sustainable sanitation alliance

Case study of sustainable sanitation projects

UDD toilets at a Girls Secondary School Kalungu, Uganda

Fig. 1: Project location

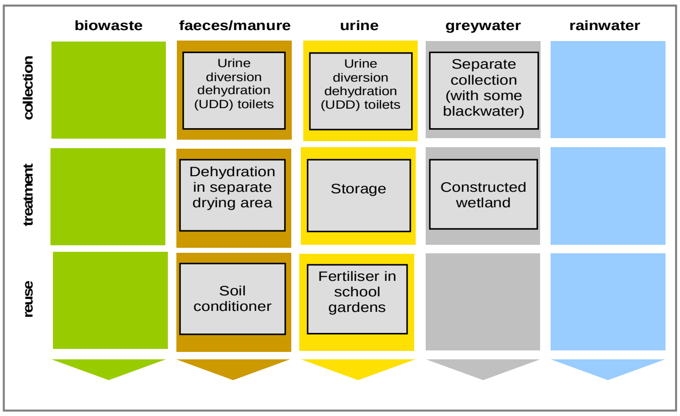

Fig. 2: Applied sanitation components in this project

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 cost: approx. EUR 70,000

Address of project location:
Kalungu, Masaka District, Uganda

Planning institution:
EcoSan Club Austria (ECA)
Consulting Firm: Technisches Büro Lechner (TBL)

Executing institution:
Norman Construction and Engineering Services, Kampala, Uganda (construction)
Technisches Büro Lechner (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 school of the "Sacred Heart Sisters" is located in the hilly areas of Masaka District, Southwest of Kampala near the town Masaka. The school is located near Kalungu, a small rural village, surrounded by farm land. 50 teachers and sisters are employed while the latter are either in the schools administration and/or teachers. 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 (only girls) used 35 pit latrines. Greywater from showers and the kitchen was discharged in a creek outside the school's compound. Due to the high ground water level, the soak pits and pit latrines located directly upstream of the school and the nearby villages' water spring, the situation was dangerous for human health.

Fig. 3: School compound of "Sacred Heart Sisters" school (source: EcoSan Club, 2009)

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.

The "Sacred Heart Sisters" school is financed mainly through the school fees, which amount to 80 € per term whereas one year consists of three terms.

4 Project history

In the year 2000, Markus Lechner (TBL) was invited by S. Maria from the "Sacred Heard Sisters" for a first site visit to gain an overview of the situation. After preparing a feasibility study, a first meeting between TBL and the school administration was organized to discuss the major issues of 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. Construction was carried out by Norman Construction and Engineering Services. Two site engineers, organizing and supervising the construction work of local contractors, were employed for the duration of the project implementation.

The idea of having a demonstration toilet for teachers and visitors came up during the discussions to convince the users of the advantages of urine diverting dehydration toilets (UDD). 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: The details of the unit were developed together with the teachers to create a consciousness of ownership and responsibility. A series of possible designs were presented to the teachers and any decisions (e.g. location of the toilet, sitting or squatting type; 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 in comparison 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 student´s toilets because it's a girl's school.
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. Wastewater is composed by greywater with a small share of black water from the sisters' house where three flush toilets are still used. However, sisters did not want to change these flush toilets because they were recently installed and are working well.

[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).

The sewer system from the sister´s 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 efforts
- Enhanced nutrient removal is not required since the amount of nutrients is low due to the implementation of a UDD toilet system.
- Legal environmental standards for discharge of effluent into water or on land (The National Environment, 1999) in Uganda can be fulfilled.
- The subsurface flow constructed wetland has no free water surface (i.e. no fly breeding)
- Effluent is not reused but infiltrated in the soil

Fig. 4: Now students' toilets – 45 UDDTs (source: EcoSan Club, 2005)

Fig. 5: Interior of a students' UDD toilet showing UD squatting pan (source: EcoSan Club, 2005)

Fig. 6: Demonstration UDD toilet for teachers and visitors (source: EcoSan Club, 2005)

UDD toilets at a Girls Secondary School Kalungu, Uganda

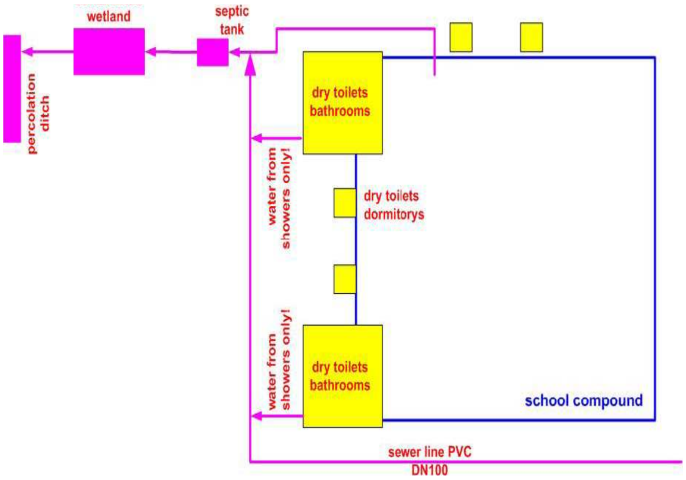

Fig. 7: Scheme of new greywater system; flow is from right to left (source: EcoSan Club)

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 squatting pan (produced by Cress tank, Uganda). Via the squatting pan, faeces, toilet paper and ash is collected in a wooden basket located in a dehydration chamber und the squatting pan. These baskets are emptied after every school term (i.e. every 3 months) and brought to an outside drying area for further dehydration 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. However, as the urine tank was placed by the school after project's end, further information on the tank are 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 infiltrated in these soak pits.

Demonstration toilet for teachers and visitors

The demonstration toilet was built with an attractive design. A designer made a first draft, before 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 to reduce the amount of urine wrongly 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 flush toilets, a horizontal subsurface flow constructed wetland system was built. Wastewater is pre-treated in a 29 m³ sized 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 17m^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 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) – see Figure 9 and 10. The bottom of the filter bed has a slope of 1%. At its lower end another area of coarse aggregate and a drain pipe (PVC DN 100) collects the purified greywater which is piped via an outlet manhole to an underground percolation ditch. Percolation ditch comprises 10 m of drain pipe DN 100 in a layer of coarse aggregate and covered with excavated material and soil. Depths of layers are characterized as follows: freeboard of 20 cm, protection layer coarse gravel (5 cm), filter sand 70 cm, PE –layer; sand 5 cm; Lining at bottom is Elephant grass.

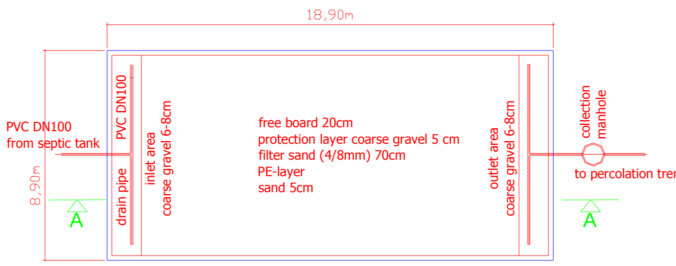

Fig. 9: Plan view – horizontal flow constructed wetland, Kalungu (source: EcoSan Club, 2009)

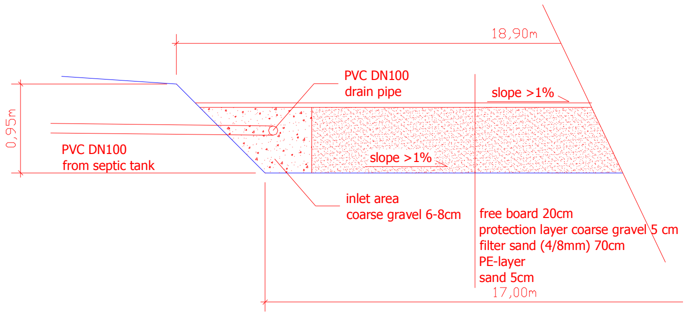

Fig. 10: Cross Section A-A – horizontal flow constructed wetland/inlet, Kalungu (source: EcoSan Club, 2009)

Fig. 11: Constructed wetland, planted with Elephant grass (source: EcoSan Club, 2005)

However it is not possible to give any examples of the volumes of wastewater, urine and faeces generated in the different subsystems since no monitoring takes place.

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 fertilizer 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: Covered drying area for collected faeces from UDD toilets (source: EcoSan Club, 2005)

The **urine** from the UDD toilets is collected in an underground tank (students' toilets) or in jerry cans (teachers' toilet). Storage for application on fodder crops takes at least 1 month and more than 6 months with a varying storage period, depending on the demand, for application on food crops. After storage the urine is used as a liquid fertilizer in agriculture with a dilution of 1:5 (1 part urine to 5 parts water)[2]. However, exact application of these fertilizers, if they are worked into the ground or under the top soil cover has not been specified. Fertilized 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 little and the school never admitted demand for irrigation water.

There has been an increase in agricultural productivity; however this has not been quantified. Agricultural products are not sold but entirely consumed at the school itself.

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 also 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 pollution of spring water by surface water) was installed to be used for drinking water supply on the school compound. However, 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 realized): 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).

For the cost comparison the following costs were considered:
- Investment costs
- Costs for reinvestment and
- Operating costs.

2 See also relevant WHO Reuse Guidelines from 2006: http://www.who.int/water_sanitationhealth/wastewater/gsuww/en/index.html

The calculation is based on the following assumptions: Timeframe is 50 years, replacement costs depend on lifespan of individual parts of the system, interest rate is 8%.The results in Table 1 show the calculated capital costs of both options. The costs are indicated in Euros calculated at an exchange rate of UGX 2060 = EUR 1 (Sept. 2004).

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 treatement system	100	m²	30	3,000
UDD toilets	45	pcm	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 treatement system	500	m²	30	15,000
flush toilets incl. Plumbing	30	pcm	291	8,730
sum				**31,619**

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 additionally required pumping station for Option 2. Urine diversion significantly reduces the nitrogen load which results in a reduction of the required 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 (incl. CWS, water supply, etc.). On inquiry of the Sacred Heart Sisters these expenses were taken by Manos Unidas. O&M 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 paid by the school. Comparing both systems it was assumed that the costs for O&M are similar.

10 Operation and maintenance

Teachers and students were trained by EcoSan Club staff and the site engineer in principles and proper operation of the newly constructed units, in particular the UDD toilets. The involvement of the teaching personnel responsible for health issues was particularly emphasized. For the teachers a brief written summary on the principles of UDD toilets, their operation and maintenance was prepared by the EcoSan Club. The responsible personnel 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. While Students are only responsible to keep the toilets clean, maintenance is done by the gardener.

Fig. 13: User training for urine diversion dehydration toilets (source: Ecosan Club)

11 Practical experience and lessons learnt

Since the project has been implemented, the school became "famous" in Uganda and worldwide for the innovative sanitation concept, and even featured in a documentary, see Section 13. Delegations from all over the country and from abroad come to visit the school toilets regularly. By the time of the revision of this case study in October 2009 the school administration even introduced an admission fee (between 17.50 EUR and 35 EUR, depending on the type of visiting delegation).

The students and the 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 developments are yet to be documented).

The experience shows that several reasons contributed to the well working 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 from the beginning of the project; critical design decisions were made by the users.
- The presence of the civil engineer, Alex Oryem, was utilized to sensitize and train teachers and students.

During an interview in February 2006 with the operator (the gardener) of the sanitation system and the school administration, both parties stated their satisfaction. Especially the administrator underlined the high value of the produced fertilizer for the school gardens. More information can be found in Jemsby (2008).

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).

The main long-term impact of the project is improved public health. However, a qualification of improved public health, on the basis of a measurement of reduced school absenteeism e.g. has not been done to this day. On the other hand, a detailed monitoring regarding the quality of dried human excreta has been carried out by the EcoSan Club from 2004 to 2006 which showed very satisfying results. Furthermore a study on the reuse of treated wastewater and sanitized human excreta in Uganda has been elaborated by Elke Müllegger in 2009 which is has not yet been published.

In 2006 the main results of the monitoring were (Müllegger, 2009):

- The implemented infrastructure is still in a good condition and is used.
- Both faeces and urine are used in the school gardens as fertilizer.
- 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)

The toilets are a great success and delegations from all over the country and from abroad come to visit the school toilets. The pupils and the teachers are proud of their well working toilets which are kept clean and well maintained. Since this was such a successful project, visits or families are picking the idea and requests are increasing.

13 Available documents and references

- Jemsby, C. (2008) The most famous toilets in Uganda. In: Sanitation Now. Stockholm Environmental Institute, pp 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
- 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)
- **Video clip** from Human Excreta Index movie (2005): http://www.susana.org/index.php/lang-en/cap-dev/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)
Markus Lechner, Elke Müllegger, Stefan Jung
Oberwindhag 1
3970 Weitra, Austria
E: elke.muellegger@ecosan.at
I: www.ecosan.at

Cresstanks Ltd. (supplier of urine-diversion squatting pans)
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

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Case study of SuSanA projects

UDD toilets at a Girls Secondary School

SuSanA 2008

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

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

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