Case study of sustainable sanitation projects

UDD toilets at a rural secondary school Kalungu, Uganda

Fig. 1: Project location

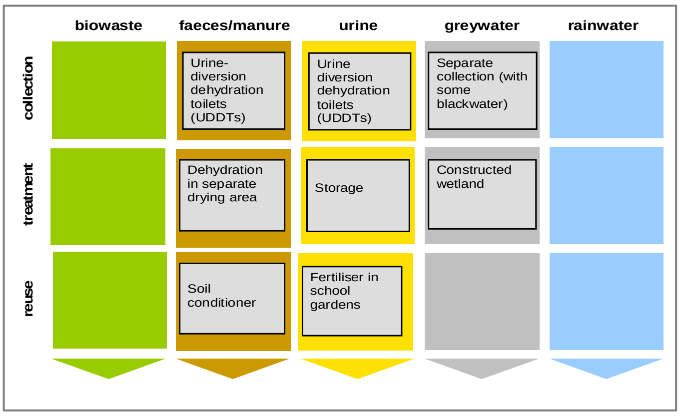

Fig. 2: Applied sanitation components in this project

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

[1] Kalungu is a small trading centre with several hundred or perhaps two thousand inhabitants (exact number not available).

drained in soak pits. The students used 35 pit latrines. 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).

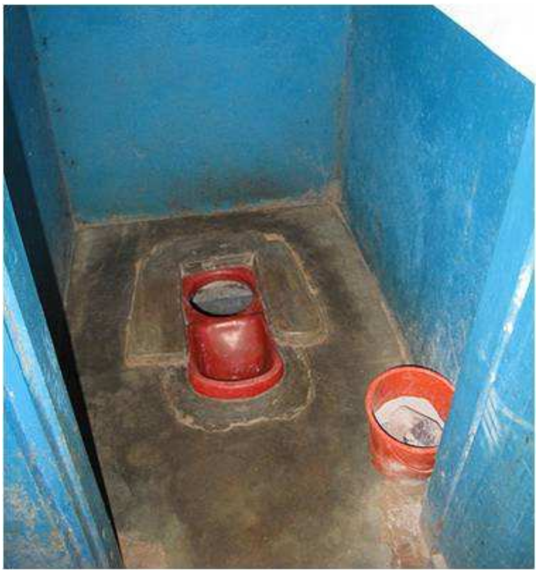

Fig. 5: Interior of a UDD toilet for students, showing UD squatting pan after approx. five years of use (source: EcoSan Club, 2009).

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

Fig. 6: Demonstration UDD toilet for teachers and visitors, five years old (source: EcoSan Club, 2009)

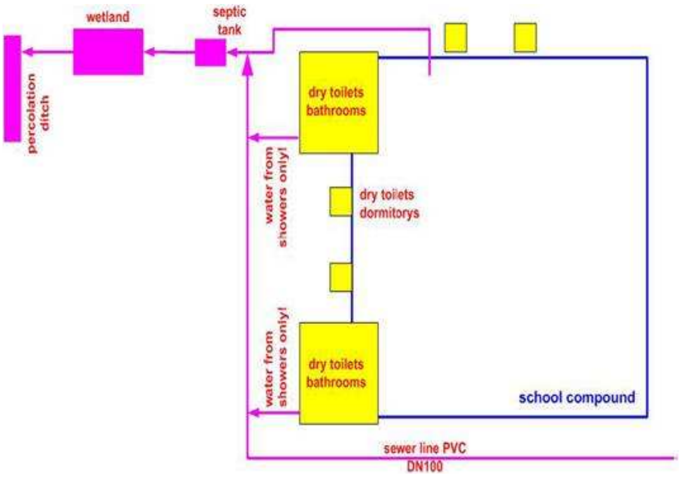

Fig. 7: Scheme of new greywater system; flow is from right to left (source: EcoSan Club).

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.

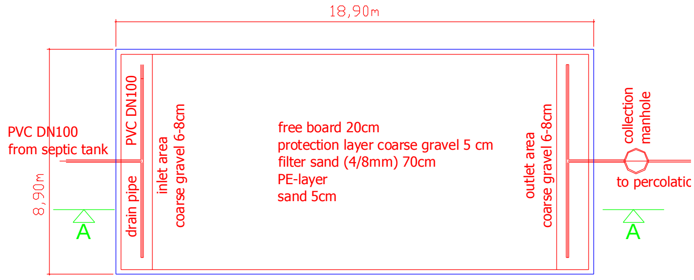

Fig. 9: Plan view of horizontal flow constructed wetland, flow is from left to right (source: EcoSan Club).

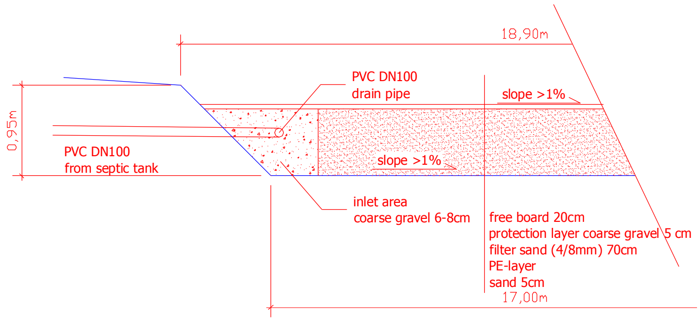

Fig. 10: Cross section A-A from Fig. 9 showing inlet area of horizontal flow constructed wetland (source: EcoSan Club)

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

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)

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.

13 Available documents and references

- Müllegger, E. (2009) Risk of reuse. Study on the reuse of treated wastewater and sanitized human excreta in Uganda. EcoSan Club, Vienna (not published yet for internal reasons).
- Ecosan Club (2009) Photos on flickr website: http://www.flickr.com/photos/gtzecosan/sets/72157622500141727/
- Jemsby, C. (2008) The most famous toilets in Uganda. In: Sanitation Now. Stockholm Environment Institute, Sweden, p 4-7. http://www.ecosanres.org/sanitationnow2008.htm.
- Müllegger, E., Lechner, M. and Jung, S. (2006) Sanitation for a girls school in Uganda. Presentation for the 4th World Water Forum, March 2006, Mexico City. http://www.ecosan.at/info/workshops/sanitation-for-a-girls-school-in-uganda.pdf
- **Video clip** from Human Excreta Index movie (2005): http://www.susana.org/lang-en/videos/the-human-excreta-index

- Lechner, M. (2004) Kalungu Girls Secondary School – Improvement of Water & Sanitation Infrastructure (project report). http://www.ecosan.at/projects/esc-consulting/infrastructure-rehabilitation/kalungu.pdf

14 Institutions, organisations and contact persons

Planning, design and construction supervision
EcoSan Club / Technisches Büro Lechner (consultancy firm)
Elke Müllegger (main contact), Markus Lechner, Stefan Jung
Oberwindhag 1
3970 Weitra, Austria
E: elke.muellegger@ecosan.at
I: www.ecosan.at

supplier of urine-diversion squatting pans
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

Construction
Norman Construction and Engineering Services
Denis Daniel Lawoko
P.O. Box 284,
Kitgum, Uganda
E: ldd077584782@yahoo.co.uk

School administration
Sacred Heart Sisters
Sr. Noelina or Sr. Maria Gaczol
Kalungu, Uganda
E: kalungugtc@yahoo.com
Tel.: +256(0)753467796 or +256(0)772467796

Case study of SuSanA projects

UDD toilets at a rural secondary school, Kalungu, Uganda

SuSanA 2009

Authors: Elke Müllegger (EcoSan Club) supported by Jana Schlick (jana.schlick@planco.org), Christine Werner (GTZ)

Editing and reviewing: Christian Olt, Carola Israel, Enno Schröder, Elisabeth v. Münch (GTZ ecosan programme - ecosan@gtz.de)