilizer containing urine and treated faeces.

This could be done through:

1. Demonstration fields
2. Free fertilizer distribution or at a very low cost
3. Awareness creation on benefits
4. Advertisement
5. Workshops
6. Direct contacting potential customers like tree nurseries or flower farms

A different solution could be that urine and faeces are reused in another way for example to produce biogas or to feed larvae of black soldier flies which are very nutritious and can be used to feed animals.

There is an urgent need to overcome the challenges otherwise a lot of users have no other option than demolishing or abandoning their UDDTs and return to the pit latrines or flying toilets they used before.

12 Sustainability assessment and long-term impacts

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).

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	

For long term sustainability and for economic sanitation, the following is recommended:

- Encourage the landlord to have a sense of ownership and to ensure good operation, maintenance and management
- Encourage users to correct use and 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, this is an important factor in the success of the system.
- To carry out pathogen tests at different stages of the faecal storage to determine health effects of handling faeces and urine during collection, transportation, treatment and reuse. This is meant to serve as a source of researched information that can be used in the decision making on utilisation of products.
- To confirm the calculated costs of operation and maintenance with the actual costs.

As showed in Section 11 there is a challenge in marketing of the UDDT products as an organic fertilizer in order to create a incentive based collection and treatment services. In order for the sustainability of the project it is crucial that these services can be organized on a solid and permanent basis. Otherwise there is no sustainability achieved.

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

The following documents are available:

Photos from this project are available on flickr: http://www.flickr.com/photos/gtzecosan/sets/72157624222612155/with/4730407176/

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
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Case study of SuSanA projects

Urine diversion dehydration toilets at a residential plot, Nakuru, Kenya

SuSanA 2010

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Case study of sustainable sanitation projects

UDDTs implemented via CBOs and Water Services Trust Fund, Nyanza, Western and other provinces, Kenya

Fig. 1: Project location

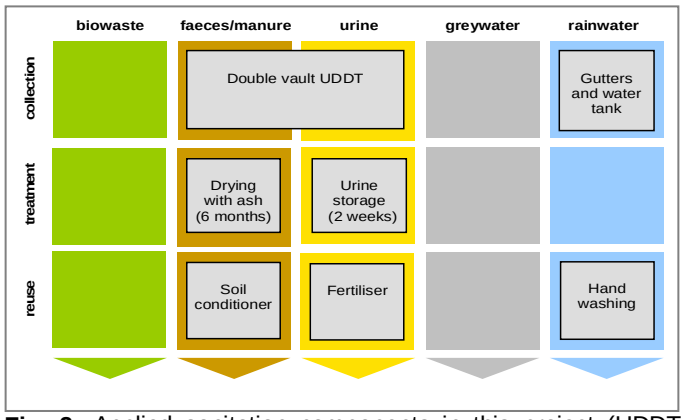

Fig. 2: Applied sanitation components in this project (UDDT stands for urine diversion dehydration toilet).

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, GIZ-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, GIZ-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. GIZ 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), GIZ-Kenya Water Program (EUR 100,000) and the GIZ-Kenya Agriculture Program (EUR 100,000). The project was implemented by GIZ-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.

Table. 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 GIZ 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, GIZ-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.

Fig. 7: Faeces collection vault which is half full (source: David Watako, GIZ-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, GIZ-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

[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

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.

The plastic squatting pan is from the local manufacturer Kentainers[7] and was designed in cooperation with GIZ. 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.

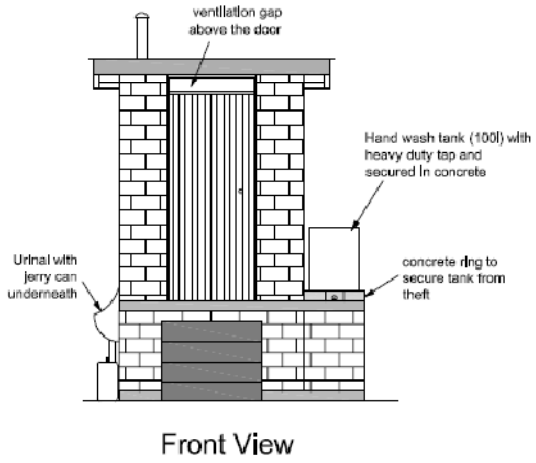

Fig. 9: Design drawings of UDDT (for website link of drawings see Section 13)

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.

Fig. 10: Various urine diversion plates at the factory of Kentainer. The double vault plate was developed by EPP (source: C.Rieck, GIZ-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.

[7] http://www.kentainers.com/kent/home.html

Fig. 11: Inside of urine storage vault with a number of urine containers (Source: Moses Wakala, GIZ-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, GIZ-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 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, GIZ-Kenya, June 2010).

[8] See GTZ Technology Review: Urine diversion components http://www.gtz.de/en/dokumente/gtz2009-en-technology-review-urine-diversion.pdf

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 look 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.

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

Fig. 14: Left: Production of hydraform blocks; Right: completed hydraform blocks (Source: Paul Mboya, June 2009).

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.

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.

Table. 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, GIZ-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 GIZ 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 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 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.

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		

[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

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 GIZ 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 GIZ Eschborn, 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 GIZ 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 GIZ 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, GIZ-Kenya http://www2.gtz.de/Dokumente/oe44/ecosan/en-memorandum-of-agreement-2009.pdf
- Mboya, P. (2010) Map of GIZ ecosan project sites, GIZ-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, GIZ-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)

[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

- 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)
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Partner organisation:
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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)

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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

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Editing and reviewing: Elisabeth von Münch (GIZ - ecosan@giz.de)

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www.susana.org

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

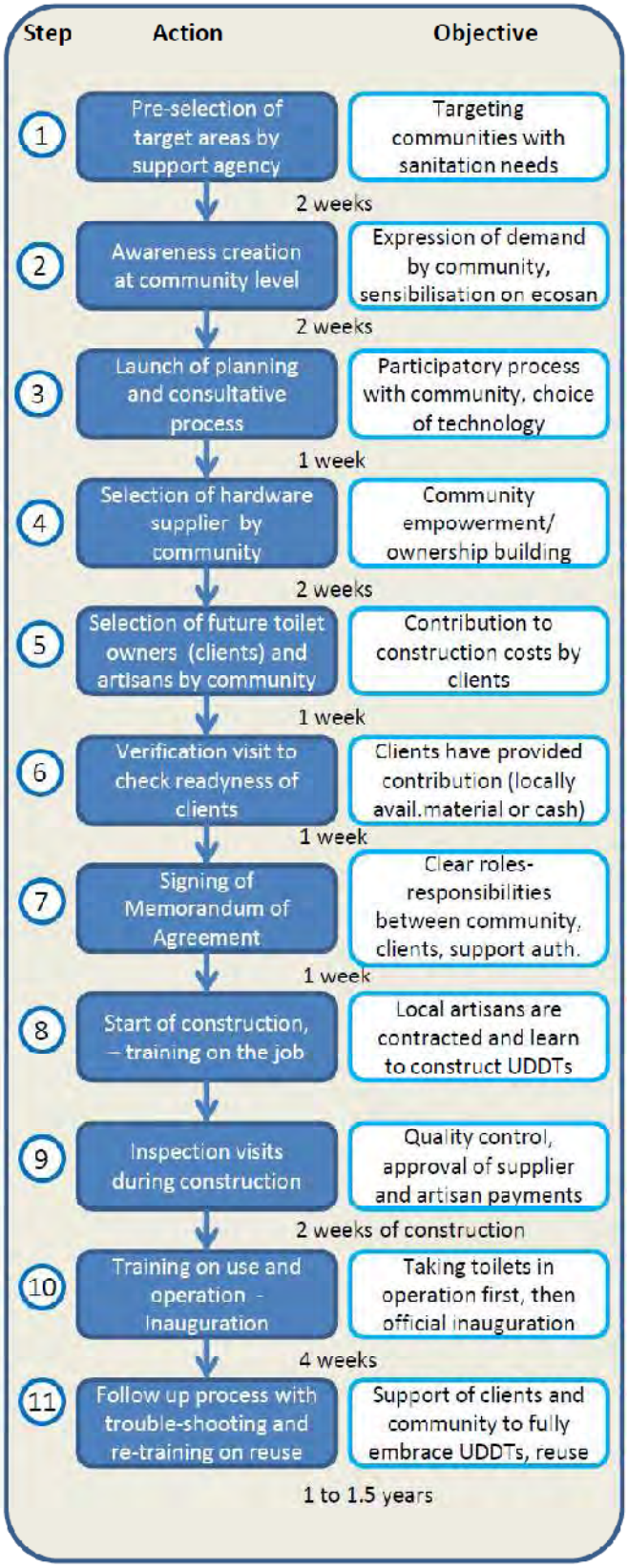
Generally communities are favourable and open-minded to change of their toilet system if they experience problems with their conventional systems like pit latrines that are not appropriate in the area due to reasons of seasonal flooding, rocky underground, collapsing soils and high groundwater tables 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

Peri-urban urine diversion dehydration toilets (abandoned) Koulikoro, Mali (draft)

Fig. 1: Project location

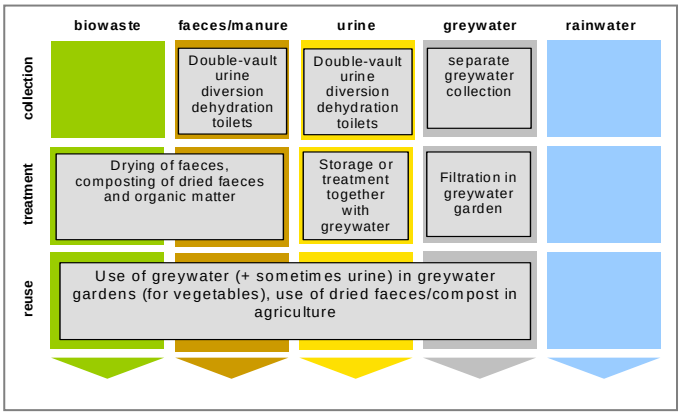


Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Small-scale peri-urban upgrading project (demonstration project)

Project period:
Start of construction: April 2000
Start of operation: Dec 2001 (currently mostly abandoned)

Project scale:
11 Urine diversion dehydration toilets and greywater infiltration gardens, each for approx. 10-25 inhabitants

Address of project location:
Koulikoro, Mali, West-Africa

Planning institution:
OtterWasser GmbH, Lübeck, Germany

Executing institution:
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Germany
BOATA GmbH, Mali

Supporting agency:
German Federal Ministry for Economic Cooperation and Development (BMZ) via Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

Update in March 2009:

In March 2009, Stefan Hofstetter[1] visited this project site. Only two local persons could be contacted during the visit. Those were Mr. Souleymane Keita who is the "Agent Voirie Mairie Koulikoro" and Prof. Dr. Sidiké Gabriel Dembelé from the University IPR/IFRA at Kalobougou. Mr. Hofstetter took photos, talked with the people who knew of the toilets and with people involved in the project. Based on this information, we updated this case study. The original text (from the GIZ project data sheet published in 2005) has mostly been left unchanged (some minor updates), and the new observations are added in each chapter after the heading *March 2009*.

[1] Stefan Hofstetter is an independent consultant, e-mail address: stefan.hofstetter@ieee.org

2 Objective and motivation of the project

- Establish a pilot and demonstration project to introduce ecological sanitation (ecosan) to West Africa in general, and Mali in particular.
- Establish an appropriate low-cost sanitation system which is easy to operate.
- Reduce the pollution and health risks caused by the lack of a functioning wastewater system whilst the water supply system for the town of Koulikoro is being extended.

3 Location and conditions

Koulikoro is the capital of Mali's second region with 26,000 inhabitants and is located 60 km east of the capital Bamako, on the river Niger. The town is spread across the sandy river valley up to the neighbouring rocky plateaus.

Fig. 3: Ecosan UDD toilet in Koulikoro with shower and greywater garden in 2002 (source: GIZ, 2002).

Around the year 2000, the central water supply system in Koulikoro was extended (with support of German development cooperation organizations KfW and GIZ), but no functioning wastewater management system existed. Due to geographical and economic reasons a centralised wastewater treatment plant was not considered (e.g. rocky ground, operational costs estimated to be twice of town council's

budget). Open wastewater flows thus exposed the entire community, especially children, to health risks.

Since 1995 the German Technical Cooperation project of GIZ, funded by the German ministry BMZ, "Improvement of the municipal water and waste management" consulted the local government, unfortunately without relevant results in the wastewater sector.

The initial situation in Koulikoro can be described as follows: Only 3% of the households have water flush toilets and septic tanks, which are poorly designed and built. About 25% of the households are equipped with soak pits or so called "puisards" (collection and infiltration pits for wastewater), most of these are simply a hole in the street or a collection basin. All attempts to infiltrate wastewater into the ground turned out to be extremely difficult due to the high groundwater table in the vicinity of the river and the rocky underground.

Nearly all households have traditional pit latrines including a showering area. Faeces and water used for anal cleansing (most of the people are Muslims) go into the pit through the defecation hole ("trou"). The urine and the shower water usually flow over the latrine floor and into either the "puisard" outside the compound, the open storm water drains or directly onto the street.

Most people live in spacious compounds (300 to 400m²), and income levels are very low. The average household size is around 10 persons, however up to 25 people often share the compound and use a single sanitation facility.

Koulikoro's agriculture area is close to town. The soil is sandy and poor in nutrients (type Sahel condition) and suffers from severe erosion during the rainy season. Untreated faeces from pit latrines are traditionally used for fertilization as farmers are dependent on affordable soil improvement.

Additional observations in March 2009:
The average household size seems to be higher now than reported in 2005 - all of the visited toilets are regularly used by more than 20 persons. Four of the toilets visited are toilets within a traditional family court and all of them are located on the plateaus of Koulikoro. A large toilet building is located at the "Lycée du Seminaire Pie XII", a school in Koulikoro.

More ecosan UDD toilets were not found, and our guide, Mr. Souleymane Keita (Agent Voirie Mairie Koulikoro), did not know any more locations (perhaps the large toilet building was counted as seven units, so that the total reported number of UDDTs is 11?).

In 2009 the under-five child mortality rate was 48 children per 1000 in Mali, and is has been decreasing during the last twenty years[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.childmortality.org and http://www.childinfo.org/).

Fig. 4: The same location as Fig. 3: greywater garden on the left side with leaking water from broken pipe (source: Stefan Hofstetter, March 2009).

4 Project history

The ecosan pilot project began operation in mid 2001. But due to the very poor cooperation of the Koulikoro municipality with the Technical Cooperation measures of GIZ, the larger GIZ project (of which the ecosan pilot project was a part of) was aborted ahead of time in late 2001. This made it quite difficult to keep the ecosan pilot project running well and many operational problems occurred (described later in this document).

In the time between 2001 and 2004, field visits by members of the GIZ ecosan team to the project site were carried out on several occasions, and the project experiences were documented (mostly in internal documents). An overview of relevant reports can be found in section 13.

5 Technologies applied

After a detailed feasibility study was carried out to investigate the options for wastewater management in Koulikoro, it was found that an ecosan system with closed loop, low tech sanitation units seemed to be the most appropriate solution. Different pilot facilities, all more or less modified versions of locally used facilities, were tested. They were distinguished by:

- a separation of urine and faeces at the source using special latrine slabs / squatting toilets
- double-vault dehydration toilets for the drying, storage and hygienisation of faeces (for later use) with a controlled drainage of seepage water
- a separate collection, storage and utilization of urine
- greywater treatment using planted soil filters ("greywater gardens").

For urine treatment, two technologies were tested: Urine was separated by the latrine slab surface and either:

- led to a collection canister for storage followed by use, or
- led to a greywater garden (small on-plot plant nourished by treated greywater or experimentally by greywater mixed with urine).

For the faeces collection, under the local climatic conditions

(high average temperatures, long dry season and short rainy season) and geological circumstances (high groundwater table or rocky underground) the two chamber desiccation latrine (double vault UDDT) with both faeces chambers above ground seemed to be the most simple and appropriate solution.

Fig. 5: Faeces vault of UDDT with opening to remove the dried faeces (source: GIZ, 2002).

Additional observations in March 2009:

- The technologies applied are not the reason for the failure of the pilot installations; various possible reasons for failure are listed in the following sections below.

6 Design information

Treatment of urine:
To prevent odour and loss of nitrogen any dilution of urine with water must be avoided. The profile of the latrine floor and drainage pipes leads the urine to a closed plastic collection canister. Pure urine is nearly sterile and can be used as a fertilizer (storage is recommended to reduce pathogens from cross-contamination with faeces)[3].

Fig. 6: Latrine urine-diversion squatting pan, where urine drains away to the drainage at the right (source: GIZ, 2002).

Treatment of faeces:
The two latrine chambers (toilet vaults) are used on an annual rotation basis to enable a full drying and hygienisation of their content before emptying. However this process was hampered by the considerable amount of water used for anal cleansing that drained into the latrine chamber. This problem was minimized by:

- Ensuring a drainage system in the chambers by sloping the floor and covering it with a layer of gravel. All liquids are drained directly into the bottom of an evapo-transpiration-basin filled with gravel, earth and plants with a high water consumption outside of the chamber.
- Providing the chambers with aeration pipes and south facing black iron access doors that increase the temperature in the chamber.
- Adding ash after using the latrine. This also served to minimize odour and protect against fly breeding.
- The design of the toilet floor allowed the urine and greywater from showering to be separately discharged, and not enter the faeces chamber.

Treatment of greywater:
The greywater garden is a suitable treatment solution, particular if enough space is available and for hot climates. Its design should encourage high-rate aerobic processes and the reuse of nutrients in the greywater by feeding the microorganisms living in the soil. The garden is enclosed in a walled area of approx. 8 m² and 50 cm depth. The dimensions however depend on factors such as the volume of water to be treated and the climate. It is filled with 3 layers – 1 gravel, 1 sand and 1 soil.

As the greywater is distributed in the irrigation system by perforated pipes it is essential to remove all solid particles that could clog them. It is therefore first decanted and filtered in a charcoal-gravel filter to remove solids such as fibre, sand and dust before distributing it below ground. Several aeration pipes are incorporated. The gardens have produced very good results with above ground plants such as okra, bananas, baobab, pepper and papayas. It is essential to fence in the garden to prevent damage by domestic animals and to monitor the filter regularly to prevent overflowing.

Additional observations in March 2009:

- In family courts many persons (often more than 20) use the toilet, and the temptation to use both toilets conjointly is very high. A lot of comprehension and discipline would be necessary to prevent this. The design of the two toilets should be altered in such a way, that only one toilet (with two holes, one covered, and one operational) exists.

Fig. 7: A former greywater garden, which was once planted with lots of banana plants (source: Stefan Hofstetter, March 2009).

[3] Note in 2009: See also relevant WHO Reuse Guidelines from 2006: http://www.who.int/water_sanitationhealth/wastewater/gsuww/en/index.html

Peri-urban urine diversion dehydration toilets (abandoned) Koulikoro, Mali (draft)

7 Type and level of reuse

The hygienic and fertilizing qualities of all wastewater fractions were scientifically researched in co-operation with the local university. Although the agricultural field trials have only been carried out for a period of two years (conclusive results can only been drawn after a minimum of three years) positive tendencies have been noted.

- Faeces are hygienised after one year of natural drying in the latrine collection chamber, which is supported by the adding of ash by the users. After that period it is collected manually by the users without any health risk and utilized for agricultural soil improvement.
- The separated urine is used as liquid fertilizer in agriculture. Experimentation has also been carried out to air dry urine, for example by spreading it over a large solid surface in the sun, to obtain a crystalline form of fertilizer (these experiments were however not successful).
- Alternatively urine has been used to humidify and enhance compost produced from organic waste. The best fertilising results (equivalent to that of mineral fertilizers) were achieved by a mixture of compost, dried faeces and urine.
- Greywater treated by a gravel filter is collected and used for irrigation or infiltration.

Additional observations in March 2009:

- In a municipal environment such as Koulikoro reuse of dried faeces and collected urine can only function if a recipient (at best a paying consumer) exists. The university nearby (IPR/IFRA Institut Polytechnique Rural de Formation et de Recherche Appliquée) stopped reusing dried faeces and collected urine a long time ago.

8 Further project components

Further components of the project included solid waste management, additional research on social and economic issues and up-scaling activities.

9 Costs and economics

The investment for the double-vault toilets was approx. EUR 270 to EUR 414 in the year 2001 - about double that of a conventional pit latrine (according to figures of the Koulikoro administration and depending on conditions such as ground and materials used).

Evacuation can be performed easily by the users themselves (traditionally a worker has to be paid every 3 years to empty the pit and to transport and discharge the faecal sludge). The recovered resources are valuable and hygienically safe fertilizers and irrigation water which promote additional food production for the household (e.g. estimated to be worth approx. EUR 25 per year based on Sorgho).

Estimates in 2001 calculated that the additional investment costs for a farming family of an ecosan UDDT in a simple layout is equal to the positive financial effects in the long run. Families without immediate agricultural advantages bear however additional costs.

An area-wide ecosan system (for the entire city of Koulikoro) was estimated to require approx. 10% of the investment and operational costs of a centralized conventional solution.

Additional observations in March 2009:

- This ecosan pilot project was part of a larger water and sanitation program carryout out by GIZ-Mali. It has thus not been possible to determine the exact costs of the ecosan pilot project separately from the larger GIZ project.
- Today owners of UDD toilets do not invest any money into maintenance of their toilet units, and no help seems to be available from the municipality.

10 Operation and maintenance

The system requires careful management following certain utilisation rules. If these rules are followed, then operational maintenance can be done by the users themselves. It covers:

- Collection and use of the urine.
- Emptying of the desiccation (drying) chamber and use of the dried faeces.
- Maintaining the filter, decanter and greywater garden, and removing solids and foreign material.
- Maintaining and harvesting the plants.
- Monitoring and controlling if necessary the volume of water in the greywater garden.
- General cleaning

Additional observations in March 2009:

- Maintenance and repair seems to have been neglected since a long time. Collection of separated urine is no longer operational either: The urine collection seems to have been out of operation for a long time for all UDD toilet units.
- The drying of the faeces is still working properly only for one UDD toilet. This is also the only unit where a single toilet is used during a one year period, and the annual rotation seems to work. All other three visited court toilets are conjointly used (both vaults are used at the same time) - proper drying of faeces is therefore no longer possible.
- Two of the visited court toilets have altered the desiccation chambers into regular pits - to be emptied by pump - those toilets cannot be called UDD toilets any longer.
- If the large toilet building at the “Lycée du Seminaire Pie XII” ever had desiccation chambers is not clear, - today this toilet building is a toilet building with pits to collect the faeces, and to be later pumped empty if they are full.
- Only one greywater garden is still operational; however the pipe into the greywater basin is broken and water leaks into the ground. Wherever else greywater still gets separated and collected in own pits, it is either directly poured onto the street to drain away, or pumped to be used in gardens.

Fig. 8: Former desiccation (drying) chambers of UDDTs have been converted into pits to collect faeces and to be pumped empty when full (source: Stefan Hofstetter, March 2009).

Fig. 9: Rusted iron covers of faeces chambers are falling apart, - no more drying of faeces is therefore possible (source: Stefan Hofstetter, March 2009).

11 Practical experience and lessons learnt

The combination of sanitation and reuse of human waste in agriculture/gardening is a promising approach for both agriculture and sanitation. Decentralized closed loop systems have two main requirements:

- high interest in recovering fertilizers and food production
- high degree of awareness and motivation, a consistent external support by experienced manpower and some initial financial support are needed.

The subject was intensively discussed with all stakeholders and the installations were developed in close cooperation with the future users and all concerned parties. Still, the above mentioned requirements were underestimated or insufficiently considered in Koulikoro. This led to a steady deterioration of most of the project facilities over the years[4].

The reasons that contributed to the failure of the facilities over a longer period are as follows:

- **Lack of interest/demand:**
  With the field visits in 2002 - 2004 it became obvious that Koulikoro was the wrong village as there was very little interest among the people. Another village was very interested, but for administrative reasons the money was fixed for this place. This was shown by a very low user commitment and a lack of awareness for the need of maintenance: Most users did not understand the importance of fencing off the greywater garden to protect it against animals. A fence was often neglected or it was not durable. The plants degenerated, the greywater was not used and there were overflows or by-passes. Similarly, decanters, filters and vertical pipes were improperly built, lacked maintenance and finally clogged. Such pilot projects should only be carried out at locations where authorities and users are interested.

- **Municipality cooperation:**
  The cooperation of the Koulikoro municipality was very low throughout the entire project and the fluctuation within its authorities was very high. This has caused the Technical Cooperation measures to be aborted ahead of time end of 2001 (the low cooperation was not specific to the ecosan pilot project but applied to the larger GIZ water and sanitation program as a whole)

- **Project scale**:
  The project scale was too small so that there was not enough urine for usage, even though the nearby agricultural university was very interested. The scale was also too small to create a small operating company because due to the lack of an existing infrastructure the collection and transport of the liquid urine was economically not viable. Pilot projects should be of a size where at least a one-person company can take care of the operation and organize the reuse. A possible scale-up should be foreseen.

- **Operating scheme:**
  An operating scheme must be found and implemented aiming at emptying, collecting and reusing the recyclates for those users who do not have the possibility to reuse them. In this project, operating schemes were investigated and discussed with the stakeholders but they were not realised due to the low number of installations.

- **Planning:**
  An alternative decentralised sanitation concept which has to integrate into existing structures and practises, requires a sensitive planning and individual adaptations to every particular context. The toilet and greywater systems were kind of forced on to the project long before the participatory discussion was developed. And this project showed that the households were not going to make it alone without long-term support.

- **Design:**
  For Koulikoro, a drying pan for urine was designed that did not work because in particular women used lots of water to wash after urinating. The separate collection of this washwater into the washwater drain was however not included in the user instructions.

In the technical regard the following observations are pointed out:

- The drying of faeces and their use is possible in Muslim countries. The issue of anal cleansing water can be solved through an appropriate construction, such as a 3-hole squatting pan, where anal washwater is collected separated and treated in a soil filter.
- The greywater garden system is a possible solution for families with a sufficiently large compound. The immediate improvement of the household´s nutritional situation was appreciated by the families in Koulikoro (although not enough so that they would invest the required time for proper maintenance).
- Urine fertilization is very productive, but was only applicable if agricultural areas are nearby, as the transport of rather high amounts of liquid on bad roads with donkey carts proved difficult. A volume reduction of collected urine would be desirable to ease handling and storage (but suitable systems, such as solar urine desiccation, have not yet been found, mostly due to odour problems).
- The use of urine for composting (household waste or agriculture residues) is a good approach in arid regions and is a promising alternative to the direct use of liquid

[4] Section 11 was entirely updated in 2009, compared to the earlier version (GTZ project datasheet) of 2005.

urine. However composting in the Sahel region can be difficult due to the dry climate and the low availability of compostable organic waste, which is instead consumed by livestock.

Additional observations in March 2009:

- Technically the approach is still valid and good. Conjoint use of both toilets should be technically inhibited to guarantee annual rotation of drying chambers.
- Ongoing support of a sanitation system is crucial for making it sustainable. Much more emphasis shall be laid on the social, cultural and educational aspects.
- The families have either not fully understood the principle of the system or they could not maintain it by themselves (e.g. cleaning or replacement of the gravel filter, repair of the greywater garden fence). People did not appreciate the value and benefit of the collected urine, as food production was not important to them.
- All plastic tubes (for air ventilation, as well as for the drainage of urine) should be protected against sunlight (e.g. covered by earth or wrapped in bonding foil), otherwise they will break very fast. Iron coverings must be regularly coated, otherwise they will corrode.
- The IPR/IFRA University at Katabougou (at 30 minutes walking distance from Koulikoro-Est) would be an ideal place to start with new ecosan UDD toilets again. This university educates about 700 students to become agronomists and foresters, and many young, educated individuals from various African countries could learn more about sustainable sanitation. Afterwards they could use their acquired knowledge and help to promote the knowledge about sustainable sanitation in Africa. Furthermore with 700 persons there would be enough fertilizer material to do long-term field trials, deliver valid scientific results and perhaps discover new things.
- More French documentation on the subject should be made available (although CREPA is already doing so in West Africa).
- At present, only one family still uses and operates a UDDT (drying faeces only, see Fig. 3 and 4). This family does not have to pay for emptying the pit, and manually empties the drying chambers themselves. The “chef de famille” Yussuf Traoré describes his ecosan UDD toilet as ingenious, he would miss it, and he wishes the project to be continued, or rather to be restarted again.
- To (re)build a longer lasting pilot installation it is crucial to have an organisation in place to support the users, to help doing maintenance, to educate, and to collect the urine and the dried faeces. Ideally the collecting organisation pays the users (even a small amount is enough for poor people to get them better involved) for correctly dried faeces and properly collected urine.

Fig. 10: Former urine collection of the toilet building at the school "Lycée du Séminaire Pie XII" (source: Stefan Hofstetter, March 2009).

12 Sustainability assessment and long-term impacts

March 2009:
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).

This project has **not been sustainable**, mainly because institutional and financial sustainability criteria were severely neglected, for the reasons described above.

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		
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

With respect to long-term impacts of this project:

- There are no immediate impacts for Koulikoro as a whole, except for some individuals that may have had a benefit for a limited time from having a UDDT available.
- On the other hand, the Koulikoro UDD toilets pre-date any other attempt at ecosan in West Africa. So it served as a regional model which introduced the idea to quite a few people and thus served to lay the groundwork for what came next - without which arguably there would have been much less ecosan in West Africa. So from an awareness raising point of view it was quite successful[5].

13 Available documents and references

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- Lohmann, T. (2003) Evaluation of ecological sanitation pilot facilities in Senegal and Mali. Project work at Technical University of Hamburg-Harburg, http://www.susana.org/images/documents/06-case-studies/external-documents/lohmann-2003-tuhh-evaluation-of-ecological-sanitation-pilot-facilities-senegal-mali.pdf

More photos from March 2009 are available here: http://www.flickr.com/photos/gtzecosan/sets/72157618823828820/

[5] Observation by Patrick Bracken, currently independent consultant in Niger (pocb123@yahoo.com).

14 Institutions, organisations and contact persons

Planning:
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Case study of SuSanA projects

Peri-urban urine diversion dehydration toilets (abandoned)

SuSanA 2009

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Appendix :

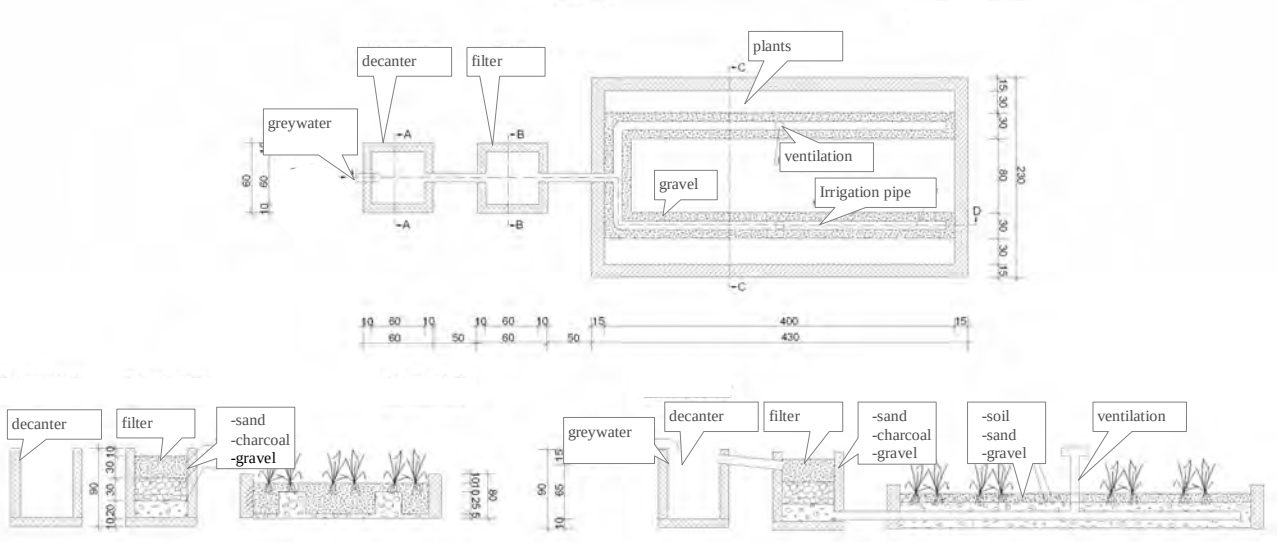

Fig. 11: Plan view and cross sections of the greywater garden (source: OtterWasser, 2003)

Case study of sustainable sanitation projects

Household UDDTs in flood-response resettlement project Guara-Guara, Sofala province, Mozambique

Fig. 1: Project location

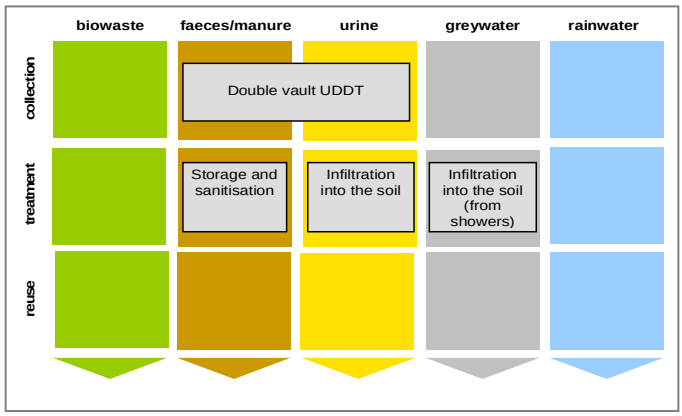

Fig. 2: Applied sanitation components in this project. UDDT stands for urine diversion dehydration toilet.

1 General data

Type of project:
Resettlement area in rural setting with individual and community-based sanitation (public and school toilets).

Project period:
First phase (UDDTs):
Start of construction: August 2002
End of construction: April 2003
Start of operation: August 2002
Project end: April 2003.
Second phase (mostly or entirely VIP latrines):
May 2004 until Sept. 2005: Partnership between UNICEF and the government.
An ongoing formal monitoring period was not planned.

Project scale:
Number of inhabitants covered: approx. 4,000
575 family UDDTs (200 built with ADA/PAARSS funds, 375 with UNICEF funds; average household size is 7)
10 public toilets
Total investment: EUR 315,210
(USD converted into EUR with an exchange rate of USD 1 = EUR 0.75, as of 1 August 2002)

Address of project location:
Bairro de Reassentamento de Guara-Guara
Distrito do Búzi, Província de Sofala, Mozambique

Planning institution:
PAARSS – in Portuguese: Projecto de Abastecimento e Agua Rural e Saneamento em Sofala (Programme for Rural Water Supply and Sanitation in Sofala)

Executing institution:
PAARSS, UNICEF

Supporting agency:
First phase: Austrian Development Agency (ADA) on behalf of Austrian Government
Second phase: UNICEF

2 Objective and motivation of the project

The project aimed at providing safe water supply and sanitation to the population resettled – after floods – in the less flood-prone Guara-Guara region in the Sofala Province in Mozambique. Fulfilling these objectives in an area characterised by high groundwater tables required a toilet technology that does not contaminate the groundwater, and thus does not threaten public health (unlike pit latrines that can contaminate the groundwater).

3 Location and conditions

Guara-Guara is located approximately 700 km from the capital Maputo, situated close to the Indian Ocean. Guara-Guara is a 15 minutes drive on meandering tar roads from the administrative post of Buzi, following the river of Buzi. Guara-Guara is situated on the crossroads between two major roads that were however destroyed during the 30 years of civil war and war for independence.

Fig. 3: Well maintained household UDDT in Guara-Guara 8 years after construction (source: A. Leitner, 2011).

Household UDDTs in flood-response resettlement project Guara-Guara, Sofala province, Mozambique

Recurrent floods tend to occur in the low-lying areas close to Guara-Guara (but not in Guara-Guara itself as it is situated higher). Buzi River and the small town of Buzi are situated below sea level or at the same level. Major parts of Buzi were flooded in 2000 as well as all the lowlands close to the river. Droughts are also a problem in the area.

During the war years, Guara-Guara had been abandoned. However in 2000, as it is higher situated than the administrative village Buzi, it was a suitable place for resettlement and future development of the fast growing village. Hence, with the resettlement areas, Guara-Guara became a suburb of Buzi and a centre of reference. It had approx. 4000 inhabitants after the resettlement (based on the official figures announced by the District Government of Búzi in the end of the resettlement process in early 2002).

The following criteria characterise the project region:

- Climate: sub-tropical climate; one hot and wet season (October - April) and one dry season (May - September)
- Geographical conditions: river basin
- Economic situation: very low income
- Hydro-geological: high groundwater table (less than 1.5 meters from the surface)
- General water and sanitation situation: most of the water for household consumption comes from shallow wells. The previous toilet type was mainly pit latrines.
- Agricultural aspects: silty sand, subsistence rain fed
- Institutional and legal framework: Guara-Guara is part of the administrative post of Buzi, under the district government jurisdiction.
- Socio-cultural conditions: aversion to fresh faecal matter; open defecation is not socially acceptable.

In Mozambique the under-five child mortality rate is currently (in 2009) 142 per 1000 children[1]. By comparison, in 1990 the rate was still as high as 232 per 1000 children.

4 Project history

The program PAARSS (a Rural Water Supply and Sanitation Project in the Sofala Province) initiated the activities in the Sofala province in 1999. PAARSS was conceived as part of the existing decentralised cooperation between the provincial government in Sofala and the Austrian Federal Government through the Austrian Development Cooperation (called ADA). The programme aimed at improving the livelihood of rural poor through access to sustainable water points and basic sanitation infrastructure in rural areas and in small towns.

In this context, PAARSS conducted pilot projects that introduced ecological sanitation (ecosan) technologies, in particular urine diversion dehydration toilets (UDDTs) in Dondo and in Madjimane, Beira.

In 2000, some parts of Mozambique experienced major floods. In the district of Buzi, 4000 people were displaced because of floods. PAARSS was one of the first actors involved in the emergency support, since it had already been operating in the area.

In the immediate emergency phase, PAARSS constructed 16 emergency latrines using drums with a capacity of 210 litres. Subsequently, in the stabilised emergency phase, when the government decided to resettle the displaced people to a safer place (Guara-Guara), PAARSS was supporting the local government responsible for planning the future water supply in the resettlement.

Sanitation was a serious problem in Guara-Guara since the groundwater table in this region is high (less than 1.5 m below the surface) and thus the entire water supply originated from shallow wells. As a means to provide safe sanitation without contaminating the groundwater, PAARSS decided to implement UDDTs in the resettlement area, where pit latrines were considered to be a danger to public health.

During the planning and implementation phases, technicians from the provincial directorates and staff from district administration were trained in the principles of ecosan. Ten local artisans were identified and trained to produce urine diversion slabs and construct the infrastructure needed.

Along with the sensitisation promoted by the local radio station and a local theatre group, seven local activists were trained to disseminate the ecosan concept, to raise awareness, and to give long-term support to users. Their activities contributed to the active participation of the users, firstly by choosing the technology within the planning phase, secondly by providing material (sand and stones) within the implementation phase, and thereafter as the main actors responsible for the maintenance of the facilities.

The involvement and collaboration of the public sector, the private sector and the beneficiaries (users) allowed for a successful construction of 200 family toilets and 10 communal toilets. The acceptance of the technology by the local people encouraged UNICEF to continue the project, thus constructing 375 additional UDDTs in Guara-Guara (2004 to 2005), and therefore providing an adequate sanitation solution for the entire community (at a later stage, UNICEF built VIP latrines instead of UDDTs).

Fig. 4: Construction of a double vault UDDT in 2003; the two faeces vaults are visible at the front (source: M. Fogde, 2003).

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

Project update in March 2011:

In March 2011, Andrea Leitner visited this project site for one day (she was working for GIZ Mozambique, e-mail address: andrea.leitner_dedmoz@yahoo.de). She visited **six household toilets and two public toilets** built by PAARSS which corresponds to 1% of all household UDDTs and 20% of public UDDTs (see Appendix for more details). Hence, her survey was just a *small snapshot but gives some general ideas*.

Ms. Leitner talked with the people who knew of the toilets and with people involved in the project. Based on this information, we updated this case study. The original text of the case study which refers to the situation up to 2006 has mostly been left unchanged, and the new observations are added in each chapter after the heading *March 2011.*

The number of UDDTs built was reported to Ms. Leitner to be 663 in total, i.e. even more than stated in this document. Name lists of people that received a UDDT for their families were presented on demand. According to Mr. da Silva Beto (from Buzi administration) all actions and transactions were done from the capital Maputo. Also, the reports were prepared and archived there and are not available at the district administration.

According to the information given to Ms. Leitner, UNICEF built common VIP latrines instead of UDDTs in Phase 2. It is yet unclear why UNICEF decided on that particular toilet type, since it has been pointed out that pits are a threat for groundwater contamination in that area. Despite several attempts by the case study reviewers, no reply was received by UNICEF on this question[2].

Ms. Leitner formed the impression that a large proportion of all the UDDTs built were abandoned or dysfunctional. Instead, people were using pit latrines.

5 Technologies applied

The technology was chosen by the future toilet owners to whom three types of UDDTs were offered. The chosen and implemented technology was: ventilated double vault UDDT, with faeces vaults above the ground and with a shower cubicle.

This type of toilet works with one faeces chamber at a time. As soon as one chamber is filled up, it is sealed and the other one is used. The full chamber will dry for 6 months. Charcoal ash is added after each defecation event to accelerate the drying process of the excreta. The faeces vaults are emptied manually with the aid of buckets, plastic bags or other medium at hand.

A shower cubicle amendment was added, as requested by the users, since showering (using a bucket filled with water) is an important aspect of the local Ndau culture.

The shower water does not affect the drying chambers since the greywater and the urine are canalised separately and infiltrated into the ground. Thereafter, if not collected for reuse purposes, they are mixed and sunk into a drain.

Fig. 5: Inside a *new* UDDT; the faeces hole is covered with a lid; the urine separation part is fitted with a sieve. You can see the ventilation pipe at the back left (source: M. Fogde, 2003).

Fig. 6: Very dirty and not well maintained UDDT (inside), 8 years after construction. It seems that both faeces vaults are used at the same time. Note the two round wooden lids to cover the faeces holes (source: A. Leitner, 2011).

Fig. 7: A public UDDT in Guara-Guara 8 years after construction (source: A. Leitner, 2011).

[2] We have been unable to verify this exactly. Madeleine Fogde stated that UNICEF built also UDDTs in Phase 2.

6 Design information

The entire construction is made of both conventional material acquired in Beira (cement, uPVC pipes, zinc sheets, steel rods, chicken wire, and smaller components), and local material (gravel, stones, sticks, wood and water) provided by local masons and toilet owners.

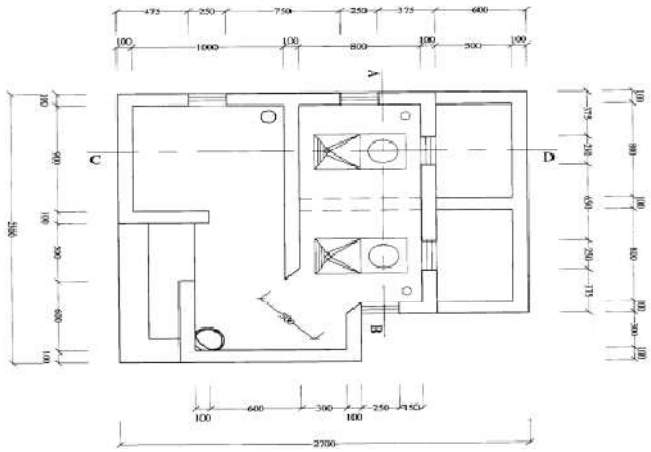

Fig. 8: Drawing of a household UDDT with a shower cubicle on the left (source: PAARSS).

Project update in March 2011:

Some construction shortcomings and maintenance failures have become apparent:

- Cracks in the walls of the faeces vaults, rainwater can enter.
- Rainwater entering through the gaps around the ventilation pipe at the roof.
- Cracks in the urine drain pipes, urine can enter faeces vaults.
- In some cases, the floor of the UDDT or shower cubicle was broken.
- The narrow doors and steep stairs leading into the UDDTs are not conducive for people with disabilities. According to Madeleine Fogde, the users never complained about this as they are generally skinny. The advantage of this arrangement is that no door is necessary (thus saving costs).

Since the faeces vaults of the UDDTs were built very large, it took a very long time for them to fill up. In 2006 when the intensive monitoring ended, i.e. 3 years after construction, the faeces vaults were still not full. By the time the faeces vaults finally filled up (some time after 2006), people did not know anymore how to empty the faeces vaults.

Fig. 9: Situation 8 years after construction: Left: walls of faeces vault with deep cracks. Right: bathing cubicle's concrete floor is broken (source: A. Leitner, 2011).

Fig. 10: The entrance to the UDDTs is very narrow (source A. Leitner, 2011).

7 Type and level of reuse

The main objective of the project was to introduce a sanitation technology that would protect the groundwater. So far, some cases of using dried faeces and urine for growing vegetables have been reported, but the reuse component of ecosan has not been actively promoted nor monitored by the project partners as it was not the main aim of the project.

The project implementers of the UDDTs report that synergies with agriculture projects for the reuse of urine and faecal matter were intended. Therefore, workshops, study visits etc. were provided for extension workers, agricultures engineers, local administrators, etc. in order to become familiar with the concept.

However, due to limited human resources for the supervision, the project could not be taken further and the overall success in terms of reuse was low. This was especially due to the fact that the particular region in Mozambique was hit by serious drought periods during the years 2003, 2004 and 2005, and therefore families were very vulnerable in terms of food security.

Since agricultural activity always requires rainfall, it was feared that urine would burn the crops in case the process was not adequately supervised. That would have been a disastrous thing to do, in the midst of a serious food shortage.

The main conclusion remains: in order to implement the agricultural reuse component of ecosan in an integrated manner, a proper project design and staffing is needed. As a pure WASH program, PAARSS had unfortunately no structure to implement the agricultural reuse component as well.

8 Further project components

In addition to sanitation facilities, PAARSS constructed six communal water points (hand pumps). Schools were also involved in the program as they are focal points where students can learn about hygiene and the potential of ecosan.

9 Costs and economics

The costs shown in Table 1 include both, Phase 1 by PAARSS and Phase 2 by the Department for Water and Sanitation (DAS)/UNICEF with PAARSS' remote advice. Unit costs are based on direct investment on infrastructure only. A cost breakdown for the UDDTs is not available.

The average total cost per double vault UDDT for households, financed by ADA and UNICEF, was **EUR 458**, although initially as much as EUR 1017 had been expected and calculated. Two important factors contributed to the lowering of the costs per unit. Firstly, economies of scale, due to buying large quantities of material, lowered the costs by 30%. Secondly, the involvement and contribution of future toilet owners lowered the costs by 25% (labour and construction material locally available).

Table 1: Total project costs financed by ADA and UNICEF (labour costs are most likely included).

Activity	Total EUR[a]	Beneficiary/users
575 family toilets (UDDT)	263,350	575 families (7 members per household), i.e. 4025 people
10 public toilets (UDDT)	7,120	Entire community of about 4000 people
Community education	15,250	Entire community
Consultancy	14,240	not applicable
Supervision	15,250	not applicable
Total	**315,210**	

[a] USD 1 = EUR 0.7468, exchange rate as of 1 August 2002

When converting the total project costs (EUR 315,210) by the number of users (4025 people), a value of about EUR 80 per user is derived. These costs are very high; however, the UDDTs built under this project were purposefully not built in the cheapest possible manner but in an impressive, beautiful and long-lasting style. This was done because the project wanted to show people (users, planners and engineers) what UDDTs can look like and make them into desirable objects. For this reason, they were also built at important places such as mosques. The UDDTs built under this project were the first UDDTs in the country.

Project update in March 2011:

There is no information regarding how the labour costs were calculated. Ms. Leitner was told that the total amount from ADA and PAARSS went to the implementing construction agency GATEAR. In this amount, labour costs were included. Subsequently, the selection was done through tenders. The distribution of funds was the responsibility of GATEAR.

10 Operation and maintenance

Each family signed a memorandum of understanding when requesting a UDDT. It is jointly agreed that the families have to contribute with labour and construction materials. After receiving the toilet, each family takes care of O&M measures such as checking the collected material, replacing ash, emptying, etc.

The trained activists thereby supervise the latrine owners. If the owners have technical problems, they contact the artisan responsible for the construction (this is happening in a free sanitation market and there is no more need for facilitation).

There are ten public toilets, four of which are located in schools. These are operated by teachers and school children who are taught how to use the toilets. Maintenance is organised in small groups and supervised by the school guard, who also benefits from the compost. Pupils bring charcoal ashes to school on a daily basis (for covering the faecal matter). The operation of the other public latrines follow the same rationale: people in charge of the functioning of a particular latrine are responsible to find a suitable management option for its maintenance. Accordingly, the latrines located close to a water point or within a market are operated by committees and local authorities are responsible for the latrine located within their headquarters.

Project update in March 2011:

It seems that maintenance was the biggest problem for keeping the UDDTs clean and usable. Despite the fact that all locals who were interviewed in March 2011, expressed their general satisfaction with the sanitation system built by PAARSS, the reality looked somewhat different (see photos provided here and in flickr photo database, link is in Section 13).

Only two out of six visited household UDDTs were still usable and well maintained 8 years after construction (i.e. one third). The other ones, including public UDDTs, were abandoned, also due to the fact that UNICEF sometimes built new VIP latrines just besides existing UDDTs for the same households.

There was no indication that any of the faeces vaults got emptied at one point in time. Rather, the vaults were sealed once they were full (this took a long time as the vaults are very big), since the users did apparently not know how to empty the vaults and what to do with the dried faeces. Therefore, reuse of UDDT end products did not occur, at least in most of the cases. It seems that especially the aspect of awareness creation failed, e.g. why the faeces holes should be closed with a lid, etc.

According to one local mason, one of the reasons why many UDDTs had deteriorated over time was that costs were too high for maintaining the UDDT. Apparently, good quality material to do the refurbishments is simply too expensive for the locals.

On the other hand, there is evidence that some people used their UDDTs properly: Two out of the visited household UDDTs were still in good condition. It would be useful to understand why some households continued to use their UDDTs while the majority did not (more monitoring needed).

Fig. 11: Discussions about the current state of the UDDTs. This UDDT is no longer in use, note empty faeces vaults and the vault cover on the ground (source: A. Leitner, 2011).

11 Practical experience and lessons learnt

The practical experiences listed here are based on information up until 2006 (see also the mid-term report of Borowczak and Parkinson (2005) in Section 13). In 2006, the PAARSS project was rated to be very successful.

Guara-Guara was the first location in Mozambique where UDDTs got implemented at a reasonable scale. When PAARSS first introduced UDDTs in the Dondo Municipality, most professionals from different sectors, including those from the water sector, were very cynical and rather negative regarding its acceptance among rural citizens. However, after Guara-Guara, they changed completely their views and the cynicism vanished.

Hence, the technology is by now well accepted by the local community and decision makers as a durable and long lasting investment, despite initial worries about cultural conflicts and costs. Today, UDDTs are recommended by Mozambique's national guidelines when the groundwater level is less than 1.5 metres from the surface[3].

The UDDT technology solves problems of sanitation in adverse hydro-geological conditions and protects the environment. Furthermore, the technology enables the reuse of sanitised urine and faeces, which could further add agricultural and economical benefits to the community.

Users should be involved in the choice of the sanitation technology and structure design, as community participation in such decisions contributes to appropriate use and maintenance, due to better knowledge of the technology and increased ownership.

Even in post-emergency situations, project cost sharing amongst beneficiaries is possible. Community participation in project implementation reduced the unit cost by a factor of 25%, allowing the project to reach out for more people than initially planned.

The technology has been applied by other local initiatives in the area of Guara-Guara as well as in other towns or districts:

- UNICEF constructed 375 additional UDDTs in Guara-Guara, 43 in Marromeu, and 50 in Beira[4]. In regards of Beira, the same community as the one where PAARSS started its interventions has been served. In total, there are now 575 UDDTs in Guara-Guara.
- Mozambican Red Cross constructed 12 UDDTs in Nhamatanda district and Beira.
- Rotary Club of Beira constructed 4 toilets in Beira and constructed 4 new ones in Mussassa primary school. These are twin houses with shared toilets but separate showers (for more information, please see Borowczak and Parkinson (2005), p. 31 and 33 (see Section 13)).

In 2006 it was estimated that there are about 5200 users of UDDTs in the entire Sofala Province.

Fig. 12: Household UDDT in good condition, 8 years after construction; note metal faeces vault covers are still in place (source: A. Leitner, 2011).

Project update in March 2011:

It appears that awareness creation was neither sufficient nor sustainable. Most of the locals simply do not know the advantages of UDDTs and what to do with the end products. Successful long-term awareness creation and understanding for the UDDT system was furthermore constrained by the

[3] We have been unable to obtain a copy of these guidelines, it is not totally clear if they really exist. According to Ms. Leitner: "*None of the local authorities could provide concrete information on this. Since in Phase 2 UNICEF together with the government decided to build VIP latrines instead of UDDTs, it is doubtful that UDDTs have become a national standard and got incorporated in the national strategy*".

[4] We tried to verify this in March 2011 but have been unable to do so, since UNICEF did not reply yet.

change of technology: from UDDTs in Phase 1 (PAARSS) to VIP latrines in Phase 2 (UNICEF). One can assume that this led to confusion amongst users and stakeholders.

Another important lesson is that faeces vaults should be designed to fill up after only one year so that the users get into the routine of emptying one faeces vault each year.

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[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] During the time of project implementation, local communities did not implement reuse (see Section 7 for details).

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 expected long term impacts are to continuously provide safe water and sanitation services in a resettlement area characterised by high water tables. Thus, the major goals of the project were to protect human health and consequently the environment which has been achieved.

However, the UDDTs were very expensive, thus spontaneous replication without outside financial support has hardly occurred. Some water technicians and administrators have apparently constructed UDDTs on their own initiative.

This pilot project had impacts that go beyond Guara-Guara alone, since it was well publicised and well documented in many publications and helped spread awareness about ecosan in Mozambique and the region. The central government is currently mainly pursuing CLTS (community-led total sanitation) for the rural areas with assistance by UNICEF, but UDDTs are also part of national strategies.

Project update in March 2011:

Visits to the project areas after 2006 by one of the authors, Luis Macario, have led to the estimate that about 80% of the families continue to use the UDDTs. Nearly 5% of the households and UDDTs are abandoned, and the other 5% are used in a very seasonal form (farmers whose fields are far away from Guara-Guara and people who got jobs in Búzi Town or elsewhere).

With respect to the percentage of UDDTs still in use, a rough estimate by Ms. Leitner came to a maximum of only 30%. This indicates that this project was not a failure, but that certain shortcomings – especially regarding awareness creation and ongoing monitoring and support – severely limited the *long-term* success of the project.

13 Available documents and references

More photos from this project are available in the flickr photo collection of SuSanA and GIZ: http://www.flickr.com/photos/gtzecosan/sets/72157625791958930/

Until 2006, this project was documented with many publications (but no reports are available since then):

- Anonymous (2003) Austria: A case study on commitments-related best practice or lessons learnt in water, http://www.un.org/esa/sustdev/csd/csd13/casestudies/case/caseaustria.pdf
- Borowczak, W., Parkinson, J. (2005) Project for rural water supply and sanitation in the province of Sofala / Mozambique- PAARSS (2003-01/03), Austrian Development Agency (ADA), Mid-term review, Final Report Version 2.1, 10.10.2005, http://www.entwicklung.at/uploads/media/4.1.8._ADA__Mid_Term_Review_PAARSS_10_2005.pdf
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- Jung, H. (2006) The new Water Sector Policy of Austrian Development Cooperation, ADC and its local implementation, A presentation at the Water Forum in Mexico explaining PAARSS, http://www.worldwaterforum4.org.mx/sessions/FT3_48/The%20new%20Water%20Sector%20Policy%20of%20Austrian%20Development%20Cooperation,%20ADC%20%20and%20it%E2%80%99s%20local%20implementation.pdf

- Macario, L. (2005) Ecological sanitation in Guara-Guara, Third International Conference on Ecological Sanitation, Durban, South Africa, http://conference2005.ecosan.org/presentations/macario.pdf
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- Manndorff, H., Noest, B., Reiter, W., Dos Santos Jose, E. (2004) Evaluation of the Country Programme Mozambique of the Austrian Development Cooperation, Final Report by L&R Sozialforschung, Vienna, Austria, 28 July 2004, www.oecd.org/dataoecd/56/26/35125045.pdf
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14 Institutions, organisations and contact persons

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Mr Bulaunde – local Watsan specialist based in Guara-Guara, working for the District Government (mobile: +258 825873510)

[5] DAS is the government institution responsible for the implementation of all water and sanitation activities in the Sofala province with 10 districts. PAARSS was a support project to this institution, with funding for implementation of infrastructure in 5 districts (one of them was Buzi where Guara-Guara is located).

Case study of SuSanA projects

Household UDDTs in flood-response resettlement project Guara-Guara, Sofala province, Mozambique

SuSanA 2011

Authors: Madeleine Fogde (EcoSanRes –SEI), Luís Macário (WSP Mozambique), Juliana A. Porsani (EcoSanRes – SEI).

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www.susana.org

Appendix: Details of the 1-day visit of Andrea Leitner

Places visited
District: Buzi
Town: Buzi
Met with: Sr. Beto Fernando da Silva (administration Buzi), construction technician during Phase 1 (PAARSS 2002-2003) via the company GATEAR.
Visited 3 household toilets (3 x PAARSS), and spoke to several household members.

Town: Guara-Guara
Met with: Sr. Simao dos Santos Pita (administration Guara-Guara), Sra Belia Frederico (administration Guara-Guara), Sr. Fernando Hoyo-Hoyo (union leader and mason of Phase 2 (UNICEF- pit latrines))
Visited 3 household toilets (2 x PAARSS, 1 x UNICEF), and spoke to several household members; 3 public toilets (2 x PAARSS, 1 x UNICEF).

Case study of sustainable sanitation projects

Otji-Toilets for peri-urban informal households Omaruru, Namibia (draft)

Fig. 1: Project location.

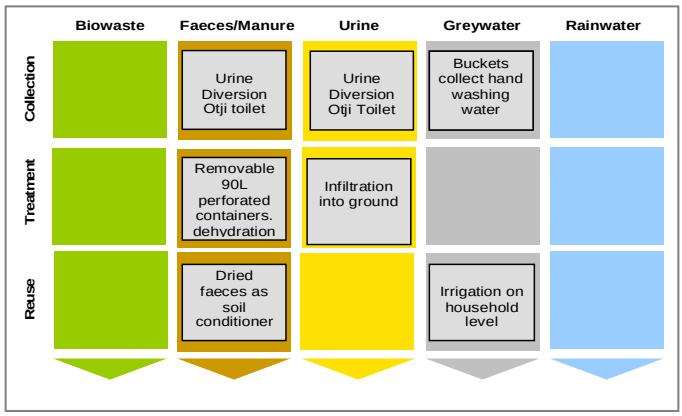

Fig. 2: Applied sanitation components in this project, Otji-Toilets work like UDDTs

1 General data

Type of project:
Pilot scale urine diversion dehydration toilets for peri-urban informal households

Project period:
Construction period: Dec. 2010
Start of operation: Dec. 2010

Project scale:
Number of dry toilets: 21
Number of inhabitants covered: approx. 140
Total investment: EUR 17,000

Address of Project Location:
Hakahana, Omrauru, Namibia

Planning institution:
Namibian Water Resource Management – Deutsche Gesellschaft für International Zusammenarbeit (GIZ)
Wilhelm Zeraua Rd, Old Rossing Foundation Building, Omaruru, Namibia

Executing institution:
Namibian Water Resource Management – Deutsche Gesellschaft für International Zusammenarbeit (GIZ) & Omaruru Basin Management Committee (OmBmc)

Support institutions:
German Federal Ministry of of Economic Cooperation and Development (BMZ)

2 Objective and motivation of the project

As Namibia is the driest country in southern Africa, a national toilet system sustained by fresh water is not sustainable in the long run. To provide access to safe, affordable sanitation for all Namibians, it is essential to consider dry sanitation as proactive measure to water shortages and as a way to save precious water resources in the wake of climate change. Not only do dry toilets save water and thus facilitate drought adaptation strategies; ideally, they also produce fertiliser to sustain crops and can thus effectively eliminate the need to dispose of human waste via a centralized sewage system.

Against this background, the Omaruru Basin Management Committee decided to pilot 21 Otji-toilets in Omaruru (Fig.3). People living in the project area have no access to safe sanitation. Especially, for women and children, the traditional way of “going to the bush” is dangerous. During the rainy seasons, water related health problems such as diarrhoea are increasing. The project was planned as a pilot study to show that dehydration toilets with urine infiltration are an appropriate sanitation solution for the informal settlements of Omaruru, Namibia.

Fig. 3: Otji-toilet with attached hand washing basin (source: GIZ, Kleemann, 2011)

The name Otji-Toilet is only used in Namibia, where it has been introduced as a product name. Moreover the name is well-known in Namibia. Technically speaking it is a urine diversion dehydration toilet (UDDT).

Otji-Toilets for peri-urban informal households Omaruru, Namibia (draft)

3 Location and conditions

Omaruru lies about 200km northwest of Namibia's capital city Windhoek, on an altitude of 1200m above sea level, in the Erongo region. The climate in the area is arid with a yearly precipitation of 280mm in average (Omaruru municipality, 2010). Depth of ground water table?

Omaruru has about 12,000 inhabitants. The population lives spatially separated in the town of Omaruru (2,000 inhabitants), and the partly informal settlements of Hakahana (6,000 inhabitants) and Ozondje (4,000 inhabitants). The project area is located on the edge of Hakahana and can be describes as informal and peri-urban.

Many people live in self built shacks made from scrap metal and wood, some buildings are also made from bricks. Drinking water is provided through taps. Depending on the location of their house, people have to walk up to 300m to get water. Sanitation facilities are not available in this area. For the people living in the town, sanitation is provided through septic tanks, suction trucks and oxidation ponds.

Farming and tourism are the main economic factors in Omaruru. Due to the Omaruru river the water level is quite high and vegetation is relatively dense. About 30% of the population are unemployed (Omaruru municipality, 2010). Socio-cultural conditions are diverse. Most of the white population, from different origin live in the town. The majority of the black population consider themselves as Ovambo. Beside that, mostly Herero and Damara people live in Omaruru.

In 2009 the under-five child mortality rate was 48 children per 1000 in Namibia, and is has been decreasing during the last twenty years[1].

4 Project history

The need for proper sanitation was raised at one of the Omaruru Basin Management Committee (OmBMC) Meetings in the beginning of 2010. Members of the OmBMC travelled to the Clay House Project (CHP) in Otjiwarongo, a town 100km from Omaruru, to learn about the construction of dry toilets and to have a look at examples in town which were already built and in use.

The Clay House Project (CHP) is a non-governmental organisation, based in Otjiwarongo in Namibia. Its overall aim is to promote environmental and socially sustainable development. The European Community is currently funding this project which aims to promote the building of 600 Otji-Toilets in Otjiwarongo and all over Namibia. The funding started in February 2008 and runs to the end of 2011.

During this exposure trip GIZ gave a presentation on different sanitation options and discussed with the members the most feasible options. The Otji toilet which were first developed in 2003 in Namibia and have had approximately 1200 installations[2] across Namibia was the example shown in the exposure visit.

The selection of the pilot project area and beneficiaries was based on a rapid baseline survey including a demand assessment as well as a movie show of the toilet system conducted by the OmBMC in cooperation with GIZ. In the area water is limited and has to be carried up to 300m from taps. There are no sewers and no cesspools in the area which could be used for flush toilets. Beneficiaries were selected on a "first pay first served" basis and in coordination with the ongoing formalisation process of the Omaruru Municipality.

The pilot project construction of 21 toilets was finalised by the end of 2010. Since then, the toilets were maintained by the owners. An awareness campaign for a period of one week was conducted to further promote the toilets and to highlight the importance of washing hands after using the toilets. After the dry toilets have been in use for about 3 month GIZ and the OmBMC carried out a small survey in order to assess the satisfaction among toilet users. All users were happy to have a toilet!

At the moment 21 toilets, which were built during the pilot project, are used in Omaruru. The OmBMC has evidence for a demand of additional 100 toilets. Until now, however, funds for additional toilets have not been approved from the Municipality and the Regional Council.

Future

The future of the applied sanitation system in Omaruru is highly dependent on the political decisions made. It turned out, that although the system proved to be appropriate, there is still a tendency towards water based sanitation systems. A major challenge will therefore be, to persuade and consult the responsible decision makers. Apart from that, the OmBMC will further raise awareness also among farmers and in the tourism sector.

Depending on the further development of the project in Hakahana a strategy for the reuse of the sanitation products will be developed. Persons were identified, which would be willing to empty the toilets. GIZ is working on a public private partnership (PPP) strategy. The objective is to support a local business in establishing a production scheme of the otji-toilets in the area.

5 Technologies applied

The Otji-toilet is based on dehydration and was considered especially suitable for a region with intense solar radiation and low precipitation.

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childmortality.org and http://www.childinfo.org/).

[2] Since the development of the Otji-Toilet in 2003 about 1.200 Otji-Toilets have been installed nationwide across Namibia as well about 100 self builder sets have been sold. The breakdown of where the 1200 Otji-Toilets were installed is as follows; 600 for an EU-Toilet-Programme; 83 for an EU housing programme; the Municipality Otjiwarongo bought 100 in connection with the development of Erven where the CHP have built clay houses. The Municipality paid for the toilets which where built inside the houses (solar ventilated inside the toilets). The Municipality of Outjo bought 200 and Aranos bought 40 Self-Builder-Sets. The Oshikoto Region bought 49 Otji-Toilets and the City of Windhoek 57. Other customers included NGOs (for example: the Desert Research Foundation of Namibia (DRFN)), Farmers and Safari Lodges (for staff and camp sites). In future the CHP is going to be promoting more the Self-Builder-Set so as to encourage local builders to create a job opportunity for themselves.

Otji-Toilets for peri-urban informal households Omaruru, Namibia (draft)

The functional plan (Fig. 5) shows the main features of the Otji-toilet. The ventilation and dehydration is driven by the sun. Therefore, the “back” of the toilet is always oriented strictly north (southern hemisphere). Air then circulates through the toilet into the drying area and out through the ventilation pipe, which makes the toilet odourless. The collecting bucket (90 liter container) is situated under the toilet bowl and moved to the drying area when full. The bucket with the dried faeces is emptied and moved beneath the toilet bowl. It is estimated, that four people can use one container for about 6 month.

The toilet bowl is designed in such a way, that fluids touching the wall of the bowl are collected in a small chute and can be drained away through a pipe and separately infiltrates it into the ground (Fig. 4). No problems of blockages of the collection chute or the urine pipe, which is 20mm in diameter, have been reported.

Fig. 4: Cross section of urine diversion bowl (left) where urine collects in the little trough at the bottom as demonstrated in urine diversion bowl (right) (source: CHP, 2009)

However the urine could also be collected in containers and stored for reuse. The faeces are collected in a 90 litre container which is perforated. Faeces and paper stay in the container, whereas liquid infiltrates into the ground. Thereby, dehydration is more effective. Some users have indicated that they use ash to cover the faeces after defecation, but this is not widely practiced at the moment. As the pilot project finished only about four month ago, no containers had to be emptied until now.

There is a potential for reuse as many of the toilet owners or their neighbours have a small garden on their compound. However, not all of them can imagine using urine or dried faeces as a fertiliser. The oxidation ponds of the Municipality are not far away and could be used to properly dispose material, which cannot be reused.

The toilets were built by teams of members of the CHP in Otjiwarongo and locally available labour from Omaruru. Except for the brick construction, the toilets were prefabricated in Otjiwarongo and delivered as “self building sets”. The team of the CHP was important to ensure the proper construction of the toilets and to train local labour for possible future projects. In some cases, the beneficiaries contributed to the construction of the toilet (digging, painting).

There are no rights reserved on the technology, in figure 5, of the Otji-Toilet nor on the name. However the Urine Diversion System (UDS)-Bowl is a registered patent in South Africa and Namibia. The UDS-bowl was developed at the end of 2008. Since the beginning of 2009 a number of propotypes have been in use at the Clay House Project compound in Otjiwarongo, Namibia. Since 2010 about 100 units have been installed at different places nationwide in Namibia. The most are installations are in Windhoek with 57 units.

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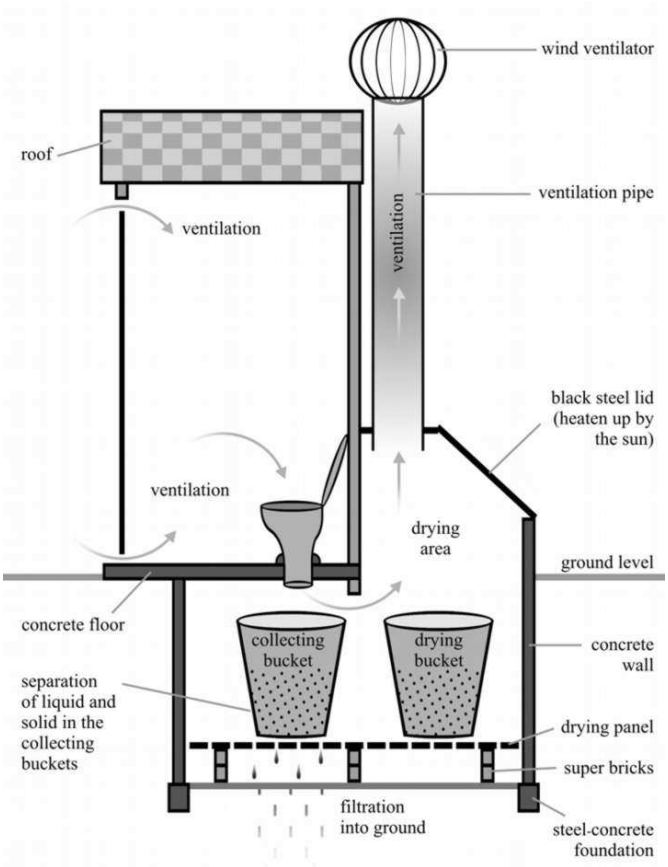

Fig. 5: Functional plan of the Otji-toilet without urine diversion bowl (source: CHP, 2009)

6 Design information

Basic design parameters

The project was initiated, following the urgent need of sanitation facilities in the poor areas of the informal settlements of Omaruru. Furthermore, the project was designed to show the advantages of dry sanitation systems, especially, in arid regions such as Namibia. The aim of the project was also to involve the local authorities in such a way, that they can implement sanitation facilities in the future based on the findings of the pilot study.

Assumptions

The Otji-toilet was considered an appropriate solution for the project area. As water supply and other relevant infrastructure is limited, dry sanitation was favoured. Furthermore, water saving was considered crucial when designing new sanitation facilities.

Applied design and construction method

As experience in the design and construction was available from the CHP, there were no changes required. The prefabrication in at the CHP is based on empowerment of local communities and low technology. Toilets are designed to work with a minimum of maintenance. Except for the toilet bowl, all toilet parts are made in Otjiwarongo. Once the toilets are built no further investments are necessary as the

emptying can be done by household members or locally available labour.

Construction material used
As mentioned above the toilets were partly prefabricated by the CHP. The most important parts were made from metal (lid box, door, doorframe, roof structure, ventilation pipe, steel foundation ring) and concrete (dry plates, floor plates, side plates for lid box). Apart from that, the toilet bowl was delivered through the CHP and material such as screws, nuts silicon and wire were used. For the toilet house, bricks, cement and sand were used. The roof tiles were also fabricated by the CHP and designed to keep the toilet cool compared to the drying chamber.

Further information, including the self building manual of the CHP are available under: http://home.arcor.de/clayhouse/

7 Type and level of reuse

The level of reuse of this project is yet to be demonstrated, as the system has not been in use for long.

However, there are certain design parameters of the toilet which indicate the focus on providing save sanitation rather than reusing its products. In the following, reuse possibilities are outlined.

Urine
The toilets currently used in Omaruru all infiltrate the urine into the ground. It remains unused.

However, urine can be easily collected through the urine diversion bowl and an attached container at the end of the pipe. Then it can be used as fertiliser. Therefore, awareness raising among the population and trainings are necessary.

Faeces
The dried faeces can be used as soil amendment or can be co-composted with other biodegradable material. On a small scale the material can easily be used on the compound of the households. Some of the users can imagine using the material, others are reluctant. Again, awareness raising among the population and trainings are necessary.

Greywater
Water from the attached handwashing facilities is collected and used for irrigating gardens. Most people use the greywater on their compound and often is directly applied to water plants..

8 Further project components

In addition to the construction of the toilets basic handwashing facilities were attached (Fig. 6) to the toilets with a handwashing instruction. To raise awareness among the population a dry-toilet and handwashing campaign was initiated.

Fig. 6: Basic handwashing facilities attached to the toilets. The pink bucket provides fresh water, the cup is used to fill the basin and the black bucket collects the greywater which can be used for irrigation (source: GIZ, Kleemann, 2011).

The GIZ and the OmBMC are currently trying to upscale the project. There is demand for about 100 additional toilets.

To make the project financially sustainable the funding for additional toilets should come from the Municipality of Omaruru or Namibian Ministries as a general service provision. Additionally, GIZ works on a concept to support the application for funds from the national government.

As already mentioned, the establishment of a PPP is planned within the GIZ resulting in a local producer for otji-toilets and lower prices for the toilet.

A relaunch of the awareness raising campaign on dry toilets and sanitation is planned, as well as trainings on reuse.

9 Costs and economics

One Otji-toilet costs about EUR 776, which makes it an unaffordable commodity for the people living in the target area. Costs for the toilets of the pilot project were covered by the German Federal Ministry of Economic Cooperation and Development (BMZ). Beneficiaries contributed a minor part of EUR 15 to the toilet. The contribution served as a “registration fee” and was important to create a feeling of ownership to secure that people look after the toilets and maintain them well.

Operation and Maintenance costs are very low. Once the construction is finished, the toilet can be used. With four people using one toilet, it takes about six month for the 90l container to fill up. After the first year of operation, the container with the dried out faecal matter has to be emptied every six moth depending on the number of people using the toilet. If a toilet needs to be emptied twice a year.

Table 1: Costs for the material, labour and transport needed to construct a Otji-toilet (source: CHP, 2009).

Cost break-down:	Price in EUR
Lid box	61
ventilation pipe	27
door	56
door frame	20
steel roof structure	28
foundation steel ring	20

roof tiles (cool tiles)	9
urine separation toilet bowl	60
pipes and fittings	15
perforated 90l container	45
side plates	20
dry plates 70 x 70	15
floor plate	14
silicon, wire, etc.	5
superbricks	96
cement bag	24
Sand m^3	10
paint l	29
Total materials costs	**554**
Estimated labor and transport Costs	**222**
Total Costs	**776**

Obviously the transport costs are dependent on the distance from the place where the toilets are currently prefabricated (in this case Otjiwarongo, about 140km).

Because the toilets are custom-made by the CHP and many parts are especially produced for the toilets, it was not possible to compare with market prices. With the establishment of a local producer through a PPP, it might, however, be possible to lower the prices.

10 Operation and maintenance

When investigating the toilets three month after the construction, all of them were in use and well maintained. Most owners also lock their toilets when they are not around.
Until now no maintenance, was necessary, except for regular cleaning of the toilet bowl, as none of the containers were full. Some toilet users indicated that they will empty their toilet on their own and use the material on their compound as fertiliser or bury it. As there are only a few toilets existing until now, it seems reasonable to engage one or two persons willing and able to undertake the emptying.

One possibility for the Municipality to meet its obligation of providing general service to the people would be to instruct someone within the Municipality to collect the material and bring it either to the nearby oxidation ponds or the local dumpsite or to supply it to a local gardener.

Another possibility would be to contract someone who is familiar with the operation and maintenance of the toilets to collect the material. This person would need to be able to transport the material whenever necessary. Ideally, a second person would be available to step in. For transport a pickup car would be ideal. Because the number of toilets is yet relatively low, also a wheelbarrow or a donkey cart could serve the purpose for the beginning. It is important to brief the contracted person of where to dump the material.

The payment for the emptying could be established informally but should in the long run be covered by the municipality and financed through waste collection fees or water charges. If toilet owners would charge for the use of their toilets, emptying cost could also be covered. On a household level that seems not likely as many people do not want other people to use “their” toilet. For small pubs (“shebeens”), however, that could be a good solution

11 Practical experience and lessons learnt

The Otji-toilet is an appropriate technology for the conditions of the project area. It is independent from other infrastructure and can be built almost everywhere.

From a financial point of view, the contribution of the beneficiaries seems very low. However, to reach the poorest among the population, there is the need of highly subsides will facilities, as they will not save money to get a toilet in the first place. In the future, the toilets should be built with local money as part of the general service for the inhabitants of a settlement.

The acceptance of the toilets is high, which is not surprising, as people who were without sanitation facilities now have one, and appreciate it. There are also many of the users who are especially happy to have a dry system, as they do not have to pay for water.

The small scale of the project makes it difficult to establish a reuse scheme other than the use on household level.
A main issue is the difficulty to persuade decision makers of the appropriateness of the system. There are many people who still favour water based sanitation. Also some users are keen to have a flush toilet. It is important to remember, however, that many people cannot afford water for the toilets. Without the support of decision makers it will not be possible to establish a dry sanitation system on a large scale. As the price level in Namibia is quite high the toilets are not affordable for the poor.

The pilot project was, however, very important to persuade some decision makers and people of the appropriateness of the technology.

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	

Otji-Toilets for peri-urban informal households Omaruru, Namibia (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 www.susana.org: 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 is to provide relevant information for decision makers and to persuade them about the necessity of saving water by introducing appropriate sanitation systems. Furthermore, improved public health and safety, especially for women and children are key aspects of the project.

13 Available documents and references

More photos:
http://www.flickr.com/photos/gtzecosan/sets/72157626328329107/

CHP – Clay House Project (2009): Dry toilet systems, http://home.arcor.de/clayhouse/

CHP – Youtube Video: http://www.youtube.com/watch?v=mRXFSAdImgA

CHP – Clay House Project (2009): The Otji-Toilet: self builder manual, http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=916

CHP – Clay House Project (2009): The Otji-Toilet, http://susana.org/lang-en/library?view=ccbktypeitem&type=2&id=915

Omaruru Municipality (2009): Omaruru Town Profile.

14 Institutions, organisations and contact persons

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Case study of SuSanA projects

Otji-Toilets for peri-urban informal households in Omaruru, Namibia

SuSanA 2011

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Case Study of Sustainable Sanitation Projects

Urine diversion dehydration toilets in rural schools
Huye and Ngororero Districts, Rwanda

Fig. 1: Project location (country shown in circle)

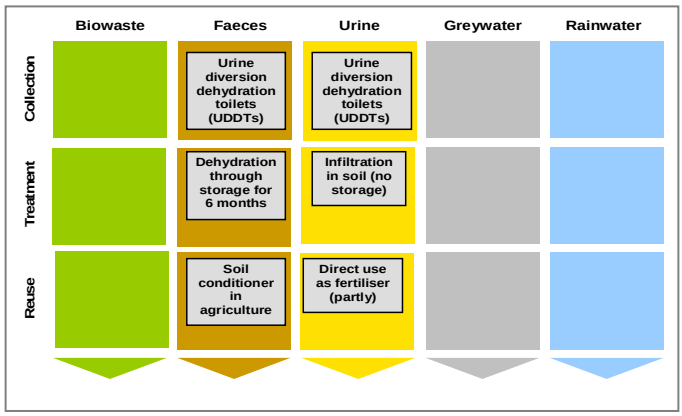

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Demonstration project at rural schools

Project period:
Start of Planning: Nov. 2006
Start of construction: Jan. 2007
End of construction: March 2007
Start of operation: July 2007
Project end: April 2007 (end of GTZ-Rwanda project, but toilets are still in use)

Project scale:
Target group: 2800 Pupils in 2 rural districts of Rwanda (Huye and Ngororero)
24 UDDTs built in two primary schools: in Kiruhura (Huye District) and Kiziguroro (Ngororero District)
Total investment: EUR 19,200

Address of project location:
Kiruhura Primary School Huye District, Western Province, Rwanda
Kiziguro Primary School, Ngororero District, Southern Province, Rwanda

Planning Institution:
German Technical Cooperation (GTZ), Programme on Health Cooperation, Rwanda
School of Public Health (ESP), part of the National University of Rwanda, Kigali, Rwanda

Executing Institutions:
GTZ-Rwanda (Program "Health Cooperation") and DED (German Development Services)

Supporting Agency:
GTZ-Rwanda and GTZ program "Disease Control and Health Promotion" on behalf of German Federal Ministry for Economic Cooperation and Development (BMZ)
Further supporting partners: Christoffel Blindenmission (CBM, Germany), Population Services International (PSI), Foundation for Water and Sanitation (FEA, Rwanda)

2 Objective and motivation of the project

The overall objective of this demonstration project (which was a component of a much larger project led by GIZ-Rwanda called Health Cooperation) was to:

- Build urine diversion dehydration toilets (UDDTs) as a pilot and demonstration project to test the new concept of ecosan (ecological sanitation) with UDDTs in rural primary schools and provide a healthy school environment.
- Assess the scope and reduce the burden of disease for rural primary school children in a resource-poor environment through cost-effective and sustainable school health interventions.
- Sensitise and train pupils and teachers by using skill based behaviour change towards good practice of hygiene at school.

3 Location and conditions

The school health intervention project was undertaken in four rural schools located in the districts of Huye of Southern Province and Ngororero of Western Province (see map in Fig. 4). Whilst four schools were covered in the project, only two of them received UDDTs and these two schools are the focus of this document.

Fig. 3: The photo shows Kiruhura primary school classrooms. It was the holiday period, so only the headmaster was there. All photos in this document taken by: E. Dusingizumuremyi, Nov. 2009.

Urine diversion dehydration toilets in rural schools Huye and Ngororero Districts, Rwanda

Rwanda is a small landlocked country situated in the Great Lakes Region, covering an area of 26,338 km^2. Based on the administrative reforms in 2005, the country is now divided into five regions/provinces with 33 administrative districts.

The population of Rwanda was 9.31 million in 2008. The under five mortality rate caused by diarrhoea is 11.3% which makes this sanitation-related disease the 3rd biggest killer of children under five after malaria and pulmonary infections[1]. In Rwanda, the under-five child mortality rate is currently **112 children per 1000**, which is very high but at least there is currently a downward trend towards fewer child deaths[2].

The annual rainfall varies from 700 mm in the eastern plateau, to between 1200 mm and 1400 mm in the central plateau. This good rainfall is a sign that rainwater harvesting has potential in the country as a water resource including for schools. Rwanda has a moderate climate with an average temperature of 18°C.

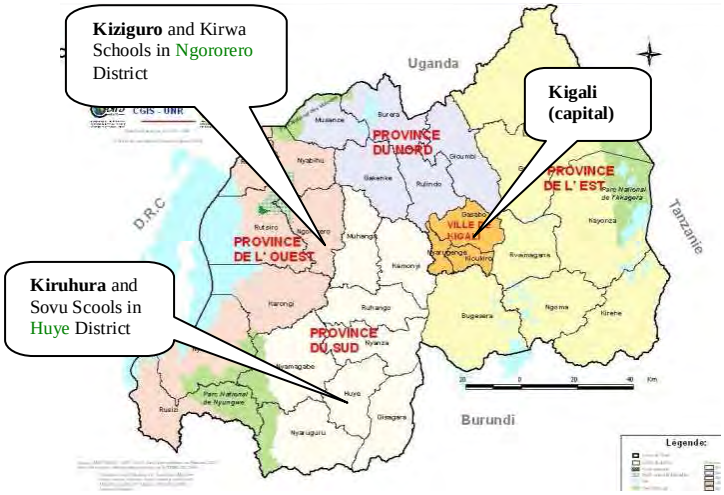

Fig. 4: Map of Rwanda, showing the location of the four schools covered by the project; in bold the two schools with UDDTs. Distance from East to West of the country: approx. 150 km (source: http://cgisnur.org/maps_admin.php3).

Generally, the sanitation infrastructure in rural districts, including school sanitation, is under the supervision of the districts due to Rwanda's decentralisation policy. The district has personnel in charge of health, education and social affairs. This unit is coordinated by the social development coordinator. At the national level, there are three ministries which are concerned with public health, child-friendly school environment and adequate sanitation infrastructure. Those ministries are the ministry of health, ministry of education and the ministry of infrastructure, respectively.

With a population density of 329 people/km^2, Rwanda is one of the most densely populated countries in the world (similar value to the Netherlands and India). The fertility rate of women is 5.8, and a very high percentage of 49% is under 15 years of age.

Rwandan education policy is emphasising primary school education for all, where all Rwandans will have free access to 9 years universal primary education starting from February 2010. But inadequate sanitation and poor hygienic conditions at schools result in high drop-out rates due to illness.

4 Project history

The work of the German-Rwandan Health Program[3] under the title "Intersectoral cooperation for school health" consisted of two phases: (i) situation analysis and (ii) implementation of action plan. The situation analysis consisted of definition of target groups and responsibilities as well as conducting school surveys.

There were five partners in this project which was called "School health initiative":

1. GIZ-Rwanda (under the program called "Health Cooperation") in collaboration with DED provided technical support and funding.
2. The School of Public Health (ESP), part of the National University of Rwanda, was the implementing partner of the baseline assessment including a knowledge, attitude and practice survey, medical check-ups and deworming campaigns.
3. Christoffel Blindenmission[4] financed and executed the eye treatment as well as the eye survey.
4. The leading global health organisation "Population Services International" (PSI) was in charge of sensitisation[5] of teachers, pupils and parents as well as the distribution of Sur Eau for clean drinking water.
5. The organisation "Fond de l'Eau et Assainissement" (FEA, Foundation for Water and Sanitation)[6] was in charge of construction of water and sanitation facilities and the sensitisation of pupils and teachers.

The four rural primary schools to be included in the project were selected from two rural districts (Ngororero and Huye District):

- **Kiziguro** obtained a rain water harvesting tank of 10 m^3, 12 UDDTs and 10 handwashing facilities.
- **Kiruhura** (assisted by Rheinland Pfalz Partnership in terms of classroom construction) received 12 UDDTs and 10 handwashing facilities.
- **Kirwa** (assisted by UNICEF) obtained only 10 hand washing facilities.
- **Sovu** (assisted by Concern International in terms of classroom construction) received a water tank (5 m^3) and 10 handwashing facilities.

[1] Ministry of Health (2008 and 2009), see Section 13 for details

[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/).

[3] The activities of GTZ in Rwanda are described here: http://www.gtz.de/en/weltweit/afrika/595.htm. Partners are Ministry of Health and Ministry of Education for the school health initiative.

[4] A German NGO which supports in particular projects for handicapped people in developing countries (http://www.christoffel-blindenmission.de/index.html)

[5] http://www.psi.org/where-we-work/countries/rwanda

[6] **FEA** started in Rwanda in 1983 as an NGO funded by the Austrian Government. It is now a joint project funded by the European Union, Austrian and Rwandan governments. FEA's objective is to reinforce the existing local technical capacities in the planning, implementation, maintenance and management of water and sanitation facilities. FEA has vast experience in building sanitation and water facilities in schools, hospitals and other environments in Rwanda, Uganda and Kenya.

Urine diversion dehydration toilets in rural schools Huye and Ngororero Districts, Rwanda

During the baseline study[7] conducted by GIZ-Rwanda from November 2006 to February 2007, almost 2,000 students in these four primary schools were examined, including rapid anamnesis and clinical check up, eye and stool examinations as well as a number of knowledge, attitude and practice questions. The study aimed at supporting existing school health programs and initiatives at the national level.

Normally, the age range in primary schools in Rwanda is 6 to 12 years because primary school starts at the age of 6 after 3 years of nursery school. But due to the Rwandan policy of education for all, older pupils are also allowed to attend primary schools in Rwanda.

The baseline study found that frequent diseases of the pupils were: fever/malaria, stomach problems like abdominal pain or diarrhoea, flu/cold and respiratory diseases. All the diseases mentioned above can be prevented or reduced through the provision of adequate sanitation and hygienic conditions at the school (and at home, although this was not part of this project).

The baseline study also revealed that about 7% of girls have their menstruation periods and 17% of them miss school sometimes during their menstruation days due to lack of separate and adequate sanitary infrastructure.

About 85% of children use the school toilets on a daily basis while others do not use them because of long queues or filthy toilets (students prefer to urinate and defecate in the surrounding bushes). The pit latrines at all schools were unhygienic and their maintenance was a problem. About 97% of children's families have pit latrines at home and 3% have no latrines at all.

The construction of UDDTs, provision of handwashing facilities and installation of water tanks took place in **January to March 2007**. Deworming and eye treatment was also carried out at the same time. The construction of UDDTs was followed by sensitisation at all schools in collaboration with PSI. The operation of UDDTs in the two schools of Kiruhura and Kiziguro started in July 2007 (see Paul (2007b) for an initial assessment of the UDDTs).

Fig. 5: Toilet block with 10 single vault UDDTs at **Kiruhura** Primary School (teachers have another 2 UDDTs built separately). Five cubicles are for boys, five for girls[8].

[7] Paul (2007a), see Section 13 for details

[8] It is normally advisable to separate the entrances to the boys' and girls' toilets better, such as with separate buildings or dividing walls.

Fig. 6: Toilet block with 10 UDDTs built in **Kiziguro** primary school (teachers have another 2 UDDTs built separately). Five cubicles are for boys, five for girls.

Qualitative monitoring of health outcomes was carried out in July 2008 with interviews (without medical examinations due to financial constraints). At this point, the UDDTs had been in use for just over a year (Herzog, 2008). Some improvements in health were observed although those related to the once-off deworming and eye treatment for the children had mostly faded away again.

To gain an updated impression on the state of these UDDTs, Eugene Dusingizumuremyi (consultant for GIZ, e-mail: eugedu@yahoo.com) **visited the four schools on 11 and 16 November 2009**, after the toilets had been in use for 2.5 years. He interviewed headmasters or deputy headmasters of the schools.

5 Technologies applied

GIZ-Rwanda and FEA decided to construct single vault UDD toilets in the two primary schools of Kiruhura and Kiziguro because of ease of maintenance, less odour and the ability to produce a safe fertiliser. UDDTs with a single vault were chosen because of the high quantity of faeces per day. Faeces have to be sanitised in the separate drying shelter. It is not easy to get enough ash at the school to be added to the vaults every day.

Single vault UDDTs are cheaper to construct than double vault UDDTs. For single vault UDDTs, the external drying shelter plays a crucial role instead of double vaults.

In Kiruhura primary school, the single-vault UDDTs have collection baskets made out of tree branches which are located inside of the faeces vaults. These baskets are not strong enough though and some of these baskets have been destroyed (in that case the faeces are collected directly in the vaults).

In the Kiziguro primary school, faeces are collected in the faeces vault (without a separate container) and the vaults are emptied when they are almost full. There is no data collected on how often the vaults need emptying at the two schools.

The urine is directly infiltrated into the soil in both schools, except in Kiziguro where half of the urine is collected in 20 L

jerrycans and reused directly as fertiliser in coffee plantations (see Section 7).

Table 1: Comparison table of important parameters in the two primary schools with UDDTs.

Parameter	Name of primary schools	
	Kiruhura	Kiziguro
Location	Province: South District: Huye Sector: Rusatira Cell: Kiruhura	Province: West District: Ngororero Sector: Ngororero Cell: Kaseke
Number of pupils	1197	845
Single vault UDDTs for pupils	10	10
Single vault UDDTs for teachers	2	2
Ratio of pupils to toilet cubicle[a]	120:1	85:1
Handwashing facilities	10	10
Water tanks installed	0	1

[a] The actual ratio is lower, because the younger students are requested to continue using the old pit latrines (exact number of those younger pupils and their pit latrines not known). The budget was too limited to build more toilets.

In addition, each of the four schools received 10 **handwashing facilities** that were installed in front of classrooms to be able to monitor the pupils if they wash hands after using toilets. Some handwashing facilities were installed near the toilets and this is normally the preferred location. But these handwashing facilities, which had been recommended by FEA, were found to be too fragile (the system consisted of a jerrican which is fixed to a wall, with a small water pipe and flap to close and open it). In July 2008, only 2 out of 10 were still in use in Kiziguro and in November 2009 none of these handwashing systems were in use anymore.

The superstructure the UDDTs is made of different materials, ranging from cement to bricks and stones for the foundation, vaults and stairs. The toilets have a concrete floor into which a plastic urine diversion squatting pans is inserted. These pans were imported from Uganda (see Section 14 for supplier's details). The roof is constructed out of trees and corrugated iron sheets. The doors are made of timbers.

Water sources for the four primary schools:

- **Kiruhura** primary school is connected to a water pipe from the adjacent secondary school financed by a foundation.
- **Kiziguro** primary school is not connected to a water supply network but has a rainwater harvesting system (10 m^3 tank provided under the project). When the water in this tank runs out, the pupils have to bring water from their homes (taken from wells or springs).
- **Sovu** primary school has now a 5 m^3 water tank connected to a water pipe where water is paid for by a foundation.
- **Kirwa** primary school uses rainwater harvesting and is also connected to a water network from a natural spring (this school is supported by UNICEF-Rwanda).

Since none of these rural schools uses groundwater from the school compound, groundwater pollution from pits or from urine infiltration at the school site was not regarded as a potential problem.

Fig. 7: Back view of the two UDDTs for teachers in Kiruhura primary school. At the base (covered by the bushes) are the access doors for the faeces vaults.

6 Design information

As mentioned above, the design and construction of the UDDTs was carried out by FEA (Fond de l'Eau et Assainissement). Drawings and photos of the UDDTs are available on the flickr website (see Section 13 for link).

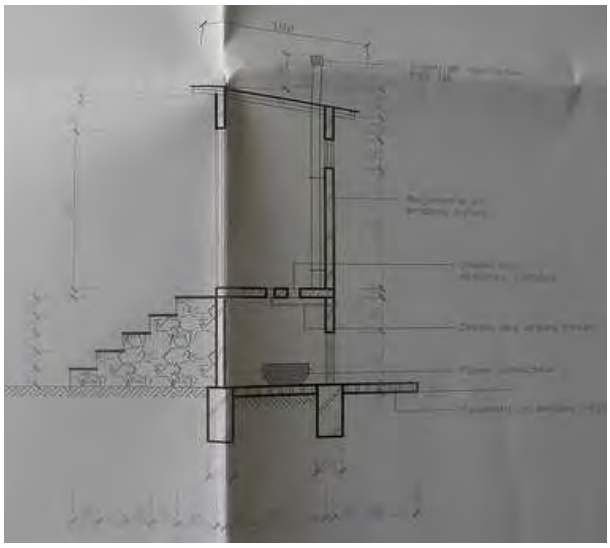

Fig. 8: Photo of a design drawing showing side view of one single vault UDDT with basket for faeces (drawing by FEA, Rwanda, Nov. 2007). More drawings are available (see Section 14 for link).

The single vault UDDTs were designed based on an average of 700 pupils per primary school (the current number of pupils is higher however, see Table 1). The toilet cubicles are 1 m x 1 m (length by width), and the faeces vaults are the same plan area as the cubicles and are 1 m high (therefore total volume of the faeces vaults: 1 m^3).

All UDDTs are built entirely above the ground, as is normal for UDDTs, to facilitate maintenance and emptying of the vaults and to accelerate the drying process. The compartments have a small staircase of 3 to 4 steps. The number of steps depends on the terrain. The UDDTs have access hatches to

remove faeces from the vaults which are made of painted red metal (the red painting was done to avoid corrosion of the metal).

The ventilation of the faeces vaults is provided with PVC pipes installed at the back of the UDDTs. The pipes start in the vault and reach up to approximately 75 cm above the roof and have a diameter of 110 mm (see Fig. 7). The openings are covered with fly screens to prevent flies from entering.

At Kiruhura, there are waterless urinals for boys made of walls plastered with a mixture of sand and cement (they are located on the side of the UDDTs).

The shed for drying of faeces (after drying in the faeces vaults) is fenced with chicken wire and its roof is made out of corrugated iron sheets. It is directly behind the UDDTs and its length is the same as that of the UDDT block.

Fig. 9: Inside view of UDDTs at Kiruhura primary school showing plastic urine diversion squatting pan and bucket with ash for covering faeces after defecation. Toilet has been in use for 2.5 years.

7 Type and level of reuse

Use of urine:

Only one of the two schools uses urine as a fertiliser and this is at Kiziguro, where *half of the urine* is collected in 20 L jerrycans and reused directly as fertiliser in coffee plantations[9]. The urine is mixed with water at a ratio of 1:3 (urine: water).

There is no information on what kind of fertilisers was used before (composts of organic matters are common in Rwanda and are used everywhere). There is also no information on whether the urine is resulting in increased yields, but it is likely to do so.

In Kiruhura primary school, urine is not collected at all (but infiltrated) because the teachers were not comfortable with the idea of using urine as fertiliser. During the visit in Nov. 2009, the GIZ consultant told them how urine can be used as fertiliser. Despite the limited space of gardens at the school, they need fertilisers.

Most of the schools in Rwanda have school gardens where urine can be used as fertiliser. Thus, it would be useful to provide full information and training on the reuse of urine.

Use of dried faeces:

The dried faeces from the UDDTs contain also menstrual pads and anal cleansing material (toilet paper and hard paper) and are stored for 6 months in the drying shelter before being reused as soil conditioner.

In Kiruhura primary school, faeces are kept for six months in the drying shelter. After six months faeces are used as fertiliser in the garden of vegetables (in Kiruhura) and on banana plantations after just four months in Kiziguro.

As the menstrual sanitary pads are not biodegradable they should be collected separately in waste bins to be disposed and treated separately. It is not clear whether and how the school guards pick out the sanitary pads before applying the dried faeces as soil conditioner.

There was no information available on the state of sanitised faeces before being reused as fertiliser. The schools do not have special equipment to empty and transport dried faeces. School guards arrange themselves how to transport the faeces.

Fig. 10: Open vault of a UDDT in Kiziguro primary school. Paper is used as cleansing material.

Fig. 11: This photo taken in Kiruhura Primary school shows the dried faeces after 4 months in the drying shelter. The faeces will be reused as fertiliser after six months.

[9] The school does not have containers to collect urine. They are only using one jerrycan per toilet block. Not all toilets are connected to one jerrycan, only half of them.

Urine diversion dehydration toilets in rural schools Huye and Ngororero Districts, Rwanda

Fig. 12: Banana plantations where faeces are used as soil conditioner in the Kiziguro primary school garden.

8 Further project components

Sensitisation and skill based behaviour change followed the construction and installation of sanitary and water infrastructure prior to the operation of UDDTs. The target group of planned sensitisation and behaviour change campaign was teachers and pupils.

With the aim of achieving a sustainable maintenance of the new facilities and to establish a sense of ownership, all schools received sensitisation and training on utilisation and maintenance of the new facilities. During the Information, Education and Communication (IEC) Campaign that followed the baseline study, all children, all teachers and approximately 1,000 parents, received one-day trainings and skill based sensitisation session on the topics identified during the study.

One major sensitisation topic included the water treatment with "Sûr'Eau", and parents and the school received samples of Sûr'Eau (a chlorine based solution that is added to water to make it safe for drinking), in order to get acquainted with this method. In addition the target schools received teaching materials to facilitate their hygiene and health lessons in the future. Moreover, PSI brought a mobile cinema showing clips that sensitised parents in the community close to the two schools in Huye about water and sanitation as well as malaria.

Urine diversion toilets at Kirwa primary school:

UNICEF-Rwanda, the main funding partner of Kirwa primary school provided urine diversion toilets (UDTs) to this school (this is not a UD**D**T as the faeces are not dried). These are mobile toilets where the superstructure is made of plastic. The sub-structure consists of a pit dug underneath and with stones as retaining walls inside. The 12 mobile UDT compartments and one bathroom are fixed above the hole built with the stones. Urine is diverted and infiltrated into the soil, while faeces and cleaning water (for the plastic floor) are mixed in one single big lined pit (probably a hole was dug and protected with stones). Greywater from bathrooms is infiltrated separately into the soil.

The UDTs provided by UNICEF are rather smelly compared to UDDTs constructed by GIZ-Rwanda. The main reason of this odour problem is that cleaning water is mixed with faeces in the same pit. Even if the urine is diverted into a soak away pit, cleaning water for the plastic floor is mixed with faeces, and this results in bad smell and attracts flies and other insects.

9 Costs and economics

The capital costs for the UDDTs, handwashing facilities and water tanks are shown in Table 2 below (a further break-down of the costs is not available). All costs were covered by the project partners, and the schools had no costs at all (meaning the toilets were 100% subsidised), not even via contribution of labour.

The costs for the UDDT toilet blocks are on the high side, although they do include the training sessions and drying shed (the cost is equivalent to EUR 500 for one UDDT; or EUR 6 per student, as the schools have on average approx. 1000 students).

In terms of annual costs, there are only the salaries for the schools guards who do the maintenance of the UDDTs but who are employed by the school already for other duties (see next section).

Table 2: Capital costs for the installations at four schools, including material and labour, in EUR (Source: adapted from Paul (2007a). GIZ-Rwanda received the funds for the initiative from the GIZ Program Disease Control and Health Promotion.

Item	Quantity	Cost per school	Total Cost
UDDT toilet blocks (12 toilet stands/per school)[a]	2	6,017	12,034
Handwashing facilities (10 units per school)	4	143	573
Water tanks (10 m^3)	2	3,295	6,590
Total cost			**19,198**

[a] Includes drying shed and sensitisation for pupils and teachers.

10 Operation and maintenance

Operation and maintenance activities in the two schools with UDDTs include:

- Keeping the toilets clean
- Covering the faeces after defecation with ash as drying material (done by the users; ash is brought by pupils every day)
- Monitoring the level of urine and faeces in the collection containers and vaults (this is done by the "school guards" who also transport the dried faeces to the fields).

Each school has day and night guards. School guards are in charge of hygiene and security at the schools and are paid by the schools.

Each school has two teachers in charge of hygiene, a male teacher and a female teacher in charge of boys and girls respectively. Pupils are reminded daily on how to use the UDDTs properly. Specifically, in Kiziguro primary school, each classroom has UDDT guidelines displayed inside the classroom (photos shown in Flickr photo set, see Section 13 for link). And teachers keep explaining the proper use of UDDTs. In Kiruhura primary school, they have a morning session on hygiene and code of conduct during the general

assembly for all pupils. This is an opportunity to remind all pupils on the correct use of UDDTs.

In all primary schools, the pupils have STE ("Science et Technologie Elémentaire" meaning "basic science and technology") course for classroom. This course has a component of hygiene.

To be on the safe side, both schools preferred junior pupils not to use the UDDTs because it is difficult for them to follow UDDT guidelines[10]. But, after one year at the school they are allowed to use them (i.e. at the age of 6 or 7 years old).

11 Practical experience and lessons learnt

The UDDTs constructed in the two schools are in good shape and well used by pupils and teachers (about 2.5 years after they have been inaugurated).

At Kiruhura, separate cubicles of the UDDTs were assigned for each class in addition to providing separate toilets for boys and girls. This measure proved to be very effective in enhancing the students' ownership for the respective toilet cubicles, especially when it is reflected in the maintenance rules whereby each class cleans their own toilet cubicle(s).

Maintenance has become an issue because the UDDTs have been constructed by FEA without involvement of local people (due to time constraints at the time when the project was implemented). This is the case of Kiruhura primary school where two compartments of UDDTs are not functioning anymore because the urine pipes became clogged after only a short time. There is nobody in that place who can repair such UDDTs, the headmaster said[11].

The problem of repairing UDDTs can be solved by training of local technicians and other interested people on the maintenance of UDDTs and sanitisation of urine and faeces before reuse as fertiliser. In turn, trained technicians can help UDDT owners in repairing them when necessary.

It is advisable to have bins in the girls' UDDTs (and the related user training) where the adolescent girls can dispose of sanitary pads separately from faeces – this would make reuse of dried faeces easier.

The UDDTs are preferred by the pupils compared to the formerly used traditional pit latrines. In addition to acceptance of UDDT by pupils and teachers the surrounding households would like to have them. But they think that the cost of UDDTs is too high – so no spontaneous copying has taken place so far.

[10] These are new students for their first year, and pupils of nursery schools (nursery school pupils range from 3 year to 6 years old).

[11] It seems that the pipes got clogged by misuse of UDDTs (something was thrown in the urine pipe which got stuck inside). This could easily be replaced and fixed by the school guards. Another possible reason is that the slope of the urine pipes was not high enough.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 3) indicates five sustainability criteria for sanitation, according to vision of SuSanA, document 1. The project has its strengths and weaknesses.

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 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 following can be concluded:

1. The main expected impact of the project was to improve public health and in particular to reduce the rate of diarrhoea incidences in school children. UDDTs are a preventive tool to lower disease and parasite infestation (intestinal worms). But no data is available on actual intestinal worms' reduction.
2. The new school toilets reduced the toilet queues, as well as bad smell at the two schools.
3. The demonstration UDDTs have not yet resulted in any upscaling activities for ecosan systems by the schools or by the Ministry of Education.

It is possible that an opportunity for scaling up of ecosan systems is within the National Strategy of "Child Friendly

Schools" planned by the Ministry of Education in collaboration with UNICEF.

13 Available documents and references

- Link to a set of **photos** of UDDTs and **drawings** at the two schools (December 2009): http://www.flickr.com/photos/gtzecosan/sets/72157622872968074/
- Herzog, K. (2008) Intersectoral Cooperation for School Health: Report on the Impact and Sustainability of the Initiative in Rwanda, Report for GIZ (Program „Disease Control and Health Promotion"), Eschborn, Germany. http://www2.gtz.de/Dokumente/oe44/ecosan/en-school-health-report-rwanda-2008.pdf
- Paul, F. A. (2007a) Baseline Assessment and Intervention Study on Initiative "Intersectoral Cooperation for School Health", Rwanda: Final Report for GIZ (April 2007), Kigali http://www2.gtz.de/Dokumente/oe44/ecosan/en-final-report-school-health-rwanda-2007.pdf
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Other relevant national government documents:

- Ministry of Health (2009) Rwanda Interim Demographic and Health Survey 2007-08, Demographic and Health Survey document, Kigali-Rwanda, http://www.moh.gov.rw/index.php?option=com_docman&task=cat_view&gid=64&Itemid=14.
- Ministry of Health (2008) Environmental Health Policy. Kigali Rwanda, http://www.moh.gov.rw/index.php?option=com_docman&task=cat_view&gid=58&Itemid=14.
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- Ministry of Education (2007) Politique de la santé scolaire (in French; Policy of school sanitation). Kigali, Rwanda. Hard copy available in the Ministry of Education (www.mineduc.gov.rw)
- Ministry of Health (2005) Health Sector Policy. Kigali, Rwanda. http://www.moh.gov.rw/index.php?option=com_docman&task=cat_view&gid=58&Itemid=14.

14 Institutions, organisations and contact persons

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Supplier of urine diversion squatting pans
There is no data available on the company that supplied the plastic squatting pans but it was probably Crestanks in Uganda
Crestanks Ltd.
P.O. Box 11381
Kampala, Uganda
E 1: scs@crestanks.co.ug
E 2: janet@crestanks.co.ug
E 3: crestank@africaonline.co.ug
I: www.kentainers.com

Case study of SuSanA projects

Urine diversion dehydration toilets in rural schools, Huye and Ngorerero Districts, Rwanda

SuSanA 2010

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Case study of sustainable sanitation projects

Community ablution blocks with sewers or infiltration eThekwini (Durban), South Africa

Figure 1: Project location.

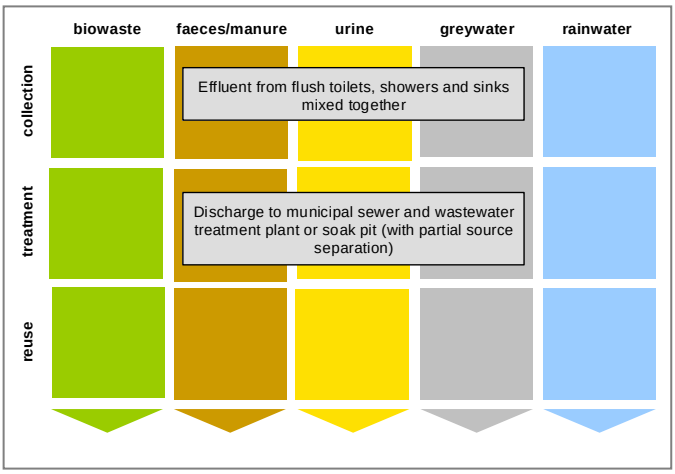

Figure 2: Applied sanitation components in this project (currently no reuse taking place).

1 General data

Type of project:
Ongoing, full-scale project of urban upgrading with community-based water and sanitation.

Project period:
Start of construction:
2004-2007 by eThekwini Health and Housing Departments
2009-2011 by eThekwini Water and Sanitation Department
End of construction: construction still ongoing

Project scale:
Number of ablution blocks:
108 brick blocks built by eThekwini Health, Architecture and Housing Departments
240 container blocks built by eThekwini Water and Sanitation Department

Number of inhabitants covered: Approx. 600,000

Total investment: 280 million Rand (31 million EUR)

Address of project location:
Informal settlements in urban and peri-urban areas of eThekwini municipality, Durban, South Africa.

Planning institution:
eThekwini Housing Department and Water and Sanitation Department, Durban, South Africa.

Executing institutions: EWS and consultancies companies (i.e. Aurecon, SBA); local contractors (i.e. Sanyati, WBHO) and subcontractors (i.e. Emzini Projects)

Supporting agency:
eThekwini municipality of Durban, South Africa.

2 Objective and motivation of the project

The Constitution of South Africa gives responsibility for provision of water and sanitation to the local governments. Other legislative pillars governing the water and sanitation sector in the country can be found in the Water Supply and Sanitation Policy (DWAF, 1994), the Water Services Act of 1997 (RSA, 1997), the National Water Act of 1998 (RSA, 1998), and the White Paper on Basic Household Sanitation (DWAF, 2001).

In Durban, eThekwini Water and Sanitation (EWS) is the authority responsible for providing water and sanitation to the 3.5-million population. Under this mandate EWS has the duty to provide services according to principles of:

- Equity (easily accessible to the population)
- Affordability
- Environmental effectiveness (pollution prevention, health promotion, complain with national and provincial legislation)
- Sustainability (limited cross-subsidy, is maintained and accepted by communities).

Fig. 3: Prefabricated container in Durban (source: eThekwini Water and Sanitation, 2010).

Community ablution blocks with sewers or infiltration eThekwini (Durban), South Africa

EWS is world leading service authority, providing the population several water and sanitation options, such as roof and ground water tanks, and urine diversion dehydration toilets[1].

Among these services, an important initiative is designed to provide communal water and sanitation facilities to un-served informal settlements in the urban and peri-urban areas of Durban, located within the sanitation waterborne edge (Figure 4). The purpose of this intervention is to provide each household with access to basic services, pending the formal housing intervention. The installation of community ablution blocks (CABs), in fact, is linked to a city re-housing programme, which aims to eradicate informal dwellings over the next decades and relocate people in fully serviced houses (eThekwini Municipality, 2006). Thus, CABs are a temporary service for those informal urban settlements that will not be upgraded by the Housing Department in the next 5 to 15 years.

This initiative was started by the eThekwini Health, Architecture and Housing Departments in 2004. Since the end of 2008, the project has been taken over by eThekwini Water and Sanitation (EWS).

This case study documents the efforts to serve informal settlements undertaken by EWS.

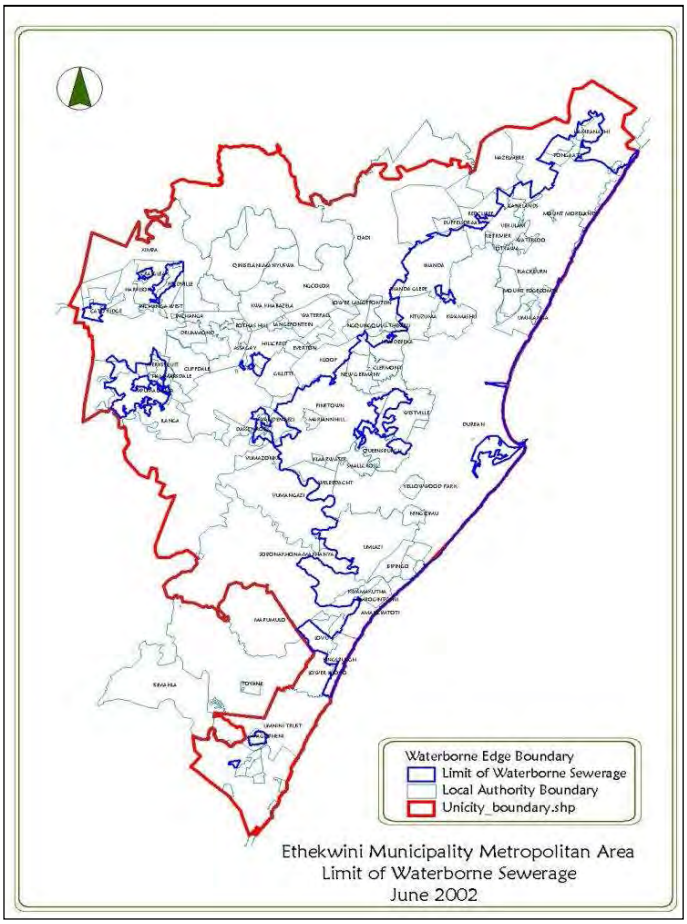

Fig. 4: eThekwini waterborne edge (source**:** EWS, 2002).

[1] see separate SuSanA case study: http://www.susana.org/docs_ccbk/susana_download/2-791-en-susana-cs-south-africa-ethekwini-durban-uddts-2010.pdf.

3 Location and conditions

The achievement of sustained water and sanitation systems in South Africa is a daunting task due to water scarcity, water stress and high urbanisation rate caused by increasing migration from the rural areas (UNEP, 2002).

In the urban and peri-urban areas of Durban, 1 million people live in informal settlements, densely populated areas, characterised by different soil types, generally floodplains and dolomitic lands (Eales, 2008).

At the time this case study was prepared,150,000 families are estimated to occupy 417 informal settlements in eThekwini, living in basic shacks and suffering from poor water and sanitation conditions. Standpipes and water tanks are the main sources of water supply, whilst open defecation, pit latrines or Ventilated Improved Pit (VIP) latrines are the most common sanitation options.

Fig. 5: Image of a typical informal settlement in Durban (source: Roma, 2010).

In South Africa, the under-five child mortality rate is currently 62[2] children per 1000.

4 Project history

Community Ablution Blocks are shared water and sanitation facilities of brick construction (the old type installed by the Health Department) or prefabricated containers, modified to meet acceptable standards by adding ventilation and appropriate plumbing. Generally, the facilities are characterised by female and male blocks, provided with toilets (and urinals for men), showers, hand wash and laundry basins. A block should serve 100 housing units; in reality, however, a single block may serve up to 200 dwellings (each composed of an average of 5.5 people).

[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 the age of five if subject to current age-specific mortality rates. (http://www.childinfo.org/mortality.html and http://www.childmortality.org/)

Since 2004, the implementation of CABs was undertaken under the joint responsibility of eThekwini Housing and Architectural Department, with health and hygiene education provided by the Health Department. Under their supervision a total number of 108 ablution blocks of brick construction was built.

From the end of 2008, EWS took over the Health Department in the implementation of the communal systems. EWS role involves the maintenance and repair of old existing blocks and the delivery and installation of new blocks, in the form of prefabricated containers. Since the take over, EWS has installed 240 CABs, which together with the existing 108 accounts for 348 facilities. In 2010 all CABs have a caretaker, cleaning material and toilet papers paid by EWS.

5 Technologies applied

There are several technology options for CABs depending on the characteristics of the areas where they are installed (Buckley, 2005). These are the following:

Sewer discharge
In densely populated areas located in close proximity to a sewer line, the toilet block is connected to a sewer system. Each block has two separate areas: the male part is characterised by 2 or more flush toilets and 2 urinals, 2 wash hand basins and 2 showers. The female part presents 4 or more flush toilets, 2 wash hand basins and 2 showers. Laundry facilities are generally present. The dwellings should be within a radius of 150 to 200 m from the toilet block.

Lighting at night is provided via translucent roof sheeting and external mast mounted floodlighting. Provision is made for a storeroom and washstand. In some areas a fencing system is provided.

Wastewater is reticulated to the nearest wastewater treatment plant (WWTP). There are 27 WWTPs serving eThekwini municipality, which treat 500 ML/d and serve 498,341 people approximately. The WWTPs produce approximately 95 tons (dry) sludge per day. By 2020 this quantity is expected to increase to 120 ton/d. Of the sludge currently produced, 50% is disposed together with pre-treated effluent through the two sea outfalls, 20% is incinerated and 30% is stockpiled at treatment works sites.
The South African Department of Water Affairs (DWA) has established the Green Drop initiative to assess the performance of wastewater treatment plants in the country.

The WWTS performance is measured against a set of criteria:
- Process control maintenance and management skill
- Monitoring programme efficiency
- Credibility of waste water sample analysis
- Regular submission of Waste Water quality results to DWA
- Waste water quality compliance
- Waste water failure response management
- Waste water treatment works capacity

According to this programme the overall management and performance of Waste water treatment plants in eThekwini is deemed very good, producing an Average Green Drop score of 80% (DWA, 2009).

Ablution block to storage tank or VIP pit

Where no local connection to the sewerage system is feasible, the toilet Block is connected to a storage tank or to VIP pits. Generally an effluent minimization strategy (diversion of grey and urinal effluent, low flush) is adopted to reduce the cost of transporting the effluent. The effluent is reticulated into a storage tank (or individual pits) and emptied at regular intervals by the municipality. Adequate space and road access must be available for a vehicle to pump the effluent out of the tank.

In the municipality, there are 8 toilet facilities with VIP latrines. Generally, a single block serves 50 informal housing units (composed of 4 people per dwelling, on average). The block structure has a separate part for males and females but, in this case, no showers are provided. Only faeces and urine may enter the pit.

Water Provision
In those CABs connected to the sewerage systems, water is reticulated to the facility. Typically, blocks are supplied with water meters and water consumption per person is estimated to be around 35-40 litres per day.

In the VIP block, water is supplied through standpipes located at a reasonable distance from the ablution block and drained to a soak away. Laundry activities take place around the standpipe and not drain into the pits.

6 Design information

A series of criteria must be met to implement a CAB project (Gounden, 2008). These are the following:

- Land acquisition: informal settlements are located in private plots; hence a formal permission from the landowner to build in his/her land must be obtained by the municipality.
- Space consideration: Sites or plots must be greater than 250 m^2.
- The average slope of the ground must be less than 1:3.
- Environmental consideration: there must be low risk of groundwater pollution, or if present, this must be can be mitigated.
- Site must have basic level of water supply.

Design parameters vary among different areas, as different local contractors tender to design, construct and deliver the facilities. While under the management of the Health Department, containers of brick material were built, EWS opted for prefabricated containers that can be easily moved and substituted (see Figure 3).

Containers are designed, built and implemented by consultancies, local contractors and sub-contractors, which are appointed by EWS by means a tender process.
Containers dimensions and design specification may vary among suppliers. Typically, male and females units are separated in different blocks. A male block generally contains:
- 2 urinals
- 2 or more flush toilets
- 2 showers
- 2 washbasins

A female block includes:
- 4 or more toilets
- 2 or more showers

- Hand wash basins
- Laundry basins outside the facility

Figure 6 below illustrates the typical layout of a toilet block.

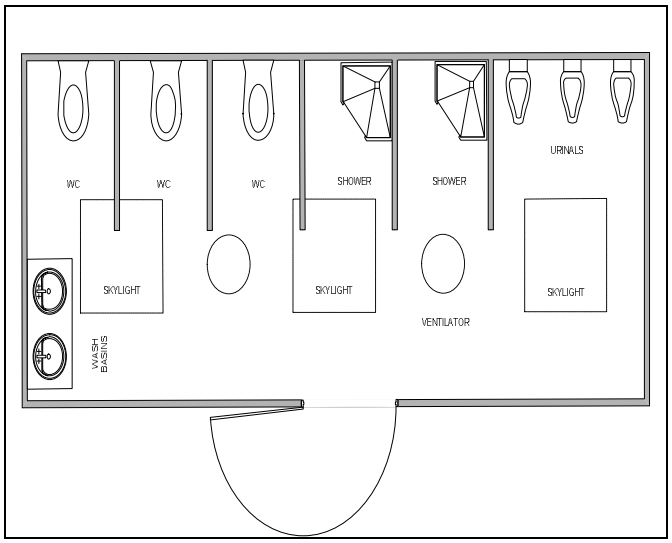

Fig. 6: Typical design of a CAB (source: EWS, 2009).

Fig. 7: Examples of washbasins and laundry facilities at CABs (source: EWS, 2008).

7 Type and level of reuse

Currently, no reuse options are in place in the CABs. Wastewater reuse would be a beneficial option, for water scarcity represents a severe problem in eThekwini municipality and in most areas of South Africa. Where compliance with national law and regulations is met, wastewater reuse could be employed for agricultural purposes and/or groundwater recharge. Furthermore, the reuse option would be economically beneficial if compared with the costs generated from operation and maintenance of centralised conventional treatment systems and the environmental and health negative effects derived from using simple sanitation options such as VIP latrine.

The EWS department has welcomed several research projects looking into possibility of reusing human waste. Among these, EWS is exploring future opportunities to increase the sustainability of CAB by introducing Decentralised Wastewater Treatment systems (DEWATS) to new and existing blocks. The DEWATS systems, based on anaerobic baffle reactor treatment technology, can reduce water pollution and guarantee an economic and sustainable reuse of treated effluent for agricultural purpose. Biogas production will also be generated in the facilities.

8 Further project components

The implementation of community sanitation by EWS has been accompanied by the provision of educational and training to the communities. EWS is involved in a wide range of programmes focusing on promoting water conservation, water demand management, sanitation, health and hygiene awareness in informal settlements. Educational material, (such as posters and explanatory leaflets), is provided in both English and isiZulu and distributed to communities by EWS officers.

Further educational initiatives take the form of street theatre performances, which reach out a broad spectrum of users, particularly the poorest and illiterate ones. Community participation is enhanced further through a competition, run in conjunction with the street theatre, with draws and prizes as incentives.

More specific training activities are addressed to the caretakers of communal facilities. Caretakers are trained by EWS staff on technical, environmental, hygiene and management aspects related to the facilities. Furthermore, the caretaker is encouraged to report leakages, pipes breakdown to the EWS costumer care help line.

Besides training and education initiatives, the municipality has encouraged the implementation of Community Health Club (CHC) pilot project by Africa Ahead (www.africaahead.com). In the Community ablution block of Johanna road, Africa Ahead trains facilitators from the communities to promote health and behavioral change by means of PHAST (Public Health Action Support Team) participatory activities. Similar approaches have been adopted by the organization in several other African countries (Waterkeyn, 2010).

A final component of the CABs project under EWS management, is the creation of several local jobs as labour for the construction of the facilities is sourced from local communities and the stimulation of small business development for the provision of blocks and products by use of local resources.

9 Costs and economics

The total investment costs for EWS - from January 2009 to December 2011 - was 280 million South African Rand (ZAR) (31 million EUR). The actual cost of prefabricated containers is 65,000 ZAR (7,200 EUR). The total costs for a pair of CABs, including transport, site preparation, O&M, hardware and software is approximately of 200,000 ZAR (22,100 EUR).

Through a tender process, EWS selects programme consultancies, local contractors and sub-contractors dealing with the project implementation. Specifically their duties are the following (EWS, 2010):

- Local consultants provide design services for each informal settlement and monitor the quality of the construction works.
- Contractors and sub-contractors have the purpose to lay new water and sewer lines including connections to existing infrastructure, as well as constructing the platforms for the toilet blocks/containers. Sub-contractors receive 20% of contractors' budget, whilst local labour receives 10% of contractors' budget (EWS, 2010).

The project is entirely funded by EWS: CABs users do not pay for the services provided. In terms of the Water Service Act (1997), all municipality customers, irrespective of the level of service, receive the first 6 kL of water per month at no cost (EWS, 2004). As of 1 July 2010, this amount of free water provided has been increased to 9 kL of water per month. Thus, any customer who limits their monthly usage to below this figure receives a free water supply. Similarly, there are no charges for the disposal of use of the first 9 kL of water per month (EWS, 2010b).

10 Operation and maintenance

Health practitioners and community education officers employed by the municipality are in charge for the facilitation and monitoring of the communities served by the CABs. The municipality provides maintenance of the systems, supplies cleaning materials and toilet paper.

A caretaker, appointed by the municipality, is in charge of the daily management of the facility, providing cleaning and communicating with health practitioners and education officers in case of problems in the facility. Caretakers' responsibilities are:

- Management and cleaning of the facility,
- Ensuring availability of toilet paper and cleaning products, (provided by the municipality),
- Reporting to EWS about structural problems with the facility (i.e. leakages),
- Supervising the facility during duty, to ensure access to user.

Under management of the Health Department caretakers have worked on a voluntary basis, deriving their salary from collection of voluntary contributions from users. Since EWS' takeover, caretakers are appointed and paid by the municipality to maintain the systems.

Fig. 8: Interior of CAB (Left) and flush toilet in CAB (Right) (source: Roma, 2010).

In some informal settlements, free use of CABs did not lead to community's sense of ownership for the facilities. Problems such as broken pipes and toilets, unclean and malodorous units, as well as lack of soap have been identified (Roma et al., 2010). Thus, CAB performance is entirely dependent on the caretaker's work and users' willingness to keep the facilities to a good standard, which underlie a sense of ownership for system provided.

Fig. 9: Caretakers outside a CAB in Durban (source: EWS, 2008).

11 Practical experience and lessons learnt

Surveys and assessment of experiences with CABs are routinely undertaken in the areas by EWS and by external research projects (Roma et al., 2010). These activities are extremely important as users' feedback on the services provided enables the municipality to adapt new interventions to identified problems.
Table 1 illustrates some of the lessons learnt from past experience and the related interventions undertaken.

Table 1: Lessons learnt from past experience and related interventions.

Past experience	Interventions made
Major maintenance problems have been identified in areas where there was no caretaker supervision.	Local caretakers are appointed and paid a regular salary by eThekwini municipality.
Users did not purchase toilet paper and used newspapers instead causing blockages of the systems.	Toilet paper and washing material are provided by the Municipality and freely distributed by caretaker.
In some CAB areas crime and anti-social behaviours occur at night, making it difficult for women and children to use the facilities.	The provision of lights and fences, as well as constant presence of a caretaker provides a safer environment.
Copper pipes and other material used for taps and shower has been stolen.	Materials have been replaced by plastic pipes and taps.

Experience with CABs has proved that building a facility alone does not systematically eradicate the problem with poor water and sanitation, rather a more holistic approach is required to cover all aspects.

Generally, acceptance of the systems is mixed: dwellers living in close proximity to the block are more satisfied with the services provided by the facility. This is because they do not have to walk long distance to use the systems carrying clothes or water buckets.

Further interventions to improve the liveability of the facilities and infuse a sense of ownership in the community will be taking place from mid 2010. This will involve the introduction of micro-finance schemes with the construction of kiosks and shops inside or next to the blocks to generate employment in the communities and encourage social gathering at the facilities.

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 emphasized (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[1]		
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					

[1] not part of the project

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).

The impacts of EWS intervention in informal settlements are several. From a health perspective, the systems provide a solution to the urgent water and sanitation situation faced by informal settlements of Durban. The interim provision of basic water and sanitation can tackle waterborne and water related diseases widespread in the areas, as well as help mitigate the impelling HIV problem in informal settlements, providing the hygienic services necessary for people suffering from AIDS.

Financially, the construction of CABs can generate new job opportunities for people in informal settlements, alleviating the high unemployment in the areas. On a greater scale, CAB projects can stimulate the development of local entrepreneurship by sub-contracting construction works to local enterprises. From a social point of view, the introduction of water and sanitation services will infuse a sense of dignity onto local communities and allow for people's privacy as well as increase security for women.

Although communal blocks are conceived as temporary solutions, EWS is striving to enhance the project's sustainability by encouraging initiatives that stimulate users' ownership of the facilities, their involvement in O&M.

Only few external research investigations on the social impacts of CABs have been conducted (Roma et al., 2010). EWS is planning to undertake impact assessment studies of the sustainability of the implemented toilet blocks and investigate their impacts from health, socio-economic, technical and environmental perspectives.

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eThekwini municipality: www.durban.gov.za
Department of Water Affairs and Forestry: www.dwaf.gov.za

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Central area: Aurecon
Western area: BKS (Pty) Ltd
Southern area: CBI Consulting Engineers (Pty) Ltd
Contractors:
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Central area: Sanyati (Pty) Ltd
Western Area: WBHO/IN-SITU PIPELINES JV
Sothern area: WK Construction (Pty) Ltd

Subcontractors:
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- Abangani Projects

Central area:
- Emzini Projects
- Madondo-Hughs

Western area:
- Royal Africa Trading
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- Ekuhawukeni Trading Enterprise

Case study of SuSanA projects

Community ablution blocs with sewers or infiltration, eThekwini (Durban), South Africa

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Case study of sustainable sanitation projects

Large-scale Peri-urban and rural sanitation with UDDTs eThekwini Municipality (Durban) South Africa (draft)

Fig. 1: Project location

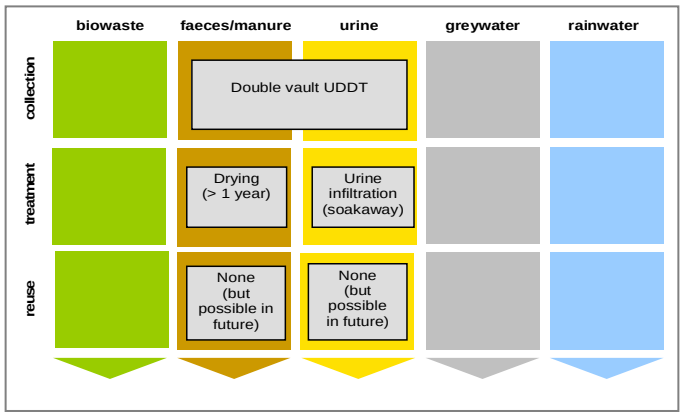

Fig. 2: Applied sanitation components (UDDT stands for urine diversion dehydration toilet).

1 General data

Type of project:

Large-scale Free Basic Water Supply and Sanitation (UDDT) provision to households in rural and peri-urban areas of eThekwini municipality

Project period:
Start of construction: 2003
End of construction: ongoing (but most UDDTs completed by end of 2010)
Start of operation: 2003
Project end: Ongoing

Project scale:
75,000 household UDDTs have been installed in 65 peri-urban and rural areas of eThekwini municipality, serving approximately 450,000 people in total (6 people per household).
Total approximate investment as of 2007: EUR 62,179,000 or ZAR 594,723,187 (equivalent to approx. EUR 833 per household for water and sanitation).

Address of project location:
eThekwini Municipality, Durban, South Africa

Planning institution:

eThekwini Water and Sanitation (EWS)

Executing institution:
Construction Branch of EWS
Institutional and Social Development (ISD) consultants
Project Steering Committee (PSC)

Supporting agencies:
eThekwini municipality (funded through Municipal Infrastructure Grant)

2 Objective and motivation of the project

The development and implementation of urine diversion dehydration toilets (UDDTs) in eThekwini municipality began in 2002 in order to address the sanitation "backlog" in the rural and peri-urban areas of eThekwini, which had come about due to the expansion of municipal boundaries to include a number of rural and peri-urban areas. The goal was to prevent further outbreaks of waterborne diseases among the population. When the rural water and sanitation project started, the municipality estimated a backlog of 175,000 households without adequate sanitation including 68,500 households even without access to safe water[1].

Fig. 3: A household with a UDDT is visited by a local facilitator (source: EWS).

This rural water and sanitation project is unique in South Africa as it integrates the delivery of household water facilities (yard tanks) and appropriate sanitation services (UDDTs) as well as household hygiene education and operation and maintenance training as a single 'package'. The municipality delivered approximately 75,000 water and sanitation packages to un-served areas between 2003 and 2007. Based

[1] It is very difficult to estimate this backlog exactly: Another estimate by Teddy Gounden put the figures in 2002 at 140,193 households without access to sanitation including 55,432 households also without access to water supply.

on an average household size of 6 people, this equates to 450,000 people served.

3 Location and conditions

In South Africa, the Department of Water Affairs and Forestry formulates the national policies and legislation governing the delivery of water and sanitation. The legislative pillars of the water and sanitation sector in the country are found in the National Constitution of the Republic of South Africa, the Water Supply and Sanitation Policy (DWAF, 1994), the Water Services Act of 1997 (RSA, 1997), the National Water Act of 1998 (RSA, 1998), and the White Paper on Basic Household Sanitation (DWAF, 2001).

In Durban, the eThekwini Water and Sanitation (EWS) unit is mandated with the implementation of policies under this legislative framework and is responsible for water and sanitation service delivery in the municipal area.

eThekwini Municipality, the local authority of Durban, comprises an area of approximately 2,297 square kilometres, with a total population of 3,468,084 (South African Institute of Race Relations, 2009). eThekwini has a sub-tropical climate with temperatures ranging from 16℃ and 25℃ during the winter months of June, July and August. Summer temperatures can reach 32℃ with relatively high humidity during the hot season. The average yearly rainfall is 1020 mm.

Fig. 4: Double vault UDDT in Maphephetheni in the eThekwini rural area (source: EWS).

Peri-urban and rural areas of eThekwini municipality are not served by waterborne sewer systems, due to problems of land ownership, housing density, inaccessible terrain (hilly) and capital and operating costs. Existing sanitation in the poorest part of Durban are Ventilated Improved Pit (VIP) latrines, (approximately 45,000 are present in the municipality) and open defecation.

In the municipality peri-urban and rural areas, the average household size is of 6.5 people[2]. The vast majority of the population is of isiZulu ethnicity. Average employment levels are very low at 13% of the population living in the areas, whilst 12.5% is unemployed (hence searching for employment) and 27% is economically inactive (eThekwini Municipality Community profiles)[3].

In South Africa, the under-five child mortality rate is currently 62[4] children per 1000.

4 Project history

The UDDT project was initiated in the aftermath of a cholera outbreak which occurred in Durban in August 2000, where 100,000 cases were reported and 70 deaths resulted. This incident and its consequences on the population's health brought the government's attention to addressing the water and sanitation backlog in South Africa as a matter of urgency.

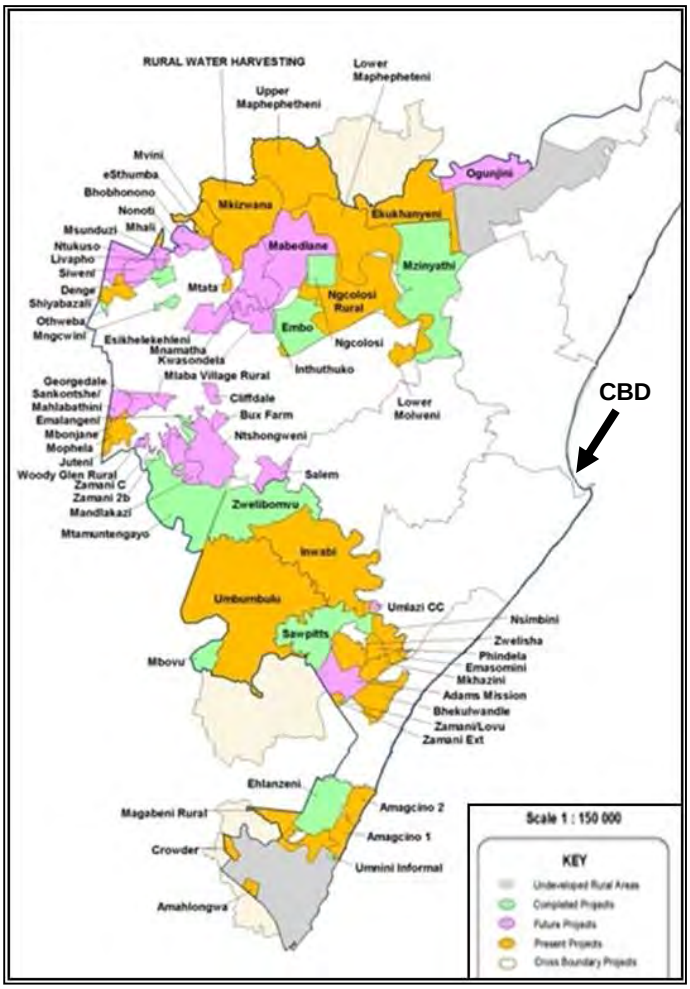

Fig. 5: Rural Water and sanitation project areas in eThekwini area (source: EWS). The coastline of the municipality is 75 km in length and at its widest point 50 km inland. The colours

[2] In informal settlements there are approx 5.5 people per dwelling. In rural areas there are 6 to 6.5 people per dwelling.

[3] The remaining portion of the population is either under the working age, or over the working age, or have voluntarily decided to remain out of the labour market.

[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 the age of five if subject to current age-specific mortality rates. (http://www.childinfo.org/mortality.html and http://www.childmortality.org/)

on the map are: grey are undeveloped rural areas; pale green are completed projects; pink are future projects; yellow are current projects and white are cross boundary projects (as of 1 September 2005) (awaiting a more up to date version of this map).

The city authorities were faced with a massive sanitation and water backlog in the rural and peri-urban areas of the municipality in 2000, following the enlargement of the municipal boundaries to include numerous outlying villages into the eThekwini municipal. The backlog required urgent response to avert another outbreak of this deadly waterborne disease, cholera. It was decided to provide a packaged solution of both sanitation and water simultaneously. The basic sanitation and water package was to include a urine diversion dehydration toilet (UDDT) and a 200 litre yard water tank to all households outside of the reach of waterborne sewage system. The rural sanitation and water project was driven by the need to introduce a sustainable approach to accelerate the delivery of water and sanitation services to the poor un-served areas of the municipality.

A pilot project began in 2003 in the Mzinyathi, a peri-urban area west of Durban central. During the pilot project various designs for sanitation were looked at and the final decision to adopt the UDDT system was taken. The pilot and other implementation areas are selected on the basis of technical feasibility, financial need and human resources available and health related index, giving priorities to those areas with high incidence of waterborne diseases and where open defecation is still an established sanitation practice.

The following planning and implementation protocols are applied.

1. Planning
   - Prioritisation of project areas by the Health Department.
   - Local stakeholders consultation (EWS, health department, councillors)
   - Feasibility study by EWS: boundary definition
   - Approval of Council
   - Approval of budget
   - Appointment of Institutional and Social Development (ISD), geotechnical and hydrological consultants to undertake survey.
2. Implementation
   - Resource allocation, programming, site and establishment and start construction.
   - Introduction of project and project team to community by trained ISD community facilitators.
   - A rule governing the number of toilets built per household, was that only households with more than 8 people could have *two* toilets[5].

The construction began slowly as systems were trialed in 2003. Thereafter construction rose to 1,100 units per month (for 11 months of the year). As targets were met the rates declined. By late 2005 the project had rolled out 13,000 water tanks and 35,000 UDDTs. The roll-out of water saw 30 reservoirs and 1,500 km mains pipelines being laid. The lower adoption rate of the water tanks was attributed to the once off EUR 36 connection fee, which was not charged for UDDT implementation. Currently, in 2011, there are approx. 75,000 UDDTs (a number of 90,000 UDDTs has also been quoted in some publications but this is regarded as incorrect?).

The project is now being reassessed and the implementation team is going back and providing facilities for new migrants to the area.

5 Technologies applied

UDDTs are waterless toilet systems, where urine and faeces are separated at the source. In this case here, urine is piped into a urine soak-away pit which is constructed below the ground. The urine diversion is useful – even if urine is not used as fertiliser – because it allows drying of faeces, hence less odour, flies and no faecal sludge production.

Fig. 6: UDDT back view showing access doors to two vaults and ventilation pipes (source: EWS).

Two faecal vaults collect dry faeces to allow them to dehydrate, desiccate and slowly decompose. Most of the pathogens die off due to the drying process. Thus, the handling of human waste is relatively safe, provided that precautionary measures (such as use of gloves and hand-washing) are taken.

Several factors have influenced the selection of UDDTs over available sanitation options:

- Financial: the provision of waterborne sewage infrastructure to rural areas is much too costly. Similarly the cost of emptying single ventilated improved pit (VIP) latrines is very high (over 1,800 Rand per unit, approximately 188 EUR (exchange rate for South African Rands (March 2011): 1 EUR = 9.57 ZAR)). In 2005 it was estimated that the eThekwini Municipality would have to spend approximately EUR 7.3 million to address the 100,000 pit latrines which needed urgent emptying within the municipal boundaries.
- Technical/Physical: physical considerations (terrain configuration and inaccessible hilly locations) make VIP emptying by tanker trucks a daunting task, as well as the provision of a sewer system in the area impractical.
- Health: Manual emptying of VIP pits is a daunting task due to the health hazards for operators.

[5] Traditional customary rules governing the isiZulu people state that the Makhoti (daughter in-law) may not use the same toilet as her in-laws. Hence in some cases building only one toilet per household still left the daughter in-law without access to basic sanitation.

- If appropriately used, a UDDT allows a safe on-site disposal of human waste, with no need for municipal intervention.
- The volume of waste material handled is less than in a VIP latrine, where urine, greywater, faeces, cleansing material are all mixed and collected in the VIP pit.
- There is no need to build a new pit and superstructure after a UDDT is filled.
- The risk of environmental damage is limited as the waste is decomposed before exposing it to the outside environment, in contrast to the conventional VIPs, which allow seepage of human waste into the soil and potentially into the groundwater.
- UDDTs can be built closer to the houses as they do not smell[6]. (Have the UDDTs gradually moved closer to the houses over time, as the people have realised that they do not smell?) In more rural and traditional homesteads putting a UDDT inside one house is not a choice as multiple households within the homestead share the one or two UDDTs built.

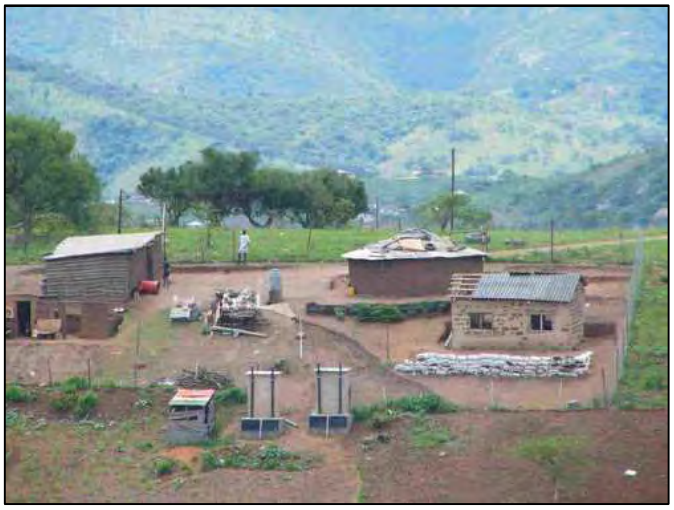

Fig 7: UDDTs' placement (front middle) in a traditional homestead (source: WIN-SA, 2006).

6 Design information

Water supply

Until July 2010, EWS has provided to each household 6 kL of drinking water per month free of charge. The yard tank is automatically filled with 200 litres of drinking water per day. Municipal mains are laid along district road reserves (land designated for roads??). Communal mains are laid along tracks and paths, supplying between 15 and 30 consumers. As of 1 July 2010, the amount of free water provided to yard tanks has been increased to 9 kL of water per month, equal to 300 litres per day per household (EWS, 2010).

Sanitation provision with UDDTs

The UDDTs installed in eThekwini municipality present unique features that suit local conditions and characteristics. The system features a double-vault dry ventilated toilet based on separation of urine from faeces. The urine is diverted to a soak away located near the toilet. A wall-mounted urinal, for male use, also diverts urine to the soak away.

[6] eThekwini Municipality did not offer the option of installing the UDDTs inside the houses, due to concerns that they might damage the house while constructing the UDDT.

The natural slope of the ground is used so that no stairs (or only few steps) are needed and the vaults are accessible at the lower end of the slope. One disadvantage of this design is possible dampness / moisture in the vault coming through the front wall over time.

A urine diversion plastic pedestal is located above the first chamber, which collects faeces, anal cleansing material and bulking agents. Sand or ash are added to the faeces after each use to facilitate drying of organic material and prevent odour and flies.

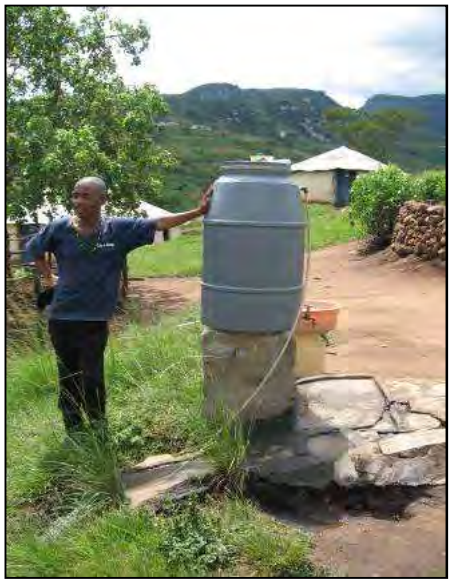

Fig. 8: 200 L yard water tank in Maphephetheni (source: EWS).

Fig. 9: Inside view of UDDT: urinal for men (left), bucket containing sand or ash and cover over second vault on the left side, as well as urine diversion pedestal to the right (source: EWS).

Once the first vault is full, it is sealed and allowed to rest and dry, the pedestal is moved over to the second vault. During the standing phase pathogen deactivation occurs, reducing the health hazards for the vault emptying process.

Once the second vault is filled, the first vault is manually emptied by a household member (trained by the municipality) or a local private vault clearing contractor, when the household prefers to pay for their vault to be cleared. Household members are requested to bury the content of the first vault. The pedestal is then positioned over the emptied vault, whilst the second vault is sealed and left to stand. Typically, one vault takes between **6 to 12 months** to fill, depending on household characteristics.

The pedestal used initially was an Atlas Plastic pedestal[7] which was the supplier of pedestals to the eThekwini Municipality prior to Envirosan, the current supplier (see section 11). The pedestal design was copied, with permission, directly from the concrete pedestals designed by Cesar Anorve from Mexico. The dimensions of the Atlas Plastic pedestal were kept when Envirosan designed their pedestal.

Fig. 10: Interior of a UDDT with sand container on the bottom left and plastic urine diversion pedestal at the top from Atlas (source: EWS)

7 Type and level of reuse

This project does not involve a nutrient recovery strategy. Studies have been conducted to provide a risk assessment of the reuse of faecal material from UDDT toilets:

The Pollution Research Group at the University of KwaZulu-Natal (UKZN) conducted a series of tests on pathogens in buried faecal matter from the UDDTs at a test site at the university (Buckley et al., 2008a; Buckley et al., 2008b).

Trönnberg *et al.* (2010) screened samples from the faecal vaults of 120 UDDTs in eThekwini and found a high occurrence of both protozoan and helminth infections: *Ascaris lumbricoides* (59%), *Giardia intestinalis* (54%), Trichuris trichiura (48%), *Cryptosporydium* spp. (21%) and *Taenia* spp. (18%). The high pathogen load recorded in these areas suggests the need of further community health and hygiene education as a pre-requisite of human waste reuse which is in line with WHO standards (WHO, 2006).

Although eThekwini is not advocating the use of dried or composted faecal matter or urine as a soil conditioner or fertiliser at this stage, this is something that could change in the future if there is a demand for soil conditioner or fertiliser.

8 Further project components

EWS highly values the role played by training, capacity building and education in the successful implementation of the UDDT project. These activities are described below:

Training and Capacity Building
Training activities are held at several levels:

- Training of Institutional and Social Development (ISD) consultants (by EWS) on the project aims and objectives.
- Training of community facilitators (by ISD consultants) on project information, health and hygiene education (with the focus on the employment of women).
- Building capacity of the Project Steering Committees (PSCs) by means of workshops. The PSCs act as communication channels between the project management team and the communities.

Education
ISD consultants liaise with local structures (councillors, tribe chiefs) to access the communities and provide appropriate education. Local facilitators who are selected, managed and trained by the ISD consultants, conduct house-to-house education.

During the project cycle, each household receives five visits from EWS health practitioners and education officers to perform the following activities:

1. Briefing on plans to provide water and sanitation to the household.
2. Health and hygiene education.
3. Information on how to use the UDDTs.
4. Explanation on the water system supply.
5. Education on operation and maintenance of the systems provided.

Fig. 11: Street theatre for hygiene and health education

Other ongoing education activities are routinely undertaken by EWS:

[7] http://www.atlasplasticsafrica.co.za/portable-toilets/sanitary-ware/attachment/plastic-toilet-pedestals/

- Post-implementation educational visits carried out using the PHAST approach (Participatory Hygiene and Sanitation Transformation).
- Sanitation and hygiene education by means of street theatre performances in public areas, such as schools, shopping centres, and taxi bays. The street theatre was used to reinforce the educational message around the correct use of toilets and breaking the cycle of waterborne disease. Crowds were attracted in innovative ways to the street theatre, such as through the use of mobile entertainment lorries and giveaways to the crowd for correctly answered quiz questions.

Development of local job opportunities

The implementation of the rural water and sanitation project aims to also increase local job opportunities by training and employing local skills in the project through:

- Recruiting local labour in construction and maintenance.
- Developing and supporting the emergence of local construction contractors.
- Developing local businesses for supply of bricks, sand, pre-packed dry and concrete mix.
- Setting up independent contractors to provide general operation and maintenance services.
- Training and employing local people as facilitators which created employment opportunities for women, young people and disabled. A guideline for employing facilitators was that 50% should be women, 35% youth and 15% people with disabilities.

Related water and sanitation projects

A further component of EWS efforts to provide adequate sanitation facilities to poor households in the municipality's informal settlements was the introduction of Community Ablution Blocks (CABs) in urban and peri-urban areas of Durban. These are communal water and sanitation facilities providing flush toilets, hand wash and laundry basins in areas located within the sewer system. For more information concerning CAB please see the separate SuSanA case study titled "Community ablution blocks with sewers or infiltration, eThekwini (Durban), South Africa" (http://www.susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=792).

9 Costs and economics

The entire program since 2003 has been financed by the eThekwini municipality and is funded through the Municipal Infrastructure Grant[8].

The households do not have to contribute at all to the capital cost. This is due to the specific situation of South Africa post-apartheid, where free provision of basic services is a general expectation by all.

The cost break-down per household UDDT is shown in Table 1. The total cost of one double vault UDDT is **EUR 322** which is in the medium to high range compared to other UDDT projects[9].

It should be noted that the costs of the UDDTs units varied depending on the density of the dwellings within the project boundaries, the topography, the transportation infrastructure and the distance from the project suppliers and accessibility of the household in terms of getting raw materials to the construction site. Also, the unit costs came down over time as the project was rolled out and the quantities ordered became larger (economies of scale).

The total investment cost (including both water and sanitation) as of 2007 has amounted to EUR 62,179,000 (for 75,000 households, this is equivalent to EUR 833 per household – slightly more than what is shown in Table 1.

With regard to operating and maintenance costs, these are entirely incurred by the households and the items are listed in section 10. Dry sand or soil for covering the faeces after defecation is available for free in the area.

Table 1: Cost break-down for the household UDDTs and water supply systems (exchange rate for South African Rands (March 2011): 1 EUR = 9.57 ZAR).

Item	Cost in EUR
Material (cement, slabs, concrete)	51
Structure	8
Roof (covering)	8
Carpentry and Joinery	32
Metal work	7
Ironmongery (door locks)	5
Plumbing and drainage	8
Sanitary fittings (is this the plastic urine diversion pedestal?)	50
Equipment (what is include here?)	53
Labour	102
Total for UDDT	**322**
Project management, Institutional and Social Development (ISD) consultants, facilitation and security	75
Water supply (water tank and pipe network)	313
Total water and sanitation project (per household)	**710**

10 Operation and maintenance

The UDDT programme places the responsibility of maintaining the sanitation facility on household members and

[8] The Municipal Infrastructure Grant funding comes from the central government and is administered by the Department of Water Affairs and Forestry; it is for the provision of basic sanitation for the unserved, see (mig.dplg.gov.za/Content/documents/Guidelines/Annex B - MIG Introductory Guideline.pdf).

[9] In the publication by WIN-SA (2006) a figure of ZAR 145 million for 35,000 UDDT was quoted, which would equate to EUR 475 per UDDT with an exchange rate of ZAR 8.7: EUR 1 for 2006.

empowers them to manage and maintain their own systems. Thus, household members are responsible for the following:

- Regular cleaning of the facility.
- Provision and use of wood ash or sand and toilet paper.
- Checking for urine pipe blockages.
- Removal of dried faeces from the vault once full (every 6 to 12 months).

Maintenance duties for which households are responsible, involve minor repairs of the water tap (hand washing unit), vault doors (due to rusting, termites), roofing and occasional repainting.

Fig.12: Emptying a UDDT faeces chamber (source: EWS).

The municipality supplied each household with a rake and gloves to do the emptying of their UDDTs safely. In addition, a system of local contractors who were trained at clearing and emptying the vault contents was established. This service was offered to those UDDT owners who did not want to empty their UDDTs themselves and cost between 5 – 10 EUR.

11 Practical experience and lessons learnt

In order to benefit from the practical experiences of work being done on the ground, a good feedback system needs to be in place. eThekwini municipality did this by commissioning an independent research organisation called Human Sciences Research Council (HSRC)[10], utilising research capacity at the University of KwaZulu-Natal (UKZN) and establishing a project steering committee, local facilitators and working closely with local constructors and the community.

Since the project inception in 2003 EWS has developed further experience in providing water and sanitation services which has been translated into valuable lessons learnt:

1. Allocating responsibilities to a single unit within eThekwini municipality. Allocating responsibilities for water and sanitation service delivery onto a single unit (EWS) increased the focus on outcomes as well as on quality rather than merely service provision. In addition, the full support of the municipal council provided the necessary political will. Moreover the use of available in-house capacity in conjunction with the emerging local contractors, which were encouraged and trained by the programme, allowed for an on-going improvement of both construction design as well as the supporting programmes. The emerging local contractors' skills remained in the community after the construction team had moved on.

2. Adoption of tried and tested methods. The UDDT technology and pedestal design had already been successfully used in other projects outside of South Africa and designs were adapted slightly to suit local conditions in eThekwini. In addition the use of street theatre was adapted from successful use in areas of community education.

3. Focus on users. EWS is committed to establishing a mutual trust relationship with UDDT users, rather than dealing with anonymous communities. Households are employed on various construction tasks related to the application as well as implementation of the water and sanitation systems.

4. Ongoing monitoring and evaluation of the implementation approach. Monitoring and evaluation conducted by EWS officers and independent institutions have provided valuable recommendations for interventions. Examples of insights gained are the following:

- A number of design faults were revealed by the HSRC after the EWS commissioned the HSRC to provide ongoing feedback on the impact of the initial UDDTs rollout through a longitudinal study as an independent evaluator. HSRC surveyed a sample of 1,160 randomly selected households, examining the effectiveness of education activities, system acceptance and system maintenance by household members. For example the UDDTs rear vault chamber covers were made out of cement and were heavy, easily broken and could not be re-sealed after inspection or emptying. A new design namely a plastic sliding door was retrofitted to all UDDT installations.
- A monitoring research survey was commissioned by the Pollution Research Group and the School of Development Studies of the University of KwaZulu-Natal to assess the status and benefits of the existing UDDTs installed. The comprehensive survey, which began in January 2011, was expected to be completed by May 2011. (only 5 months?)
- As the greatest risk of propagating diseases is in the process of emptying a faeces vault and burying its contents, vaults should be designed to ease the emptying process.
- Biological degradation and drying of the UDDT waste appear to be mainly dependent on contact with air so the design of the toilets should aim for good air circulation through the vaults.
- Aerobic biological decomposition of the faeces is a very fast reaction; there is a large reduction in biodegradable chemical oxygen demand (COD) in 24 hours. Drying is a much slower processes – occurring over weeks to months.
- Vent pipes covered with mesh allowed rainwater to enter the faecal vaults. This resulted in the bottom of the UDDT vault being wet. A new model of flyscreen, supplied by TCE, with an umbrella cap was thereafter introduced to remedy this problem.
- The lugs on the original Atlas pedestal were found to be too small and weak with the result that the pedestal collapsed through the hole in the base slab (are "lugs" the handles used to attach the pedestal to the base?). This led to the supplier being changed to Envirosan (who provided stronger lugs?).
- Pedestal design for adult users made UDDTs non-child-friendly toilets, resulting in parents discouraging their

[10] See their website: http://www.hsrc.ac.za/index.phtml

children from using UDDTs. EWS together with Envirosan have developed a prototype adaptor (child seat)[11], currently on trial, to achieve child-friendly UDDTs.
- The willingness to retrofit the existing UDDTs and alter the design of the UDDT when design flaws were discovered illustrated the eThekwini Municipality's commitment to the programme and contributed to the ongoing sustainability of the programme.
- Where households showed a lack of understanding of operation and maintenance requirements, more information was provided on the emptying process. After the ISD intervention it was decided to reinforce the messages to the users by using media such as street theatre, and an educational initiative at the local schools was started.

5. Critical number of units. The fact that the programme provided large numbers of UDDTs, encouraged manufactures like Envirosan (pedestal) and TCE (flyscreen) to invest time and money into developing and adapting their product designs to function well and meet users' needs.

6. Address the expectations of rural communities. EWS recognises that social acceptance of the project and political will both constitute important factors for the success in implementation of sanitation interventions.
- The HSRC study showed that while acceptance of water supply tanks was generally high, their satisfaction with the UDDTs was lower. Particularly those peri-urban areas close to waterborne sewers aspire to get flush toilets, considered a symbol of social emancipation[12]. Conversely, rural communities showed better acceptance of the UDDTs, as no proximity to and no comparison with households with flush toilets occurred.
- The greatest challenge in terms of acceptance was the clearing of the chambers[13]. The establishment of local faecal vault clearing services by micro-enterprises in the respective communities was a method of mitigating these acceptance challenges.

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[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 part of this project.

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 local 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 *expected* impacts of this project were the following:
- Improved access to water and sanitation services, which require no operation and maintenance from the municipality and place responsibility on users.
- Reduction of cholera episodes and incidence of waterborne diseases, as well as general improvement of the population's health.
- Higher awareness of health and hygiene issues.
- Infused sense of dignity onto local communities and improvement of people's privacy and safety.
- Creation of job opportunities related to UDDTs thus providing economic development for many poor people in the area.
- Beneficial impacts on the environment since human excreta is collected and disposed of safely.

Verified impacts of this UDDT project are as follows:
- A study conducted by the University of KwaZulu-Natal (Lutchminarayan, 2007) investigated the health impacts of UDDT use, comparing users with non-users. The research was conducted on 45 household clusters (total 1337 households) in rural and peri-urban areas of Durban, subdivided into three intervention areas (which received UDDTs and water tanks) and three controls areas, which did not receive the intervention. Significant improvements in the health conditions of the population receiving UDDTs

[11] See the eThekwini photo set from Envirosan, link details in Section 13.
[12] According to information by Richard Holden: Peri-urban areas with access to in-house, full pressure plumbing and waterborne sewage are subject to strict credit control. There were two court cases, one involving residents from peri-urban Chatsworth, Durban and another from peri-urban Phiri, Johannesburg, where residents were claiming that they had a constitutional right to free water and sanitation. Both metro's won the court cases and sent the message that some people are not more privileged than others when it comes to basic water and sanitation and that people need to move to an area that suits their financial means. (what is credit control?)
[13] With statements like "It is not in my culture to handle human waste" being made often by users prior to adoption (source: R. Holden).

and water tanks were measured. Specifically, the diarrhoea incidence in the serviced areas (incidence rate of 1.9 per 1000 persons per day) was significantly lower than the non-serviced areas (incidence rate 3.3.per 1000 persons per day). Furthermore the health benefits gained were measured to be three times greater in children under the age of five compared to adults.

- The backlog of provision of adequate sanitation and safe water which the programme set out to address in 2002 was completed by the end of 2010. Currently, in 2011, the project is being reassessed and the implementation team is going back and providing facilities for new migrants to the municipal area, with estimates that on-going construction (taking in-fill houses into account) will be at 10% per year.
- The extensive communication efforts at all levels of the eThekwini basic water and sanitation programme have achieved a better alignment between officials, councillors and the end-users in the community. The established open communication channels are a significant contributing factor to the success of this programme and shall continue to ensure its sustainability.

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More photos:
More photos of these UDDTs are available in this photo collection:
http://www.flickr.com/photos/gtzecosan/collections/72157609450416716/

Further readings:

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Executive summary of eThekweni Municipality Basic Water and Sanitation Programme.
http://www.durban.gov.za/durban/services/water_and_sanitation/policies_and_guidelines/business_plan/part1

Websites
eThekwini municipality: www.durban.gov.za

Department of Water Affairs and Forestry: www.dwaf.gov.za

eThekwini Community Profile:
www.durban.gov.za/durban/wardCatalog/index_html

14 Institutions, organisations and contact persons

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Large-scale Peri-urban and rural sanitation with UDDTs eThekwini Municipality (Durban) South Africa (draft)

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Case study of SuSanA projects

Large-scale Peri-urban and rural sanitation with UDDTs, eThekwini (Durban), South Africa - draft

SuSanA 2011

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Case study of sustainable sanitation projects

UDDTs for teachers at a primary school Arusha, Tanzania

Fig. 1: Project location

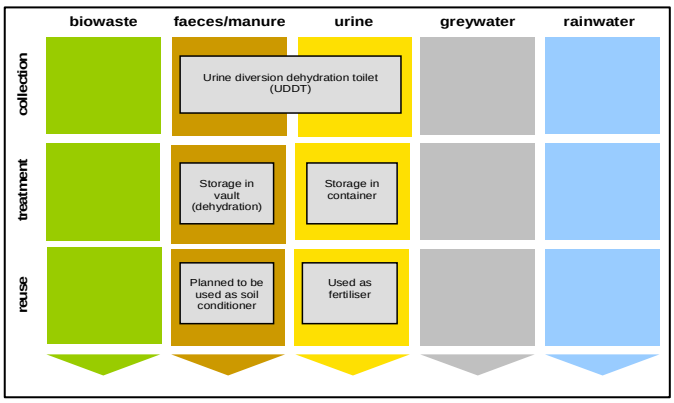

Fig. 2: Applied sanitation components in this project.

1 General data

Type of project:
New construction of pilot urine diversion dehydration toilets (UDDTs) at a school

Project period:
Start of construction: June 2008
End of construction: July 2008
Start of operation: March 2009
Ongoing monitoring period planned for: 24 months
Project end: March 2010

Project scale:
Number of persons covered: 56 (school teachers)
Total investment: EUR 1753

Address of project location:
P.O. Box 3013, Arusha, Tanzania
Daraja II Primary School, Sanare street, Daraja II ward

Planning institution:
ROSA Tanzania
Resource-Oriented Sanitation for peri-urban areas in Africa

Executing institution:

Arusha Municipal Council & University of Dar es Salaam

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 general objective of the ROSA project is to promote resource oriented sanitation concepts in schools, and the specific objectives of this project are to:

- Raise awareness of teachers on resource oriented sanitation concepts and to use this awareness as a basis for transferring the concept to students.
- Use the project for training of the community around and creating a rapid multiplying effect of the concept within the municipality.

The main expected impact of the project is to have a critical mass and wide spread adaptation of the concept**.**

3 Location and conditions

The project area (school) is located in one of the ROSA project pilot wards namely Daraja II in Arusha. The school has a small land area of less than two hectares (19,600 m^2) with pit latrines being used for excreta management. The school has a total enrolment of 2,457 students who share 17 pit latrines.

Fig. 3: UDDT toilet block (2 cubicles with 2 vaults each) made of concrete blocks in Daraja II primary school. The plastic tank for urine collection can be seen on the left side of the toilet. All pictures in this document are from the ROSA project in Arusha 2008-2010.

UDDTs for teachers at a primary school Arusha, Tanzania

Fifty-six (56) teachers share two pit latrines. The idea was to give time for the teachers to understand the resource oriented concepts and especially the O&M part with their own new UDDTs. Scaling up for the students toilets is left for the future when the capacity will have been built in the school. The estimated population of Arusha is 516,000 with 4% annual growth rate and the distance to the capital Dar es Salaam is 647 km. The average household size is 4.5 people.

Arusha municipality consists of people with multicultural religious backgrounds. About 95% of households are washers (meaning they use water for anal cleansing). This is so because apart from Muslims that do anal cleansing, non-Muslims also use water for anal cleansing due to limited funds to buy toilet paper.

In Tanzania, the under-five child mortality rate is currently 108[1] children per 1000 (compared to 163 per 1000 in 1990).

4 Project history

The selection and implementation of urine diversion dehydration toilets (UDDTs) in Daraja II primary school was based on a baseline survey carried out by the ROSA project and a series of stakeholder meetings (Fig. 4) to discuss sanitation challenges within the ward. Daraja II primary school was chosen as it was considered that it would bring impacts to the students and also community around the school. Due to limitations of resources (finance) it was decided that demonstration units should be designed for only members of staff (56 teachers) in the school.

Fig. 4: Stakeholder meetings in Daraja II ward.

5 Technologies applied

Urine diversion dehydration toilets were chosen by the project team for this project. This is due to the fact that the structure is permanent and there is a possibility of using the products from the toilet for local agriculture. Lack of smell and flies as a result of keeping faeces dry is a further advantage of this technology. Provision of two vaults per UDDT will give the product time to dry. Once one vault is full, the other vault will be used.

6 Design information

The UDDT was made based on EcoSan Club Manual (www.ecosan.eu). Four vaults were constructed (Fig. 5) in which two vaults were intended to be used by female teachers and the other two vaults for male teachers. Each vault has a size of 1 m^3 and a 1000 L plastic tank was placed adjacent to the stairs for urine collection. It is estimated that if the UDDTs are fully used it will take about four weeks to fill the urine tank. A valve has been provided at the bottom of the tank, which is used for emptying the urine tank.

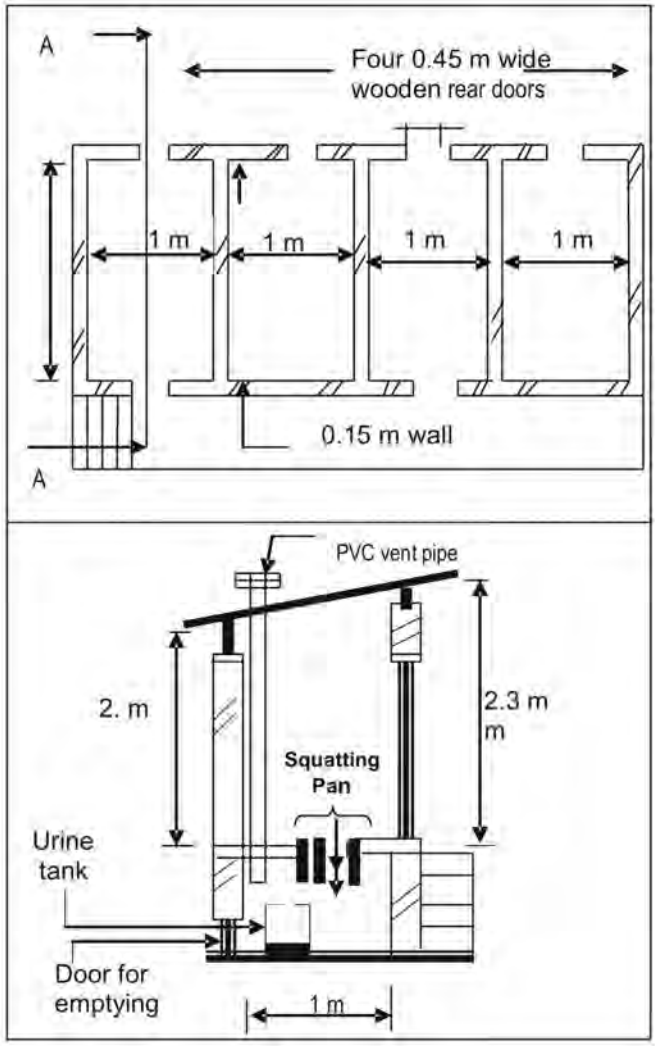

Fig. 5: Floor plan and cross section of the double vault UDDT.

For the UDDTs, concrete blocks of 12.7 cm thickness were used as substructure and the super structure was also built using concrete blocks of the same size. The plastic urine diversion squatting pans were imported from a supplier called Kentainer (Embassy area in Nairobi, Kenya). Access to the vaults is facilitated through black painted timber panels. The unit has an ablution place for washers, and the wash water is simply discharged to the ground. Emptying of faeces vaults is

[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/)

done through a rear wooden door painted black for facilitation of pathogen destruction.

7 Type and level of reuse

Since the beginning of its operation urine from the UDDTs is being used for fertilising flowers around the school compounds. This offers an opportunity for pupils in the school to learn how useful the products of UDDTs can be.

It is expected that in future urine and faeces will also be applied in other areas of the municipality where urban agriculture is carried out. Although this has not taken place yet, a ROSA project staff member from the municipality has established a section in the sanitation department to deal with the resource oriented issues in the future.

Fig. 7: Flowers in school compound fertilised by urine from UDDTs.

8 Further project components

There are no further project components.

9 Costs and economics

The costs for construction of the UDDTs in Daraja II primary school were fully covered by the ROSA project. The toilets were built by Kiure Construction Company at a total cost of EUR 1753 (see table below for a basic break-down; a more detailed cost break-down was not available).

The amount would correspond to **EUR 850** (1753 divided by two) for *one* UDDT. The cost is very high because the idea was to make the toilet impressive and nice. Also, a contractor[2] was hired to build it. Hiring a contractor is costly, because they pay tax and also charge high to make a profit. In other places where local masons were used the cost was much lower.

Table 1: Construction cost of *two* double vault UDDTs at Dajara II primary school including labour.

S/No	Particulars	Costs (EUR*)
1	Construction of substructure	878
2	Construction of superstructure	875
Total		1753

* 1 EUR = 1600 Tshs.

Building UDDTs by using local masons trained by ROSA is cheaper compared to those built by using contractors. Double vault UDDTs built by contractors cost EUR 877 as compared to those by local masons which cost EUR 410. These contractors normally offer services at high costs to earn good profit, which is contrary to local masons trained by ROSA project who do not have a company but good skills to do the work. The UDDTs for demonstration built by ROSA project followed government procurement procedure, which led the cost to be very high. This is a lesson which local authority has to take seriously.

The cost of a concrete squatting pan is EUR 3 in Tanzania, and the plastic urine diversion squatting pans from Kenya were about EUR 33 (the plastic one was used in this project). The company Henkel limited in Arusha also made glass fibre urine diversion squatting pan at a cost of EUR 63.

10 Operation and maintenance

There was a delay between the end of construction and commissioning of the new toilets due to some government protocol in commissioning of various projects. The school management wanted to make the occasion very official and to be done during independent torch day which made the whole process very much delayed. To date, the operation and maintenance of the UDDTs in Daraja II primary school has been left to the school management after receiving minimum training on how to use the toilet and reuse the UDDT products.

The headmaster has appointed one of the teachers (Ms Happiness) to be responsible for day-to-day maintenance of the toilet. She has to make sure that ashes and toilet papers are available and that general cleaning is done properly. The cleaning is done by students as part of their extracurricular (outside class) works as per school regulations.

There have been some problems in operating the UDDTs due to urine pipe blockage which has been experienced once. ROSA project staff was called to unblock the system (Fig. 7). The blockage occurred because some users poured ash into the urine compartment instead of the faeces hole. ROSA staff was called to unblock it because the school was still learning and some of the staff needed to learn as well since they were not following the required procedure.

[2] A “contractor” in the Tanzanian context is a specialist with a relatively high education level who might run a proper business.

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Fig. 8: ROSA project staff unblocking urine pipes at Daraja II primary school UDDT.

11 Practical experience and lessons learnt

There has been a follow up by the ROSA project to see what are the challenges and local constraints in operating this demonstration unit. Information on transportation and emptying operators has been collected. Through monitoring, some interventions and experiences have been shared with various stakeholders including the Daraja II primary school.

The operation and maintenance study which is mentioned in Section 13 has analysed the system in detail. Some findings are summarised below.

The estimation of transportation costs, which will allow operators to make profit, is affordable to majority of residents in the study area and as such there is a high chance for O&M of UDDTs to succeed in Arusha municipality. The important issue here is for the Municipal authority to establish resource-oriented section within the sanitation department to coordinate the process. There has been increase in the number of UDDTs by 60% from 5 UDDTs in 2008 to 8 UDDTs in 2009 as a result of the availability of masons trained by the ROSA project and promotion activities.

There have been challenges in operating the UDDTs in Arusha. These include:

- Blockage of urine pipes due to wrongly applying ashes to the urine hole.
- Smelling of toilets from time to time due to delay or inadequate application of ashes and not cleaning the urinal system.
- Delay in emptying of urine when the container is full.
- Using water for anal cleansing instead of paper or toilet paper (and not ensuring that the anal washwater is kept away from the faeces hole).

Observation on constructed UDDTs has indicated that those people who use their toilets properly (applying ashes after defecation and not allowing water to enter the faeces vault through the vent pipe or during moping, clean urinal pipe sometimes with little water) have their toilets with no flies, smell and as such their sanitation has been improved significantly. However there are some families (25% of UDDTs) who do not use their toilets properly. As a result they have flies, smell and the faeces become wet.

Much is expected to be done by ROSA project staff instead of school management: Since the unit was fully financed by ROSA project, the school management is expecting the project to continue supporting the O & M of the unit such as buying toilet paper and making follow-up visits. Hence, the ownership is low. Effort has been made to reduce this attitude.

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 the aspect not emphasized signify (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 respect to the longer term impacts of the project: The project concentrated in only three wards of Arusha: Daraja II, Lemara and Sokon I. The uptake of UDDTs has not been very good because of financial constraints. The private sector is not really enabled to get loans from banks due to lack of guarantees.

13 Available documents and references

Additional **photos** from this project are available at:
http://www.flickr.com/photos/gtzecosan/sets/72157626523775274/

Information on Arusha, Tanzania can be found at the ROSA website:
http://rosa.boku.ac.at/index.php?option=com_content&task=view&id=11&Itemid=11

Further publications:

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14 Institutions, organisations and contact persons

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www.kentainers.com

Case study of SuSanA projects
UDDTs for teachers at a primary school Arusha, Tanzania
SuSanA 2011

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Case study of sustainable sanitation projects

UDDTs for peri-urban households
Arusha, Tanzania

Fig. 1: Project location

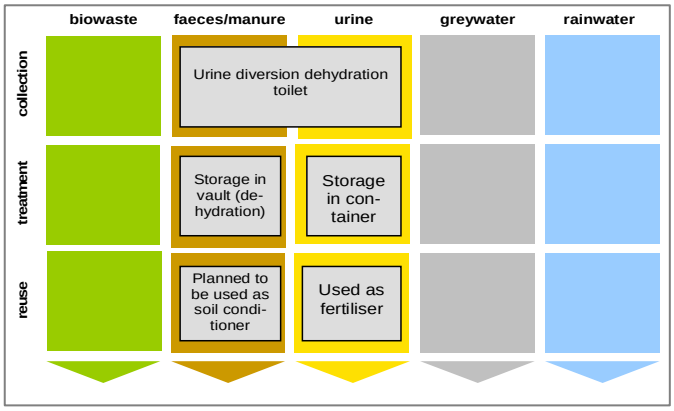

Fig. 2: Applied sanitation components in this project

1 General Data

Type of project:
Pilot scale urine diversion dehydration toilets (UDDTs) for peri- urban households

Project period:
Start of construction: February 2008
End of construction: May 2009
Start of operation: February 2008
Ongoing monitoring period planned for: 24 months
Project end: March 2010

Project scale:
Number of UDD toilets: 8
Number of inhabitants covered: approximately 36
Total investment: EUR 3,300

Address of project location:
Arusha Municpal, Central Bussines Area, Plot No 149, Block E-Building No 2 Sekei ward, Tanzania

Planning institution:
ROSA-Project, Arusha, Tanzania

Executing institution:
University of Dar es Salaam & Arusha Municipal Council, Tanzania

Supporting agency:
European Union and ISSUE-2 programme

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 general objective of the ROSA project is to promote resource oriented sanitation concepts in high density areas. The specific objectives of this project are to:

- Support capacity building in constructing, operating and maintaining UDDTs.
- Create awareness and demand of UDDTs as a viable solution for excreta management problems in the case study area and other wards of Arusha municipality.

The main expected impact of the project is an increased number of people owning UDDTs and wide knowledge on resource oriented sanitation concepts.

3 Location and conditions

The project area is located in Arusha, Tanzania. Three wards have been selected, namely: Daraja II, Lemara and Sokon I. These wards account for 26% of the municipal population. Most people are economically depending on the informal sector in the project area.

Fig. 3. Stakeholders meeting during planning phase (source: ROSA (Faraja Naiman), 2008).

It is estimated that the monthly average income per household in the project area is between 4 to 63 EUR. The area is characterised by high population density (2,600-

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Arusha, Tanzania

30,500 persons/km^2) and unplanned settlements with pit latrines being the major means of excreta management (75%). The emptying service is very difficult - especially in Daraja II - and sewerage system connection has not been established in the entire area with exception of a small portion.

The estimated population of Arusha is 516,000 with 4% growth per annum and the distance to the capital is 647 km. The average household size is 4.5 people.

Arusha municipality consists of people with multicultural religious backgrounds. About 95% of households are washers (meaning they use water for anal cleansing). This is so because apart from Muslims that do anal cleansing, non-Muslims also use water for anal cleansing due to limited funds to buy toilet paper.

In Tanzania, the under-five child mortality rate is currently[1] 108 children per 1000 (compared to 163 per 1000 in 1990).

4 Project history

The project came into existence since Arusha is one pilot city of the EU funded project "Resource-Oriented Sanitation concepts for peri-urban areas in Africa (ROSA) which took place in four countries in East Africa The design and construction of UDDTs started in February 2008 after the first draft of the Strategic Sanitation and Waste Plan (SSWP) for Arusha Municipality had been prepared.

The selection of the implementation and case study areas was based on a baseline survey and a series of stakeholder meetings, where households for demonstration were selected by a participatory approach (Figure 4). The ROSA project finished in March 2010.

5 Technologies applied

Urine diversion dehydration toilet technology (UDDT) was chosen by the project team due to the fact that the structure is permanent and there is the possibility of using the products from the toilet for local agriculture. Lack of smell and flies as a result of keeping faeces dry is a further main advantage of this technology. Due to the easy set up of these systems, household users are able to spread the information to others who do not have this type of toilet.

6 Design information

The design was adopted from EEPCO (Environmental Engineering and Pollution Control Organization), an NGO based in Dar es Salaam, which is dealing with environmental engineering and pollution control in Tanzania (http://www.eepco-tz.org/). This organisation has experience with design and constructing UDDTs in different locations in Tanzania including Pemba and Zanzibar. The EcoSan Club Manual from Austria was also consulted for designing the toilets (see Section 13 for the link).

The units constructed were double vault types (Figure 5) for five households and single vault types for three households. The size of each vault is 1 m^3. It is estimated that with 4-6 people per household, it will take 3-5 years for one vault to get full. In all UDDTs concrete blocks of 12.7cm thickness were used as substructure. The superstructure was also built using concrete blocks (Figure 6). In one case timbers (mabanzi) were used for walling. In the other cases 3-inch (7.5cm) blocks were used instead of the 5-inch (12.7 cm) blocks of the substructure[2].

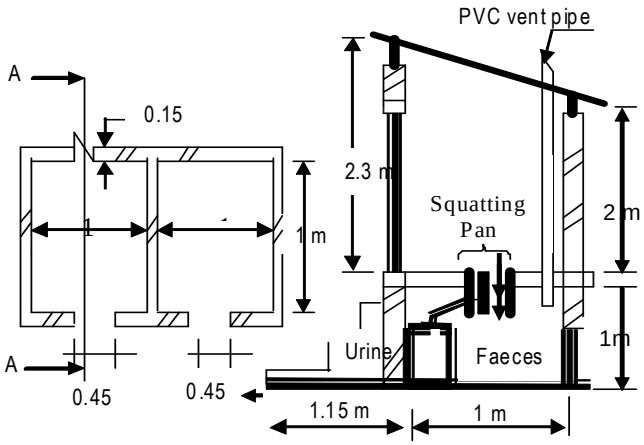

Fig. 4: Floor plan and cross section of double vault UDDT (Source: EEPCO, 2008).

Fig. 5 Single vault UDDTs in Daraja II built with concrete blocks (source: ROSA, 2008).

Some toilets were provided with plastic urine diversion squatting pans from Kenya (company Kentainer, see Section 14), but the majority was constructed using concrete urine diversion squatting pans that have been made locally in the project area (no paint is added to the concrete just ordinary Potland cement finishes). Access to the faeces vaults is provided by black timber panels.

[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/)

[2] This is usually long (3-5 years) more common will be one year.

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Urine is collected in 20 litres plastic jerrycans located adjacent to the main door (inside the vault). All UDDTs have a place for discharge of anal wash water since 95% of the people in the area are washers.

7 Type and level of reuse

The large area of Sokon I and Lemara and a small portion of Daraja II are practicing urban agriculture whereby maize, beans, banana and vegetables are the main crops in the area. The soil fertility in this area is low and the demand of fertiliser per household ranges between 0.05 to 10 tons per growing season. The cost of 50 kg urea is sold at about 30 EUR.

Due to the small size of containers used for urine collection (20 litres), urine is emptied almost after every two weeks and is then used at the farms around the households as fertiliser. Crops grown are predominantly banana and maize. Dried faeces have never been used to date since the vaults are not yet full even at those UDDTs built more than a year ago. Once the vaults are full the faeces will be dried and composted for improving soil condition or disposed to the municipal dumping area together with solid waste. The faeces from the single vault UDDTs will be dried outside the vault in a 60-liter container before composting.

The application of urine is done directly to the plant followed by an equal amount of water. The difference between those fertilised by urine and those left without urine is seen clearly in the growth rate and even the colour of leaves.

Fig. 6: Maize fertilised with urine (source: ROSA project O&M research, Arusha).

8 Further project components

- Promotion campaign on up-scaling and reuse with posters and exhibitions. The exhibitions were done every farmers day which took place on 8 August every year. In fact the ROSA project also built a UDDT at the exhibition ground.
- Research on factors affecting integration of UDDTs in informal settlements and their O&M costs.
- Research on greywater quality and quantity as well as a treatment.

9 Costs and economics

In this project most of the toilets built had their investment cost fully covered through ROSA/ISSUE-2 demonstration funds[3]. Cost sharing with households of up to 30% was seen in some cases. The cost of toilets for double vault UDDTs ranged from EUR 280 to 410 (Table 1). In Table 1, the costs vary depending on the user need. For example, if one decides to use a concrete squatting pan instead of the plastic pan, the cost will decrease by 5%.

Table 1: Cost break down for double vault UDDT in household (EUR).

COST ESTIMATION FOR SUBSTRUCTURE				
Requirements	Quantity	Unit	Unit cost	Total
Blocks	80	Number	0.29	23.1
Cement	4	Bags	6.74	26.9
Sand	13	Tins	0.24	3.1
Aggregate (0.5")	25	Tins	0.48	12.0
Basket	2	Number	1.44	2.9
Wire mesh	2	Pcs	6.74	13.5
Pipe (pvc 1")	5	Meter	1.20	6.0
Vent pipe (pvc 4") 6m	1	Number	1.20	1.2
Timber (1 x 8)	10	Number	3.37	33.7
Nails	0.5	Kg	0.77	0.4
Elbow (pvc 1")	2	Number	0.96	1.9
Wire net	1	m^2	0.29	0.3
Cap (pvc 4")	2	Number	0.96	1.9
Squatting pan (plastic)	1	Number	19.26	19.3
Labour Charge	1	Days	7.22	7.2
Total-1 (EUR)				**153.6**
COST ESTIMATION FOR SUPERSTRUCTURE				
Requirements	Quantity	Unit	Unit cost	Total
Walling blocks	120	Number	0.29	34.7
Sand	4	Tins	0.24	0.9
Nails	2	Kg	0.77	1.5
Cement	4	Bags	6.74	26.9
Corrugated Iron sheets (gauge 32)	4	Pcs	4.14	16.6
Doors	1	Number	38.52	38.5
Timber (2"×4")	3	Pcs	2.41	5.8
Timber (2"×2")	2	Pcs	1.44	1.9
Total-2 (EUR)				**126.9**
Labour	5	Days	7.22	36.1
Costs Total (EUR)				**316.6**

Note: 1.00 EUR= 2076.83Tshs (23-02-2011)

For single vault UDDTs the cost ranged from EUR 140 to 150. The operation costs are estimated to be EUR 1 to 2 a month. This involves labour costs for a person to empty the urine and to apply it at the farm near the household's compound.

The transportation costs for urine range from EUR 25 to 50 per truck which has the capacity of 6,000 to 14,000 litres. This means 300-700 households can have their urine collected every two weeks at an average of 0.07 to 0.08 EUR per

[3] ISSUE -2 was an EU funded project (Integrated Support for Sustainable Sanitation in Urban Environment). The project was not limited to Resource oriented sanitation only. The project was managed by EEPCO and supervised by WASTE in the Netherlands. It happens that WASTE was a partner organisation to ROSA project in Arusha.

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household or 0.14 to 0.17 EUR per month per household, respectively. These transportation costs are valid for a maximum of 8 km distance[4]. By using the pushcart, which can carry about 20 containers of 20 litres, these costs are estimated to be higher ranging from 0.25 to 0.31 EUR.

10 Operation and maintenance

To date, the operation and maintenance of the UDDTs within the project area is left to the households who have previously received minimum training on how to use the toilet and reuse the UDDT products. Pilot households are using their urine in their small banana, maize, flower and grass farms around their compounds.

The squatting pan is frequently cleaned with water to avoid clogging of the urine pipe and the application of ash in the vaults for stabilisation and odour prevention has been perceived well. In few incidences children discharged water for anal cleansing directly into the faeces vault and this sometimes created problems. Intervention is taken from time to time by ROSA project staff to make sure that the toilets are operated properly[5].

11 Practical experience and lessons learnt

People are very happy with their UDDTs and spread information of this new option to other areas. The pilot has made a head teacher from Ashira Primary School in Moshi to visit the area and now the school has six UDDTs for 500 students built by artisans trained by ROSA/ISSUE-2 (the distance from Moshi to Arusha is 73 km). The school paid from internal generated funds. The school was under pressure on excreta management.

Two more households in the study area have built their own single vault UDDTs without any financial support from ROSA.

Private operators who transport UDDTs' products and users of UDDTs' products are crucial key players to the success of the system. How is it working out? Were there any problems?

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).

Sustainability criteria	Collection and transport			Treatment			Transport and reuse		
	+	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).

Note: Long-term impacts since April 2010 are not known as monitoring of the project has stopped at that time.

13 Available documents and references

Additional **photos** from this project are available at:
http://www.flickr.com/photos/gtzecosan/sets/72157626523775274/

Information on Arusha, Tanzania can be found at the ROSA website:
http://rosa.boku.ac.at/index.php?option=com_content&task=view&id=11&Itemid=11

Further publications:

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- ROSA (2006). Resource-oriented sanitation concepts for peri-urban areas in Africa - a specific target research project funded within the EU 6th framework programme sub-priority, Annex I - "Description of Work".

[4] These are like petrol tankers with 6 m3 or 14 m3. The bigger it becomes the cheaper it is. The price was quoted from private operators.

[5] The intervention took place before the end of ROSA project. Municipal council has established ROSA unit within sanitation department to continue with monitoring of UDDTs you can write to pattkiny@yahoo.com for any question regarding monitoring program.

http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1095

- ROSA (2007). Assessment and baseline study for sanitation development of strategic and sanitation waste - Work package 6 team Arusha, Tanzania. ROSA Project Report. http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1096
- Senzia, M.A., Markus, L., Elke, M., Kimwaga, R. (2009). Local requirements and constraints of O&M of urine diverting dry toilets - Final report on O&M research topic. ROSA project, Arusha, Tanzania. http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1093

14 Institutions, organisations and contact persons

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Case study of SuSanA projects

UDDTs for peri-urban households, Arusha, Tanzania
SuSanA 2011

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Household composting of organic waste and faeces Kitgum Town, Uganda

Fig. 1: Project location

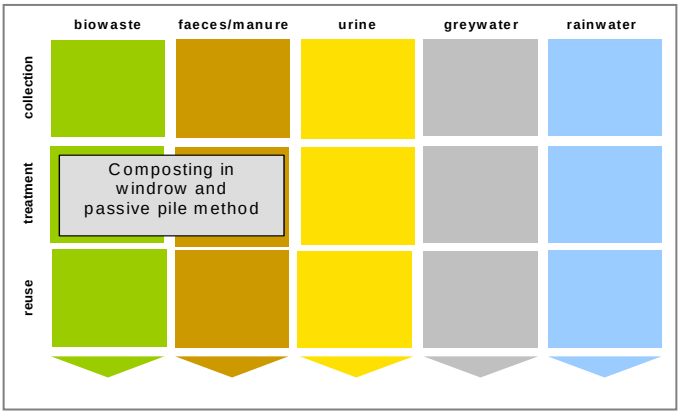

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Pilot scale construction of household based composting units

Project period:
Start of construction: April 2009
End of construction: June 2009
Start of operation: September 2009
Ongoing monitoring period planned for: until March 2010
Project end: March 2010

Project scale:
Number of inhabitants covered: 50 people (9 households)
Total investment: EUR 90 for 9 compost piles (future costs may be much lower according to type of composting, see also Section 9).

Address of project location:
Kitgum Town council, Uganda

Planning institution:
ROSA – Uganda: Kitgum Town Council, Makerere University and EcoSan Club, Austria

Executing institution:
Kitgum Town Council

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 overall objectives of the project were:

- to contribute to the current efforts for promoting resource-oriented sanitation concepts as a route to sustainable sanitation and to fulfil the UN MDGs,
- to research the gaps for the implementation of resource-oriented sanitation concepts in peri-urban areas,
- to develop a generally applicable adaptable framework for the development of participatory strategic sanitation & waste plans (SSWPs), and
- to implement resource-oriented sanitation concepts in four pilot cities in East Africa (Arba Minch, Ethiopia; Nakuru, Kenya; Arusha, Tanzania; and Kitgum, Uganda).

Specific objectives include

- Using composting in order to develop practical operation and management strategies for peri-urban areas
- Demonstrating safe resource reuse by sanitising food waste mixed with source-separated faeces using different composting techniques.

Fig. 3: Setting up of a compost windrow (photo by Samuel Olweny, 2009).

Household composting of organic waste and faeces Kitgum Town, Uganda

3 Location and conditions

Kitgum Town is the administrative centre of Kitgum District which is located in Northern Uganda, approximately 450 km north of Kampala, the capital of Uganda. Kitgum Town covers an approximate area of 30 square km and is situated at an altitude of 937 meters above sea level at the bank of River Pager.

The climate is hot throughout the year, with two marked rainy seasons from March to June and August to November, whereas the rest of the months are dry and windy. The mean annual maximum temperature is 31.8 ˚C and the mean annual minimum temperature is 17.3 ˚C, giving an overall mean annual temperature of 24.6 ˚C. The average annual rainfall adds up to 1130 mm.

The current population of Kitgum Town is approximately 62,000 inhabitants living in 8,500 households spread in 11 parishes and 32 villages.

Prior to 2006, the situation in Kitgum Town was characterised by three major factors:

a) exponential growth of the population, worsened by an influx of people – both semi-permanent residents and night commuters – fleeing from insecurity in the villages due to a precarious security situation (rebellion)

b) extremely low per capita income and inadequate access to external funding (donor funding)

c) lack of human resources as a result of the insecurity

Starting from a sanitary situation mainly based on the use of pit latrines, altogether these framework conditions led to the present situation where only a minority of people have access to sanitation facilities.

Kitgum Town Council (KTC) ranks solid waste management top on their list of sanitation problems followed by uncontrolled wastewater discharge in the central areas of town. However, the lack of adequate sanitation facilities, like toilets for excreta disposal in the peri-urban areas of the town, seems to be equally or even more important, particularly when considering the number of people concerned.

The rebellion ended in 2007, since then Kitgum Town is growing and numerous constructions are taking place in the area. Currently, there are efforts of people investing in sanitation systems and especially in ecological sanitation systems (such as urine diversion dry toilets (UDDTs), greywater tower gardens and composting).

Agriculture is the major source of income in Kitgum district with more than 85% of the population relying on sales of agricultural products. Not only in Kitgum, but also in a nationwide context is agriculture contributing largely to the economy despite mostly being carried out at subsistence level and a low degree of industrialisation.

Both cash and food crops are grown in Kitgum Town and surrounding areas. Food crops comprise beans, maize, peanuts, sweet potatoes, cassava, bananas, soya beans, sorghum, millet, cabbages, sesame seed and rice. Cash crops include: maize and sun-flower. Also grown on small scales are fruits like papaya, mangoes and oranges. Animals kept include cows, goats, sheep, pigs and poultry. People in the central part of the city, are engaged in commercial activities such as wholesale and retail business, vending in markets, and petty businesses including brick making.

In Uganda, the under-five child mortality rate[1] is currently 130 children per 1000, which is very high but at least there is currently a clear downward trend towards fewer child deaths.

4 Project history

The ROSA project started in October 2006. The first activity of the project was to conduct a baseline study, which was concluded by March 2007 in order to get basic information about the sanitation situation and the status of reusing nutrients from excreta, wastewater and greywater (ROSA, 2007).

The baseline study was carried out using local community maps, questionnaires and checklists. Focus group discussions, key informant interviews and interviews with the local community were held. The data was analysed using SPSS and EPI Info software packages. Local/international laws/regulations relevant to ROSA were reviewed; town wide data was collected, key features geo-referenced and plotted on the town map.

The baseline study findings were disseminated in a workshop for local/opinion leaders, technical and NGO staff working in KTC. In order to select system types for piloting, to carry out research and later implementation, local leaders, being the decision makers on behalf of the communities, were trained on a Multi-Criteria Decision Support System (MCDSS). This is a decision making tool that takes into account different criteria, such as various components and characteristics of a sanitation system enabling the user to make informed choices on sanitation options suitable for individual areas as well as treatment systems for faeces and food wastes to produce hygienic compost manure.

Local leaders provided input for the development of a Strategic Sanitation and Waste Plan (SSWP) and decided that pilot urine diversion dehydration toilets (UDDTs) with resource utilisation were constructed as learning objects.

Additionally, a demonstration of composting at household and community level for sanitising faeces and food wastes and converting them into soil conditioner completed the efforts. Considering the fact that the municipal solid waste collection rate was very low compared to the generation, coupled with frequent vehicle breakdowns and the cost of fuel, the Town Council and local leaders considered on-site organic waste processing via composting to be an important way to sustainably manage domestic wastes.

Nine households were identified and trained by ROSA, the Ecosan Club Austria (ESCA), and Kitgum staff (people working at the Kitgum Town Council) in February 2009 to carry out composting of solid waste and faeces. By July 2009 all targeted households had adapted the composting technique and were practicing it with minimum supervision from the ROSA staff.

The quick adaptation can be explained by the efforts put into sensitisation and training of the community. At the moment, all organic waste from the sample households is composted and applied to the gardens. Since it takes about a year for a

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

chamber to get full, the people who use UDDTs also compost the organic waste with dried faeces[2].

5 Technologies applied

Compost can be prepared in different forms or methods. The methods of aerobic composting most commonly applied are: Passive Pile Method (PPM), Aerated Static Pile Method (ASP) and Windrow Method (Haug, 1993). After a short overview about different methods is given in Section 5, a detailed description of the methods applied in the project[3] is given in section 6.

Passive pile method: In this method organic materials are placed in a pile and left for decomposition over an extended period of time. The pile is not aerated and its temperature, which is critical to proper composting, is not monitored. Passive compost piles often turn anaerobic. In this case, organisms that do not require oxygen, take control of the decomposition process, thus creating offending odours.

Aerated static pile: In this method the compost is not turned either. Instead of that, air is supplied for microbial activity through perforated pipes that are placed along the bottom of the windrow or pile. Composting is faster with the aerated static pile method.

Windrow method: In the windrow method, a mixture of feed stock materials is placed in a long, narrow pile. The pile is turned or mixed on a regular basis to provide oxygen throughout the pile. How often the windrow pile needs to be turned is determined by a variety of factors including the temperature, moisture level and porosity of the pile. The advantages of the windrow composting process include thorough mixing of materials.

6 Design information

Passive pile

Set up: As a first step, organic matter such as food residues (except meat and grease), leafs, weeds and faeces (from UDDTs) are piled up in an appropriate place. The pile it then left for decomposition. During this process the pile will reduce its volume and might release some offending odours.

To finally form compost, it takes between six months and two years from the time the material was accumulated, depending on the size of the pile, the material used and the climatic situation. The status of the pile can be checked by opening a part of it. When the colour of the material has turned blackish, the compost is finished.

Windrow

Set up: A windrow was constructed in a trapezoid shape with 2.5 m width and 1.3 m height (cross-sectional area approx. 1.6 m^2). The length of each windrow was chosen according to the size of the land available and the amount of materials to be piled at once (Fig. 4).

Fig. 4: Windrow covered with grass and mango leaves in Mrs. Aleng Christian's Home (photo by Samuel Olweny, 2009).

Generally shorter windrows were considered to be better to manage and to facilitate the mixing process, especially as the mixing of the material was done manually. A path or space of about 2.5 m was created between the windrows and they were constructed with a 5% slope towards a collection pond for the generated leachate.

Finally, the composting site should provide enough space for the collection of bulk materials and organic waste, an area for active decomposition (windrow), space for the curing stage, tools and storage of the end product (Fig. 3).

Piling and composting: Feed stocks (a mixture of food waste and faeces) and bulking materials (straw or sawdust) are mixed together according to their density and moisture level and spread into rows or piles. A commonly applied mixture ratio is 1:1. The whole length of a windrow should be made at once and piling starts with feedstock followed by bulking materials. The amount of water to be added depends on the moisture level of the feedstock and bulking materials.

After piling, micro-organisms in the mixed materials begin to feed on the nutrients in the raw material. This phase is an active decomposition phase where the windrow temperature will increase considerably.

Turning windrows: During this stage, frequent turning of the pile is important to mix the compost well, thus increasing aeration and lowering high pile temperatures. As a side effect the odour production will be minimised. The physical structure of the windrow affects the overall porosity and determines how well or how poorly a compost mix is aerated during the process.

Poorly aerated compost requires the most management in order to prevent potential build-up and release of offensive odours and a decrease in compost quality. Well aerated compost will reduce the amount of turning and improve compost quality, but can also lead to rapid drying of the compost before it has fully decomposed.

If the mix has a good structure in terms of porosity, then the windrow will only need to be turned 2-3 times during the entire process. The main reason to turn is to incorporate the material that is located on the edges and the outside of the pile or windrow into the inner regions where composting happens at a much more accelerated rate. Generally, while

[2] Answer from the main author regarding the number of operational UDDTs in Kitgum now: "It has been long since I last went to Kitgum so am not sure of how many people have UDDTs, and the person I could ask now left Kitgum".

[3] The windrow and the passive pile method were applied at the households due to small investment costs and a low complexity. Nine households have been identified in February 2009 for initial implementation.

decomposing, the mix tends to settle within 2-3 days of turning, attaining a higher level of density, which in turn requires more frequent turning.

The way of turning and its frequency can be approached differently. As stated earlier, temperature is the main way to monitor the progress of a compost mix. A compost mixture that exceeds 70 ℃ should be turned to release heat (but simple home composting, such as the method described here, would never reach temperatures this high (see also Berger (2010)). At such temperatures the beneficial microbes needed for decomposition begin to die off. For compost mixtures that have a moisture level of around 75%, turning can help release water vapour.

However, turning the compost too often can result in too much moisture being released. If both air and water are present and the pile has been mixed, either composting is finished or more nitrogen or carbon needs to be added for example by the addition of ash.

Monitoring the process: The temperature can easily be monitored by placing a hand into the pile. If the hand is not pulled back after some minutes, the temperature is below 50 °C. When the hand is pulled back after a few seconds, the temperature is above the 50 °C. If the hand is pulled back immediately, the temperature is above 70 °C which is not desired since certain beneficial bacteria will be lost (as mentioned above simple home composting, such as the method described here, would never reach temperatures this high).

Temperatures within the pile or windrow will gradually drop as active composting slows down and they will level out to ambient air temperature. Temperature could also be measured using a lance thermometer if available.

The moisture level of compost during active composting is recommended to range between 50 to 75%. This can be tested by trying to squeeze out water of a handful of compost. If some drops become visible, the moisture level is correct (Fig. 5).

Curing: When the active decomposition phase is completed after 3-4 weeks time, the compost can be moved to a separate pile where it is left to cure for another 3 months before application to the gardens.

Fig. 5: Estimation of initial moisture level of a mixture of compost and soil by the ”squeezing” method (photo by Richard Komakech, 2009).

7 Type and level of reuse

The high generation of organic waste in the town council of Kitgum that remains uncollected und untreated has forced the local people to look for low cost solid waste management options. Composting is one of the options and has been welcomed by the community. Waste that is being generated by households has been turned into compost which is later applied to their gardens as a soil conditioner and hence has increased the yields of the crops grown especially the vegetables (reports, research results and photos currently not available).

8 Further project components

A lot of sensitisation and awareness creation has been put in place concerning composting. Overall, more than 50 households were trained in hands on courses on how to make compost for their gardens. By January 2010, the total number of households performing on-site composting had grown to 100. All households who were trained on composting are doing it at their homes, producing compost for their gardens.

9 Costs and economics

Composting at household level according to the described methods involves zero to minimal costs. The inputs are usually for free and no extra investments have to be made. Some users prefer composting in a pit rather than on the ground to prevent the pile from being disturbed by the wind or roaming animals (goats, pigs and cows) (Fig. 6). The costs of digging such a pit can add up to EUR 25.

Fig. 6: Preparation of a composting pit (photo by Samuel Olweny, 2009).

10 Operation and maintenance

Operation and maintenance involves collection of household domestic wastes that are placed in piles or windrows and left for decomposition. Cow dung is sometimes being added as supplement to the nutrient level of the other wastes. Households that have UDDTs apply source-separated faeces to the compost pit whenever dried faeces are available.

O&M is mainly done by the women with the assistance of their children. Some people prefer the use of windrows while

others prefer the use of pits, especially where the spatial extent has to be minimised. Thus, the costs of O&M may be kept minimal or reduced to zero when done by the household members. Otherwise, it is estimated to cost less than EUR 10 per composting period. The costs include the turning of the compost, as well as spreading the compost on the garden.

11 Practical experience and lessons learnt

People's acceptability

- Many homes, whose members have been trained, started composting their organic waste. Most of them have prepared small gardens within their compounds where they are now applying manure and growing their crops.
- By involving people from various villages in the sensitisation workshops, the knowledge about composting could be disseminated extensively.

Lessons learnt

- Only few members of the community were willing and/or had the capacity to pay for their solid waste collection by private operators (the collection cost varies according to the particular operator and the weight of the waste). The majority of the households opted for composting to manage their organic wastes and apply the compost in their urban farmland while the few non-biodegradable wastes were taken to collection points where a Town Council truck collects them.
- The quantity of wastes generated at household level in the peri-urban areas of the Town Council is small compared to those produced by households in urban areas.
- Many private operators are sceptical about people's willingness to buy the final compost, considering the product as too expensive (1 kg of compost costs up to EUR 0.17). There are not many private operators in Kitgum involved in the solid waste collection. Usually, bids are made to the Town Council and the one offering the best bid takes up the job.

Challenges faced

- Many households in peri-urban areas only produce small amounts of organic waste. This makes the quantity of compost produced very small.
- Composting requires a certain amount of area for the process itself, the storage of raw materials and the storage of finished compost. Since land area is limited in Kitgum Town, this might pose constraints.
- The odour produced during the process of decomposition can be offensive and may generate complaints from nearby residents and by-passers.

After the end of the ROSA project, information dissemination of composting methods with other projects has been continued by the Kitgum Town Council.

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 represent weaknesses.

Table 1: Qualitative indication of the system sustainability. A cross in the respective column shows the assessment of the relative sustainability of the 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 is improved cleanliness of the area as well as increased productivity through the use of compost. This was assessed at the end of the project in March 2010 and is documented in the Town Council reports.

13 Available documents and references

More photos are available from main author.

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- ROSA (2007) Baseline study of Kitgum Town Council. Makerere University ROSA Staff. Kampala, Uganda. Available at: http://susana.org/%27.JRoute::_(%27index.php?option=com_ccbk&view=ccbktypeitem&Itemid=%27.397.%27&type=2&id=%27.783)

14 Institutions, organisations and contact persons

Project coordination, research and design support

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Training events, raising awareness

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Case study of SuSanA projects
Household composting of organic waste and faeces
SuSanA 2010

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Case study of sustainable sanitation projects

Greywater tower gardens at household level Kitgum, Uganda

Fig. 1: Project location

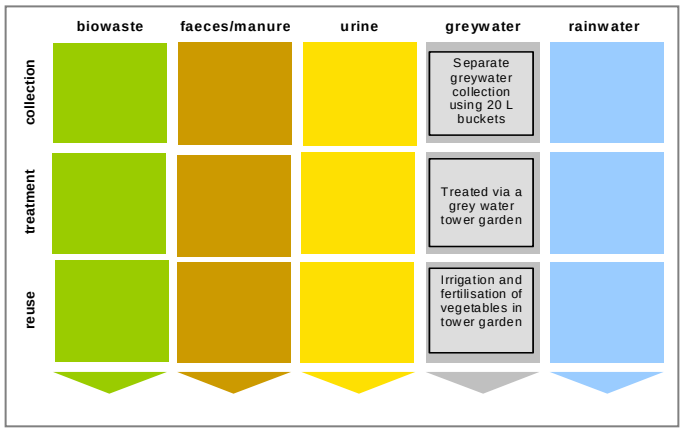

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Pilot scale construction of household based greywater reuse systems.

Project period:
Start of construction: January 2009
End of construction: February 2009
Start of operation: February 2009
Ongoing monitoring period planned for: August 2009
Project end: March 2010

Project scale:
Number of inhabitants covered: 40 (7 households)
Total investment EUR 63 per tower garden (including labour) for 21 greywater towers, giving a total of EUR 1323

Address of project location:
Kitgum Town council, Uganda

Planning institution:
ROSA Project Uganda: Kitgum Town Council, Makerere University and Ecosan Club, Austria

Executing institution:
Kitgum Town Council

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 overall objectives of the project were:

- to contribute to the current efforts for promoting resource-oriented sanitation concepts as a route to sustainable sanitation,
- to research the gaps for a successful implementation of resource oriented sanitation concepts in peri-urban areas,
- to develop a generally applicable and adaptable framework for the development of participatory strategic sanitation & waste plans (SSWPs), and
- to implement resource-oriented sanitation concepts in four pilot cities in East Africa (Arba Minch, Ethiopia; Nakuru, Kenya; Arusha, Tanzania; Kitgum, Uganda).

Specific objectives included:

- implementing the system described to demonstrate the treatment and reuse of greywater generated at households and
- scaling-up of this approach to improve nutrition and productivity and thereby contributing to poverty eradication.

Fig. 3: Two greywater towers in garden in Kitgum (photos by J. Kinobe, 2009).

Greywater tower gardens at household level Kitgum, Uganda

3 Location and conditions

Kitgum Town is the administrative centre of Kitgum District which is located in Northern Uganda, approximately 450 km north of Kampala, the capital of Uganda. Kitgum Town covers an approximate area of 30 square km and is situated at an altitude of 937 meters above sea level at the bank of River Pager.

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Kitgum Town Council (KTC) ranks solid waste management top on their list of sanitation problems followed by uncontrolled wastewater discharge in the central areas of town. However, the lack of adequate sanitation facilities, like toilets for excreta disposal in the peri-urban areas of the town, seems to be equally or even more important, particularly when considering the number of people concerned.

The rebellion ended in 2007, since then Kitgum Town is growing and numerous constructions are taking place in the area. Currently, there are efforts of people investing in sanitation systems and especially in ecological sanitation systems (such as urine diversion dry toilets (UDDTs), greywater tower gardens and composting).

Agriculture is the major source of income in Kitgum district with more than 85% of the population relying on sales of agricultural products. Not only in Kitgum, but also in a nationwide context is agriculture contributing largely to the economy despite mostly being carried out at subsistence level and a low degree of industrialisation.

Both cash and food crops are grown in Kitgum Town and surrounding areas. Food crops comprise beans, maize, peanuts, sweet potatoes, cassava, bananas, soya beans, sorghum, millet, cabbages, sesame seed and rice. Cash crops include: maize and sun-flower. Also grown on small scales are fruits like papaya, mangoes and oranges. Animals kept include cows, goats, sheep, pigs and poultry. People in the central part of the city, are engaged in commercial activities such as wholesale and retail business, vending in markets, and petty businesses including brick making.

In Uganda, the under-five child mortality rate[1] is currently 130 children per 1000, which is very high but at least there is currently a clear downward trend towards fewer child deaths.

4 Project history

The ROSA project started in October 2006. The first activity of the project was to conduct a baseline study, which was concluded by March 2007 in order to get basic information about the sanitation situation and the status of reusing nutrients from excreta, wastewater and greywater (ROSA, 2007).

The baseline study was carried out using local community maps, questionnaires and checklists. Focus group discussions, key informant interviews and interviews with the local community were held. The data was analysed using SPSS and EPI Info software packages. Local/international laws/regulations relevant to ROSA were reviewed, town wide data was collected, key features geo-referenced and plotted on the town map.

The baseline study findings were disseminated in a workshop for local/opinion leaders, technical and NGO staff working in KTC. In order to select system types for piloting, to carry out research and later implementation, local leaders, being the decision makers on behalf of the communities, were trained on a Multi-Criteria Decision Support System (MCDSS).This is a decision making tool that takes into account different criteria, such as various components and characteristics of a sanitation system enabling the user to make informed choices on sanitation options suitable for individual areas and develop a Strategic Sanitation and Waste Plan (SSWP).

5 Technologies applied

Tower gardens are a user-friendly and innovative way of using greywater for gardening in low and middle income countries and have been implemented for example in Kenya, South Africa and Ethiopia.

Three greywater tower gardens were set up at each of the selected seven households (a total of 21 towers). The study households were trained by the research team on how to set up the tower gardens as well as on the operation and maintenance aspects for effective performance.

To show the effects of this irrigation/fertilisation method, a control tower garden set up in exactly the same way as the other greywater towers and planted with the same vegetables, was irrigated with groundwater instead of greywater.

6 Design information

For setting up a tower garden, a circle with a diameter of 0.8 m was marked on the ground (Fig. 4a). This circle was excavated to a depth of about 0.5 m to form the base of the tower garden.

Wooden poles (2 m high) were planted firmly into the surrounding soil and a plastic bag (slightly lower than the

[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 reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html).

poles) with its base removed was tied around the poles to create a cylindrical sleeve (Fig. 4b).

After that, a bucket, also with its bottom removed was placed in the middle of the poles (Fig. 4c). Stones were carefully packed in the centre of the modified bucket (Fig. 4d), the remaining space between stones and bucket was filled with a soil mixture (Fig. 4e). The reason for placing the stones in the centre of the bucket was to create a vertical column, ensuring an even distribution of greywater throughout the surrounding soil mixture.

The soil mixture itself consisted of three parts of soil, two parts of animal manure and one part of ash (Fig. 4f). After reaching the upper rim of the bucket, the same had to be pulled out almost entirely in order to fill the inside again with stones and soil (Fig. 4g). The same had to happen with the bag - it was also pulled upwards to the same level as the bucket.

The whole procedure of filling and pulling bucket and bag upwards was repeated until a certain height of the tower garden (about 1m above ground) was reached (Fig. 4h – 4j).

Fig. 4: Setting up a tower garden with a height of approx. 2 m. Photos a –j are described in text above (photos by J. Kinobe, 2009).

7 Type and level of reuse

The baseline study indicated that there was no greywater reuse in the study area before (ROSA, 2007). The generated greywater was either disposed of in open places, open channels crossing the area and where possible in soak pits (68%, 11%, 21% of households, respectively) (ROSA, 2007).

These findings were corroborated by the interview results of the study where 76% of responding households disposed of laundry and 61% kitchen wastewater on the ground, while 71% discharge their bathroom wastewater into soak pits. Interestingly, 11% of responding households were already using the kitchen greywater as irrigation water in their gardens.

Interviews with locals indicated that they were not aware of any greywater disposal best practices but expressed a willingness to reuse greywater if taught how. The respondents from the study households indicated that there was no objection against having a demonstration unit for greywater reuse set up at their homes.

8 Further project components

Another project component consisted of gathering information about the impact of greywater on the soil. For that, soil samples were collected from each sample household prior to greywater application and analysed for pH, organic matter, nitrogen, phosphorus and potassium content.

After the application of greywater, soil samples were taken from the tower gardens on a monthly basis for a period of three months and analysed for the same parameters at the Soil Science Laboratory, Makerere University in Kampala, Uganda.

Greywater tower gardens at household level Kitgum, Uganda

Additionally to that, sensitisation efforts targeting different parts of the community were carried out. On the one hand they were applied to raise interest, inform the community and recruit stakeholders, on the other hand in order to assist and accompany the process of implementation.

9 Costs and economics

The investment cost for a tower garden is approx. EUR 63[2] (Table 1). The total investment costs were covered entirely by the ROSA project.

Table 1: Cost estimates for a tower garden.

Items	Costs in UGX	Costs in EUR[3]
Labour	50,000	18.50
Gravel	40,000	14.80
Buckets	45,000	16.70
Bamboo sticks	15,000	5.60
Plastic bags (e.g. second hand fertiliser or seed bags)	5,000	1.90
Compost	10,000	3.70
Ash	5,000	1.90
Total	**170,000**	**63.10**

10 Operation and maintenance

Tower gardens were operated in such a way that collected greywater from bathing and washing clothes was applied on a daily basis. The daily amount of greywater produced per household varied between 48 and 60 litres. Some of this greywater was used for cleaning the house as well as pit latrines, hence, not all of it was used for the tower gardens.

On average each greywater tower could receive about three litres of greywater per day (or 9 litres per household which had 3 greywater towers). Over the weekend, the greywater towers were rinsed with two buckets (about 10 litres) of clean water to wash away the soap residues.

The control tower garden received about three litres of water per day which had been collected from a spring commonly used as a source for water for domestic purposes such as washing, cooking and drinking. To allow gradual percolation, the greywater is slowly applied to the tower garden from a 500 ml container. The tower gardens are used to grow vegetables, mainly tomatoes and onions.

11 Practical experience and lessons learnt

The main sources of greywater in Kitgum town council are laundry, bath areas and kitchen. The effect of greywater application on the soil characteristics was not significant with respect to potassium, organic matter and nitrogen content. However a slight decrease in phosphorus content, possibly due to plant uptake was visible.

Tomato and onion plants grown in the tower gardens thrived with the greywater. Due to an infestation by pests, it was recommended to additionally apply pesticides on the plants.

Informal interviews with locals from Paradwong village in Kitgum Town Council revealed that knowledge about greywater towers was generated by the sensitisation measures and the residents were interested in constructing the units at their homes.

A walk through the area revealed fifteen additional households that set up greywater towers after realising the benefits associated with the study units. As no such systems existed in Kitgum before initiating and conducting the project, the knowledge had to be acquired from the same (cf. ROSA, 2007).

This success was also confirmed by the people involved in constructing the towers. Through the introduction of tower gardens people got an understanding of the advantages of reusing greywater. In consequence, more households set up small vegetable gardens on their land and applied greywater directly to the plants, probably motivated by the fact that there was no extra investment required compared to that for a tower garden costing EUR 63.

The clear advantage of a tower garden is the reuse of greywater for vegetable growth where there is limited land and a family cannot have a big garden like the one shown below (fig. 5).

Fig. 5: A boy applying greywater from washing his legs on tomato plants (photo by Samuel Olweny, 2009).

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.

[2] The investments cost estimations have to be considered as "pilot project costs". E.g., buckets only have to be purchased one time serving for the construction of several greywater towers. Also other construction materials can probably be obtained from the environment for a minimum price. Furthermore it has to be considered that the biggest cost fraction "labour costs" can probably be provided for free by the users.

[3] Exchange rate: UGX 2,700 = EUR 1 (dated: 04.06.2010)

Greywater tower gardens at household level Kitgum, Uganda

Table 2: Qualitative indication of the system sustainability.
A cross in the respective column shows the assessment of the relative sustainability of the 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		

After the end of this ROSA project, it is planned to undertake more investigations on tower gardens in peri-urban areas in Kampala in order to optimize the performance of the tower gardens, to assure a certain vegetable yield per soil volume as well as to further monitor the impact of the treated greywater on grop growth and on the general livelihood of the people. In general, tower gardens appear to be a promising option for solving the greywater disposal problem in peri-urban areas.

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 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).

The main long-term impact of the ROSA project is improving public health, which can be extended by improvements regarding the nutritional situation and poverty eradication, when the aspect of reuse takes off.

Regarding improvements related to public health (such as reduced rate of diarrhoea incidences in children), the effects of the entire ROSA project will be evaluated from the disease surveillance reports of the town council and the district, at least on an annual basis.

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Case study of SuSanA projects

Resource-Oriented Sanitation concepts for peri-urban areas in Africa (ROSA)

SuSanA 2011

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Case study of sustainable sanitation projects

Improvement of sanitation at Kanawat health center Kanawat, Uganda

Fig. 1: Project location

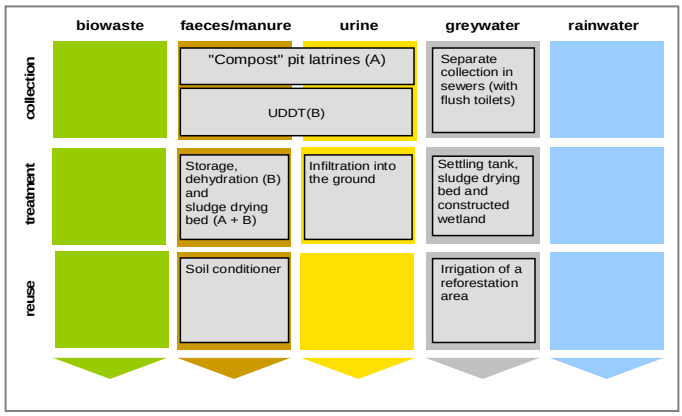

Fig. 2: Applied sanitation components in this project (A and B refer to two types of toilets used)

1 General data

Type of project:
Improvement of the sanitation system of a rural public health center

Project period:
Start of construction: January 2004
Start of operation: July 2004 (and ongoing)

Project scale:
Sanitation facilities for approx. 150 patients and 15 staff members.
Total cost approx. € 20,000 for consultancy and realization of 6 pit latrines, 1 UDD toilet block with 4 cubicles and other infrastructure components.

Address of project location:
Kanawat, Kotido District, Uganda

Planning institution:
EcoSan Club

Executing institution:
Norman Construction and Engineering Services, Kampala, Uganda

Supporting agency:
Austrian child care organisation "Dreikönigsaktion" (DKA): 100% fund

2 Objective and motivation of the project

The objectives of the project were to:

- improve the hygienic situation of the Kanawat Health Center with regard to water and sanitation as well as clinical waste.
- prevent the spreading of water-related diseases.

3 Location and conditions

The health center is located in Kotido District in the North-Eastern Karimojong region of Uganda. The is characterized by short rainfalls with long dry and hot periods. The different Karimojong tribes living in this region are still following a semi-nomadic lifestyle, mainly based on traditional livestock keeping and subsistence agriculture. The health center was founded in 1976 by Comboni missionaries and is being used by about 150 patients per day, and this number is steadily increasing.

Fig. 3: Shower and laundry washing area of the Health Center (source: EcoSan Club, 2004)

The sanitary situation before project implementation was as follows:

- Wastewater produced in the Health Center, nurses' houses and staff quarter (originating from some flush toilets and greywater from kitchen and showers) was collected in settling tanks and the overflow was drained into soak pits.
- Pit latrines served as toilets for patients' family members on the health center's compound. Due to hard rocky soil it was not possible to dig sufficiently deep pits. Thus, the toilet slab was raised by approx. 1.20 m above ground to achieve a sufficient storage volume and to ease emptying. Adjacent to these pit latrines, shelters were provided to be used as showers which however were misused for defecation. The

Improvement of sanitation at Kanawat health center Kanawat, Uganda

Health Center staff used pit latrines located near the staff houses.
- Wastewater was not treated at all. Drinking water wells within the compound were directly located near the pit latrines, showers and soak pits. Thus, the situation was dangerous for human health.
- In addition also the incinerator for the burning of medical waste was located on the small compound of the Health Center. Due to the malfunctioning of the incinerator, black and dense smoke polluted the air and insufficiently burnt medical waste was dumped uncontrolled.

In Uganda, the under-five mortality rate[1] is currently 130 children per 1000.

4 Project history

In 2002 the Austrian NGO named "Dreikönigsaktion" (DKA) started to support the health center in a first phase with an electrical solar system to supply electricity day and night independently of fuel (before that a generator with insufficient fuel supply was the only energy source).
In 2003 the second phase of the project addressed the hygienically insufficient conditions regarding sanitation, washing facilities and waste discharge.

Planning, technical design, supervision of the construction works and parts of the user training were carried out by EcoSan Club. Realization of the project was carried out by Norman Construction and Engineering Services. One site engineer, organizing and supervising the construction work of local contractors, was employed for the duration of the project implementation. The construction was completed in July 2004.

5 Technologies applied

The project consists of following 6 main components:

1. The 6 old pit latrines for the patients were reconstructed as pit latrines that can be emptied (without urine separation, for details see section 6), hereinafter referred to as "compost" pit latrines (however, the term "compost" is misleading because in fact there is no composting process taking place here). This decision was due to the following reasons:
   - The previously existing latrines which were already located above-ground had a large storage volume.
   - Local staff is familiar with their maintenance.
   - The pit content was planned to be reused at the Health Center's own cottage plantation for soil conditioning.
   - A change of users' behavior is not required.

2. A urine diversion dehydration (UDD) toilet block with 4 cubicles was constructed for the staff in order to avoid problems related to conventional latrines and to demonstrate modern technologies. The staff was regarded as able to modify their user behavior according to the demands of such a toilet system, which they did. The toilets are equipped with urine diversion squatting pans produced by Cress tank in Uganda (for details see section 14).
3. Renovation of showers and laundry washing place, connection to a sewer system in order to avoid mosquito breeding and groundwater pollution.

4. A PVC sewer was built in order to collect the remaining wastewater from the Health Center's flush toilets, showers and laundry washing place.

5. The sewer drains into a wastewater treatment system consisting of a settling tank, a sludge drying bed and a horizontal subsurface constructed wetland for secondary treatment of the settling tank's outflow. When reaching a certain level (ideally every 3 months, realistically once a year), the sludge from the settling tank is stirred and discharged by gravity via a pipe into the drying bed.

6. This treated wastewater is collected in a concrete tank to be reused as irrigation water (see section 7). The water tank is designed to store the maximum daily wastewater flow which was estimated to be 5 m³. Surplus water overflows to a subsurface percolation trench irrigating tree plantations.

Fig. 4: New UDD toilet block with 4 cubicles for the staff (source: EcoSan Club, 2004)

6 Design information

"Compost" pit latrines

The existing pit latrines were not significantly changed, only the vaults were renewed to support some composting to take place by providing emptying openings and a small extension with a metal cover for solar heating of the vault.

The health center management feared a misuse of urine diversion toilets by the patients and thus decided to stick to the traditional latrine system.

The bottom of the latrines has been sealed ex post with cement mortar. Liquids are discharged by a sewer into the constructed wetland and faecal material is emptied manually.

[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)

Improvement of sanitation at Kanawat health center Kanawat, Uganda

Fig. 5: New "compost" pit latrines for patients after reconstruction, side view (source: EcoSan Club, 2004)

Fig. 6: New "compost" pit latrines for patients, rear view, showing access openings for the removal of faecal sludge (source: EcoSan Club, 2004)

UDD toilets

The UDD toilet vaults can be emptied from the backside. Each toilet consists of an elevated concrete floor including a sealed plastic squatting pan (produced by Cress tank, Uganda). Ash is added after each defecation in order to absorb the moisture of the faeces and to raise the pH level so as to enhance pathogen destruction. The squatting pan leads faeces (together with anal cleansing material and ash) to a wooden basket located underneath in an above ground dehydration vault. These dehydration vaults are covered by metal sheets in order to benefit from solar heating. The baskets are emptied once a year and brought to an outside drying area for further dehydration. The drying area is situated close to the toilets in order to avoid long transport distances. After further drying the material is used as a soil conditioner.

Urine is infiltrated via a soak pit into the ground because its usage is not intended by the beneficiaries (see section 7). The soak pit is located next to the toilets.

Constructed wetland

For the treatment of the remaining wastewater (some flush toilets and greywater) a horizontal subsurface flow constructed wetland system was built on an area of 45 m² growing indigenous non-fruit plants. Wastewater is pre-treated in a settling tank to remove solids (by sedimentation and flotation) before it flows by gravity to the inlet of the constructed wetland. The faecal sludge from the settling tank is regularly emptied (ideally every 3 months, realistically once a year) and the material is dried together with faecal material from the UDD toilets at the drying area.

The inlet of the constructed wetland comprises coarse aggregate (diameter of 60-80 mm) in order to distribute the wastewater horizontally before it enters the actual treatment part consisting of sand (diameter of 4-8 mm). The bottom of the filter bed has a slope of 1%. At its lower end another area of coarse aggregate including a drain pipe (PVC DN 100) collects the purified wastewater which is piped via an outlet manhole to an underground percolation ditch in the nearby reforestation area (10m of drain pipe DN 100 in a layer of coarse aggregate and covered with excavated material and soil).

Fig. 7: Constructed wetland (5m x 9m) before greening in 2004 (source: EcoSan Club)

Fig. 8: Constructed wetland in 2006 (source: EcoSan Club)

Improvement of sanitation at Kanawat health center Kanawat, Uganda

7 Type and level of reuse

The project focused on the improvement of the hygienically poor situation while reuse was rather a minor point due to urgency of the first target.

But within a few months the use of the treated wastewater gained attention and local project partners started the construction of an irrigation system for its use in a reforestation area near the Health Center (different owner).

Urine is infiltrated via a soak pit into the ground. Currently there is no demand for urine as a fertilizer since the Health Center does not own plantations that could use urine as a fertilizer.

Dried faeces from the UDD toilets, so called "compost" from the pit latrines and the settling tank's faecal sludge discharged onto the sludge drying bed are buried in furrows next to the Health Center's own cottage plantation for soil conditioning.

8 Further project components

A low cost medical waste incinerator based on a project of the Applied Sciences Faculty of De Montfort University in Leicester was constructed. Burnt residues are disposed in a covered and fenced dumping area, built on request of the project owner.

Fig. 9: Medical waste incinerator constructed on the Health Center's compound, 2004 (source: EcoSan Club)

9 Costs and economics

A detailed cost breakdown is not available. However, the actual entire costs for construction and consultancy were approx. € 20,000. O&M costs are approx. € 500 per year as salary for one full time operator and some minor spare parts. Those costs are covered by the Health Center's budget.

10 Operation and maintenance

The responsible person for O&M is employed by the Health Center. He was trained in two workshops on water supply and sanitation at the Matany Hospital (September 2003, June 2004). He has also implemented parts of the ecological sanitation concept at his own home.

His main O&M activities are:

- Checking of the treatment plant
- Cleaning of the settling tank
- Emptying the UDD toilets
- Maintenance of the "compost" pit latrines
- Checking the sewer for blockages and removal of blockages

An O&M manual was prepared together with the water and sanitation workshop participants in June 2004. Back-stopping for additional questions on-site was provided by the EcoSan Club for 2 years after implementation (i.e. up until 2006).

Fig. 10: Sanitation workshop at Matany Hospital, Uganda, 2003 (source: EcoSan Club)

11 Practical experience and lessons learnt

The hygienic situation of the Health Center has improved a lot and a certain demonstration effect has been achieved. The new system still allows for further improvement and additional options.

In the case of wastewater reuse, it could be noted how a well functioning treatment system created a demand for the "product" (i.e. treated wastewater) just due to its availability and thus contributes to a multiplying effect.

However, the aspects of hygienization and reuse of faeces and urine could not be considered in detail due to financial restrictions and the special setting of this project (majority of temporary users, focus on dealing with health problems rather than agriculture).

Experience has shown that the partly reconstructed pit latrines to so called "compost" pit latrines did not lead to satisfying results. Due to their poor design and subsequently difficult maintenance the "compost" pit latrines never worked properly.

Other problems were the limited capacity of workers to read and understand technical drawings, the lack of knowledge of sanitation concepts and the partly poor workmanship of local construction companies. Thus, a certain extent of constructive adaptations became necessary which delayed the project and increased the costs.

Improvement of sanitation at Kanawat health center Kanawat, Uganda

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 emphasized (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[1]		
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	

[1]Reuse of the treated wastewater only (urine and faeces are not reused)

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).

The main long-term impact of the project is the prevention of the spreading of water-borne diseases. A two year monitoring (2004-2006) showed that the toilets are well accepted by both staff and patients, that the treated excreta (dried faeces from UDD toilets) is used in the Health Center's cottage production and the treated material is pathogen poor.

13 Available documents and references

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- Information on low cost medical waste incinerator, Applied Sciences Faculty of De Montfort University Leicester: http://www.mw-incinerator.info/en/101_welcome.html

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Case study of SuSanA projects

Improvement of sanitation at Kanawat Health Center, Kanawa, Uganda

SuSanA 2009

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Case study of sustainable sanitation projects

UDD toilets at a rural secondary school Kalungu, Uganda

Fig. 1: Project location

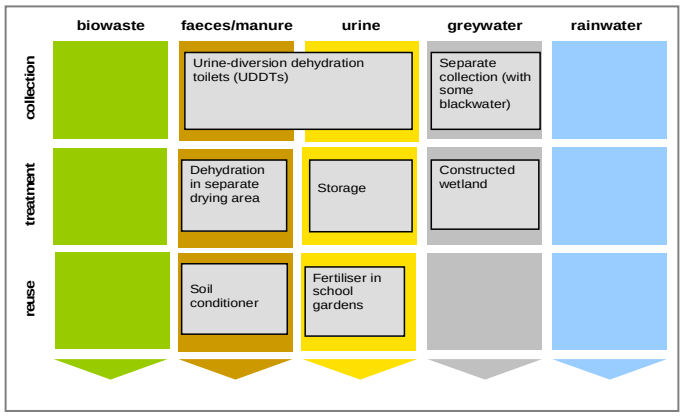

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Sanitation and water supply at a rural secondary school

Project period:
Start of planning: 2000
Start of construction: 2003
Start of operation: 2004 (and ongoing)

Project scale:
Upgrading of water supply and sanitation facilities for students (350) and teachers (50)
Construction and consultancy costs: approx. EUR 70,000

Address of project location:
Kalungu, Masaka District, Uganda

Planning institution:
EcoSan Club Austria
Consulting Firm: Technisches Büro Lechner (TBL)

Executing institution:
Norman Construction and Engineering Services, Kampala, Uganda (for construction)
Technisches Büro Lechner, Austria (for supervision)

Supporting agency:
Manos Unidas – a Spanish NGO (www.manosunidas.org)

2 Objective and motivation of the project

The objectives of this project at the Kalungu Girls Secondary School were to:

- reduce groundwater and drinking water pollution caused by inadequate sanitation systems.
- improve both quality and quantity of drinking water supply.

3 Location and conditions

The boarding secondary school for girls of the "Sacred Heart Sisters" is located in the hilly areas of Masaka District, 130 km southwest of the capital Kampala, near the town Masaka. It currently has 350 students who study and live at the school. The school is located near Kalungu, a small rural village[1], surrounded by farm land. 50 teachers and sisters are employed there (the sisters are either in the school's administration and/or teachers). The "Sacred Heart Sisters" school is financed mainly through the school fees, which amount to EUR 240 per year.

Fig. 3: School compound of "Sacred Heart Sisters" secondary school near Kalungu village (source: EcoSan Club, 2009)

The initial sanitation situation before 2003 was as follows: Wastewater from the teachers' quarters and sisters' house (flush toilets and greywater from kitchen and showers) was drained in soak pits. The students used 35 pit latrines.

[1] Kalungu is a small trading centre with several hundred or perhaps two thousand inhabitants (exact number not available).

UDD toilets at a rural secondary school Kalungu, Uganda

Greywater from showers and the kitchen was discharged in a creek outside the school's compound. The situation was dangerous for human health because the groundwater table was high, and the soak pits and pit latrines were located near the spring used by the school and local villagers as drinking water.

In Uganda, the under-five child mortality rate[2] is currently 130 children per 1000, which is very high but at least there is currently a clear downward trend towards fewer child deaths.

4 Project history

In the year 2000, Markus Lechner (from the Austrian Consulting firm TBL) was invited by Sister Maria from the "Sacred Heart Sisters" for a first site visit to gain an overview of the situation. After preparing a feasibility study, a meeting between TBL and the school administration was organised to discuss the required water supply and sanitation improvements.

In 2003, detailed planning, design, construction, supervision and training sessions were carried out by TBL with support of the EcoSan Club (an Austrian NGO). Construction was carried out by Norman Construction and Engineering Services in 2003. Two site engineers, organising and supervising the construction work of local contractors, were employed for the duration of the project implementation. The operation of the new sanitation system began in 2004.

The idea of having a demonstration toilet for teachers and visitors came up during the discussions on how to convince the users of the advantages of urine-diversion dehydration toilets (UDDTs). Constructing the same type of toilets for both, students and teachers, seemed to be the most suitable way to ensure a proper use of the toilets with support of shared knowledge.

Based on that idea, the design of the demonstration toilet unit was developed in a participatory way with the teachers to create a feeling of ownership and responsibility. A series of possible designs were presented to the teachers and any decisions (such as location of the toilet; sitting or squatting type; waterless urinal for men) were discussed with them.

5 Technologies applied

The project consists of the following three main components:

1. For the students, the existing pit latrines were replaced by 45 UDD toilets. This technology is in line with the "National Strategy to promote ecological sanitation in Uganda" (Ministry of Health, 2003). UDD toilets were selected in preference to composting toilets because their maintenance is less complicated, though secondary treatment of faeces might be necessary (carried out here via further drying). No waterless urinals are used in the students' toilets because it is a school for girls.
2. For the teachers, a UDD toilet building was constructed which also serves as a demonstration unit for visitors. It is located near the main entrance of the school and has an attractive design.
3. The remaining wastewater is treated in a horizontal sub-surface flow constructed wetland. The wastewater is a mixture of greywater with a small share of black water from the sisters' house where three flush toilets are still in use. The sisters did not want to change these flush toilets because they were only recently installed and were working well. The sewer from the sisters' house is now connected to the treatment plant. The reasons for choosing a constructed wetland were as follows:
   - Simplicity of construction and low costs
   - Low operation and maintenance requirements
   - Enhanced nutrient removal is not required since the amount of nutrients (nitrogen and phosphorus) is low due to the implementation of the UDD toilets.
   - Legal environmental standards for discharge of effluent into water or on land in Uganda can be fulfilled.
   - The subsurface flow constructed wetland has no free water surface (this prevents mosquito breeding).

Fig. 4: New students' toilets (45 UDDTs) - these are now five years old and still in perfect condition (source: EcoSan Club, 2009).

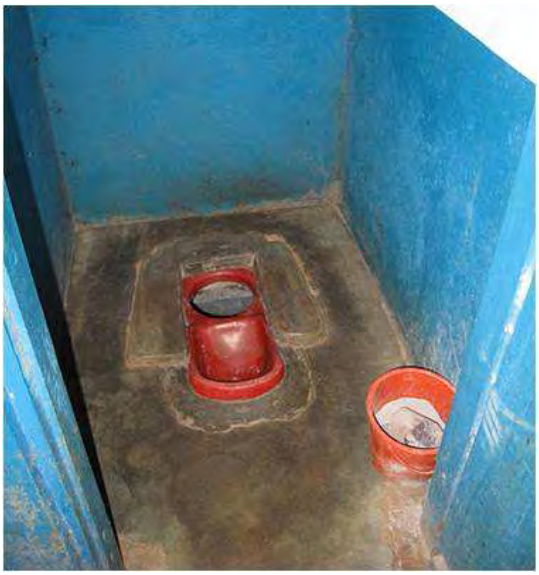

Fig. 5: Interior of a UDD toilet for students, showing UD squatting pan after approx. five years of use (source: EcoSan Club, 2009).

[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 the age of five if subject to current age-specific mortality rates. (http://www.childinfo.org/mortality.html and http://www.childmortality.org).

UDD toilets at a rural secondary school Kalungu, Uganda

Fig. 6: Demonstration UDD toilet for teachers and visitors, five years old (source: EcoSan Club, 2009)

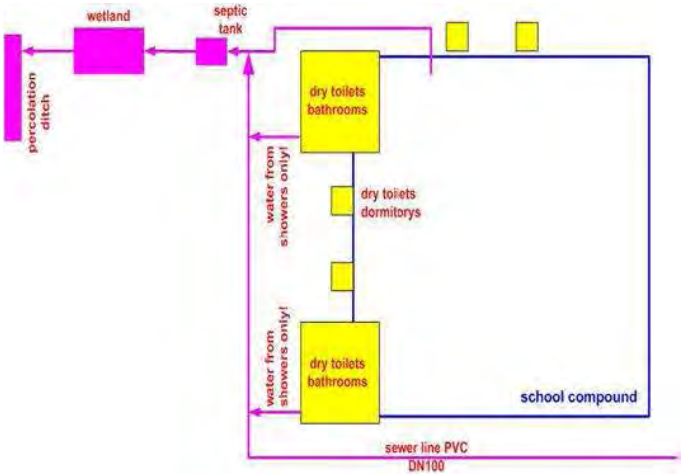

Fig. 7: Scheme of new greywater system; flow is from right to left (source: EcoSan Club).

6 Design information

UDD toilets (single-vault) for students

The UDD toilets are built in blocks which allow the operator, who is employed by the school, to empty the faeces chambers from the back of the building. Each toilet consists of an elevated concrete floor including a plastic urine diversion squatting pan (produced by Crestanks, Uganda). Via the squatting pan, faeces, toilet paper and ash are collected in a wooden basket located in a drying chamber under the squatting pan. These baskets are emptied after every school term (i.e. every three months) and brought to an outside (fenced) drying area for further drying for six months. The drying area is situated close to the school to avoid long transport distances. As the material is sufficiently dry, there is no odour.

Urine is led to an underground tank which is situated behind the toilets (as the urine tank was installed by the school, further information on the tank is not available). Urine can alternatively be led to a soak pit for infiltration into the ground. The four soak pits are next to the toilets. Experience has shown that all urine is used in agriculture and none is infiltrated in these soak pits.

Demonstration toilet (UDDT) for teachers and visitors

The demonstration UDD toilet was built with an attractive design. A designer made a first draft, and the school teachers contributed further ideas during a workshop.

Urine from the demonstration toilet is collected in 20 L jerry cans while the collection of the faecal material is identical to the students' toilets. The demonstration unit is additionally equipped with a waterless urinal for male users to reduce the amount of urine entering the faeces chamber.

Fig. 8: Wooden faeces collection basket in vault of UDDT. In front Alex Oryem, the site engineer from Norman Construction (source: EcoSan Club, 2005).

Constructed wetland

For the treatment of the greywater and some blackwater from the few remaining flush toilets, a horizontal subsurface flow constructed wetland system was built. Wastewater is pre-treated in a 29 m^3 settling tank to remove solids (by sedimentation and flotation) before it flows by gravity to the inlet of the constructed wetland, which has a size of 170 m^2. The sludge from the settling tank is regularly emptied (at least once a year) and the material is dried together with faecal material from the UDD toilets at the drying area.

The inlet area of the constructed wetland comprises coarse gravel (diameter of 6-8 cm) in order to distribute the wastewater horizontally before it enters the actual treatment part consisting of sand (diameter of 4-8 mm) – see Figure 9 and 10. The bottom of the filter bed has a slope of 1%. At its lower end another area of coarse gravel and a PVC drain pipe (diameter 100 mm) collect the purified greywater which is piped via a manhole to an underground percolation ditch. The percolation ditch comprises of 10 m of drain pipe (diameter 100 mm) in a layer of coarse gravel and covered with excavated material and soil.

The layers of the constructed wetland are characterised as follows (from top to bottom): freeboard of 20 cm; protection layer with coarse gravel (5 cm); filter sand (70 cm); a water tight layer of plastic sheet as lining at the bottom (polyethylene); and sand (5 cm). The wetland is planted with elephant grass.

The effluent from the constructed wetland is not reused but infiltrated in the soil. The volumes of wastewater, urine and faeces generated in the school are not being monitored.

UDD toilets at a rural secondary school Kalungu, Uganda

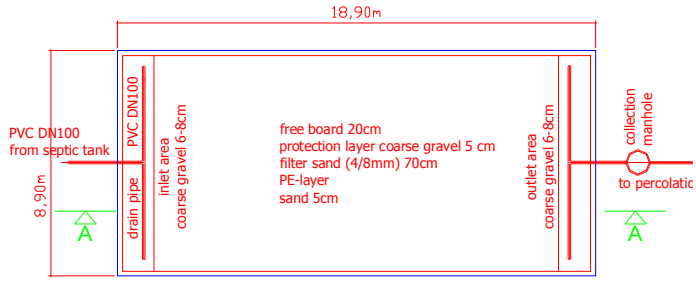

Fig. 9: Plan view of horizontal flow constructed wetland, flow is from left to right (source: EcoSan Club).

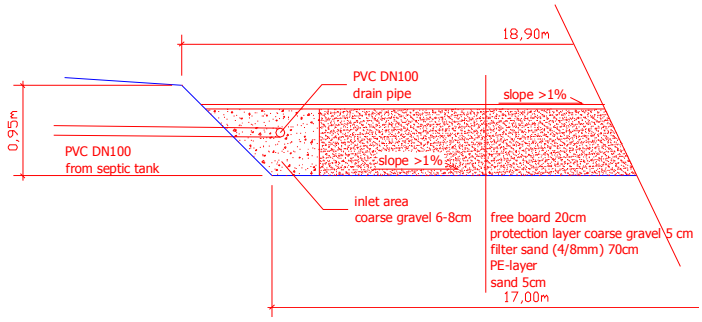

Fig. 10: Cross section A-A from Fig. 9 showing inlet area of horizontal flow constructed wetland (source: EcoSan Club)

Fig. 11: Constructed wetland, planted with elephant grass (source: EcoSan Club, 2005 – no new photos available but looks more lush now).

7 Type and level of reuse

The possibility of reuse (for urine and faeces) was one of the main motivations for the school administration to support the project since a farm producing food for the school is adjacent to the school compound.

The **dried faeces material** from the drying area is screened via a coarse-meshed sieve before being reused as a fertiliser and soil conditioner in the surrounding banana and matoke plantation or as a soil conditioner in the school gardens. The sieved-out material like sanitary pads and toilet paper is burnt.

Fig. 12: Reuse of dried faeces in banana plantation adjacent to school compound (source: EcoSan Club, 2009).

Fig. 13: Covered drying area for collected dried faeces from UDD toilets (source: EcoSan Club, 2009).

The **urine** from the UDD toilets is collected in an underground tank (students' toilets) or in jerry cans (teachers' toilet). After storage for about one month, the urine is used as a liquid fertiliser in agriculture with a dilution of 1:5 (1 part urine to 5 parts water)[3].

The exact application of these fertilisers and if they are worked into the ground or under the top soil cover, has not been documented. Fertilised cultures are banana trees, pepper, cabbage, carrots and spinach.

The treated greywater is infiltrated into the ground and is not reused as the amount of water is very small and the school has no demand for irrigation water. The elephant grass, which is growing on the constructed wetland, is harvested twice a year and then used as fodder for cattle.

There has been an increase in agricultural productivity with these fertilisers but this has not been quantified exactly. Agricultural products are not sold but entirely consumed at the school.

[3] See also relevant WHO Reuse Guidelines from 2006: http://www.who.int/water_sanitationhealth/wastewater/gsuww/en/index.html

UDD toilets at a rural secondary school Kalungu, Uganda

8 Further project components

Water supply

The existing water catchment of the spring near the school compound was renewed including filtration, pump and overflow: A solar driven submersible pump and a drinking water tank were installed and the piping network was partly renovated.

Water for general use (but not for drinking) is now pumped from the new water catchment unit to the existing main water tank and distributed to the users (school, sisters and teachers). The overflow, which is available during pump running time, is made available for the local population. This facility is large enough to include an additional storage tank for the local population in the future. In addition, a borehole with a hand pump (to avoid using spring water polluted by surface water) was installed to be used for drinking water supply on the school compound. It has not been quantified how much water is used from both sources.

9 Costs and economics

A cost comparison was carried out during the planning phase of the project, meant to serve as one piece of information among others for the decision making. The two compared options were:

- Option 1 (this is the option that has been installed): ecosan concept with 45 UDD toilets and separate greywater treatment: a sewer and a horizontal-flow subsurface constructed wetland (area approx. 100 m²).
- Option 2: Conventional sanitation with 30 flush toilets; wastewater is collected in a sewer and treated according to Ugandan standards. The main components are: a sewer, a mechanical pre-treatment, a pumping station and a vertical-flow subsurface constructed wetland (area approx. 500 m²).

Table 1 shows the calculated capital costs of both options (further details and a net present value analysis are provided in Lechner (2004)). It was assumed that the annual operation and maintenance costs were identical for both options.

The cost comparison between an ecosan concept (Option 1) and a conventional concept (Option 2) shows clearly that also financial reasons support the decision to invest in ecological sanitation. The main difference is caused by the significantly smaller wastewater treatment system for Option 1 and the pumping station for Option 2. Urine diversion significantly reduces the nitrogen load which results in a reduction of the required size (and thus expenditure) for the biological wastewater treatment system.

The actual total costs for construction and consultancy were approx. EUR 70,000 for the whole sanitation and water supply system. On enquiry of the Sacred Heart Sisters school these expenses were covered by the Spanish NGO Manos Unidas. Operation and maintenance costs (again for the whole sanitation and water supply system) are approx. EUR 500 per year for one full time person and some minor spare parts, and are paid by the school.

Table 1: Calculated capital costs of two alternative options – Option 1 is the option that has been chosen (source: EcoSan Club)

Option 1 (Ecosan)	no.	unit	unit cost EUR	total cost EUR
piping	250	m	8	2,000
manholes incl. covers	5	pcs	49	245
fittings	1	lump-sum	850	850
filter unit	1	lump-sum	3823	3,823
greywater treatment system (constructed wetland)	100	m²	30	3,000
UDD toilets	45	pcs	194	8,730
sum				**18,648**
Option 2 (Conventional)	**no.**	**unit**	**unit cost EUR**	**total cost EUR**
piping	250	m	8	2,000
manholes incl. covers	5	pcs	49	245
fittings	1	lump-sum	850	850
filter unit	1	lump-sum	3823	3,823
pumping station	1	lump-sum	971	971
greywater treatment system (constructed wetland)	500	m²	30	15,000
flush toilets incl. plumbing	30	pcs	291	8,730
sum				**31,619**

10 Operation and maintenance

Teachers and students were trained by EcoSan Club staff and the site engineer in principles and proper operation of the sanitation system, in particular the UDD toilets. The involvement of the teaching personnel responsible for health issues was particularly important. For the teachers a brief written summary on the principles of UDD toilets, their operation and maintenance was prepared by the EcoSan Club.

The person responsible for operation and maintenance (gardener) was trained both on-site by the contractor's personnel and in a training course for sanitation personnel at the Lacor Hospital in Uganda. Whilst the students are responsible for keeping the toilets clean, the caretaker is responsible for maintenance and for emptying of the toilets' containers.

Fig. 14: User training for urine diversion dehydration toilets (source: Ecosan Club, 2005)

UDD toilets at a rural secondary school Kalungu, Uganda

11 Practical experience and lessons learnt

Since the project has been implemented, the school has become famous in Uganda and worldwide for its innovative sanitation concept, and even featured in a documentary in 2005, see Section 13. Delegations from all over the country and from abroad come to see the school toilets. The school administration has recently even introduced an admission fee for visitors (EUR 18 - 35, depending on the type of visiting delegation).

The students and teachers are proud of their toilets which are kept clean and well maintained. The headmaster reported that visitors and students' families are copying the idea (these interesting developments are not yet documented).

Several factors contributed to the success of this sanitation system:

- Teachers and students use the same type of toilets and the teaching personnel is convinced of this new technology.
- All stakeholders were involved in the planning process from the beginning of the project; critical design decisions were made by the users.
- The presence of the site civil engineer from Norman Construction, Alex Oryem, was utilised to sensitise and train teachers and students.

During an interview in February 2006 with the operator of the sanitation system (the gardener) and the school administration, both parties stated their satisfaction. Especially the administrator underlined the high value of the produced fertiliser for the school gardens. More information can be found in Jemsby (2008). Another visit by Elke Müllegger (EcoSan Club) in October 2009 also found well functioning toilets and satisfied users.

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, 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).

The main long-term impact of the project is improved public health. One indicator for this would be reduced school absenteeism but this was not analysed yet. A detailed study regarding the quality of dried human excreta was carried out by the EcoSan Club from 2004 to 2006 which showed very satisfying results (see Müllegger (2009)):

- The implemented infrastructure is still in a good condition and is being used (five years after its construction).
- Both faeces and urine are used in the school gardens as fertiliser.
- Treatment of the faecal material is based on a long storage and drying period combined with a relatively high addition of ash.
- Apart from one sample (out of 3 in total) no pathogenic organisms were found in the dried material (tests included total coliforms, E. Coli, Salmonella typhimurium, but did not include helminth eggs).

The toilets are a great success and delegations from all over the country and from abroad come to visit the school toilets. Since this was such a successful project, visitors and parents are picking up the idea, and requests for advice are increasing.

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Case study of SuSanA projects

UDD toilets at a rural secondary school, Kalungu, Uganda

SuSanA 2009

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