Case study of sustainable sanitation projects

UDDTs at a church and nursery school Nakuru, Kenya

Figure 1 Project location

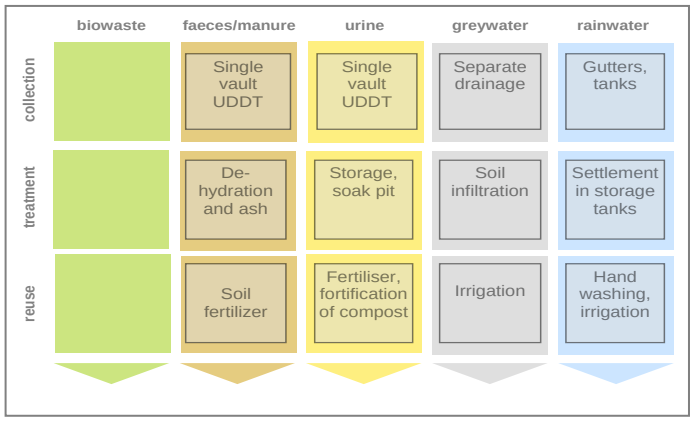

Figure 2 Applied sanitation components

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:

1. Design and construction of a masonry toilet block consisting of 2 single vault UDDTs, one double vault UDDT and a urinal for a population of 50 church members and 25 children at a cost of EUR 1,788,
2. Workshops and training on basic knowledge of ROSA concepts, demonstration on usage, operation and maintenance of the system at a cost of EUR 212

Total investment of the project described: EUR 2,000

Address of project location:
House of fire ministry church,
Nakuru London Estate
Nakuru, Kenya

Planning institution:

Egerton University/Rosa Project, Egerton-Kenya

Executing institution:
Nakuru Municipal Council/ ROSA project, Nakuru-Kenya

Supporting agency:
European Union

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

2 Objective and motivation of the project

The objectives of this project were to improve on sanitation by establishing a urine diversion dehydration toilets system that provides a fly and odour free environment and that reduces groundwater pollution and health risks associated with pit latrines.

The motivation was to contribute towards achieving the MGDs and Kenya Vision 2030 (GOK, 2007) by promoting sustainable sanitation.

3 Location and conditions

House of fire ministry is a small community church located at London estate in the North-Western part of Nakuru town. The church is lying at the foot of the extinct volcano Menengai Crater. Nakuru is a cosmopolitan town that gained its municipal status in 1952, and hosts people with different cultures, ideologies, religious, political, social and economic aspirations. It is the fourth largest town in Kenya, with a population of approximately 500,000 people and is located 160km North-west of Nairobi (MCN *et al*., 1999).

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).

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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.

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.

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

Monitoring in May 2011:

A monitoring of the ROSA projects in and around Nakuru was done in May 2011 by the consultant Laura Kraft (e-mail address: kraft_laura@yahoo.de) on behalf of GIZ sustainable sanitation program (Kraft, L. 2011). The overall objective of the monitoring was to update the SuSanA case study in regard to present status and lessons learned from the project.

For monitoring and evaluation three methods were used to gather information:

- Desk review, field observations and interviews

During the desk study different online documents were reviewed to understand the project approach and to access the latest information on the project status. This knowledge was used to prepare monitoring sheets and questionnaires for interviews with UDDT users, related service providers for excreta management and other relevant stakeholders.

The ROSA project sites described by SuSanA case studies were visited to assess the status of the UDDTs and other related facilities within the ROSA project. Interviews were conducted with teachers, students, landlords, CBO/ NGO leaders and the Municipal Council. For documentation purpose digital pictures were taken during the monitoring and uploaded on flickr (see link in Section 13).

During the visit of the church and nursery school interviews were conducted with the bishop of the church and the head teacher of the school. The state of the toilet facility was assessed by use the monitoring sheet.

Based on the resultant information, the case study was updated. The original text referring to the project state in 2009 was maintained with minimal alterations in addition to the new observations added after the headings "Project update May 2011".

5 Technologies applied

The various sanitation options including Arboloo, Composting toilet, Urine diversion dehydration toilets with both single vault and double vault were considered. The Urine diversion dehydration toilet (UDDT) was chosen due to its advantage of separately collecting the urine and faeces such that the treatment for each fraction can be specific as required. Single and double vaults were constructed to compare their performance.

The facility is divided into two sections, the female and the male section. The female side has two units; one single vault UDDT and a double vault UDDT with solar drying cover at the back. The men's section consists of one single vault UDDT and a urinal cubicle with five waterless urinals in the men's section. Two of the urinal bowls are standard ceramic urinal bowls while the other three are specially designed for children out of 5 litre plastic containers and fitted lower to the floor level (300 mm compared to standard level of 600 mm) to allow ease of use by the boys.

Due to the stigmas on handling faeces, it was agreed that the faeces will be collected in containers for ease of collection, instead of allowing it to drop on the floor of the chamber.The faeces are collected in 50 litre plastic containers placed in the single vault underneath the toilet slab. Smaller containers of 20 to 30 litres were placed in the double vault chambers which are smaller in size. Once the containers are full, they are transferred to the solar drier in the double vault and remain there until they are completely dry and odour free before they are emptied into the garden and applied around banana plants.

Urine is collected in a 100 litre plastic tank, whose overflow discharges into a soak pit; urine can be collected easily from the tank for agricultural use.

Rainwater is harvested from the roof into a 250 litre tank which is connected to ceramic hand washing basins in both the female and the male sections. The greywater from hand washing is drained into a crop field.

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 the vaults were constructed. The designed vault size is 1.1 x

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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.

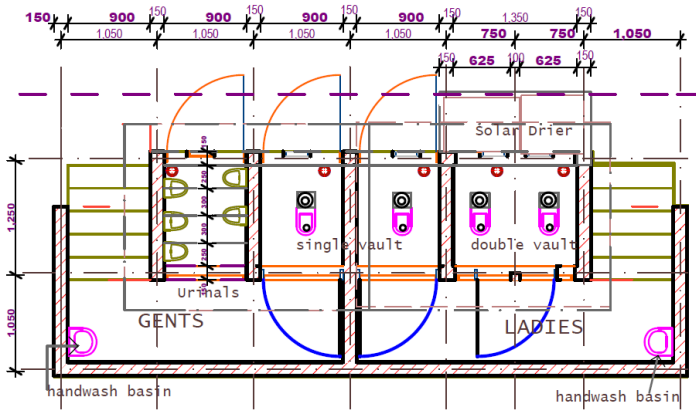

Figure 9 Floor plan of church toilet

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.

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

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	

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).

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
- 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://www2.gtz.de/ecosan/english/

14 Institutions, organisations and contact persons

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SuSanA 2010

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