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

Fig. 1: Project location

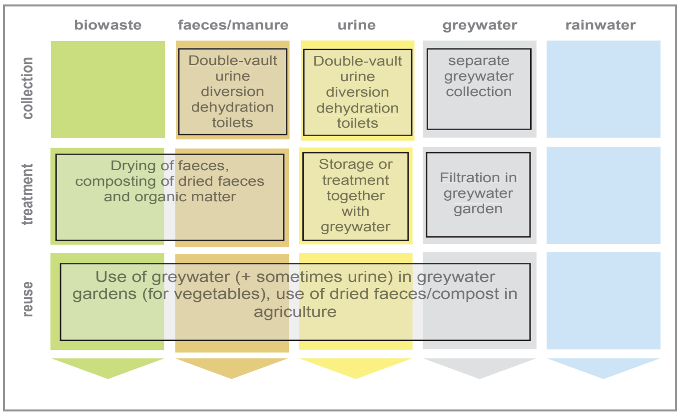

Fig. 2: Applied sanitation components in this project

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 GTZ 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: GTZ, 2002).

Around the year 2000, the central water supply system in Koulikoro was extended (with support of German development cooperation organizations KfW and GTZ), 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 GTZ, 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?).

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 GTZ, the larger GTZ 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 GTZ 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: GTZ, 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)[2].

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

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

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

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 GTZ-Mali. It has thus not been possible to determine the exact costs of the ecosan pilot project separately from the larger GTZ 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[3].

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 GTZ 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 urine. However composting in the Sahel region can be

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

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.

Sustainability criteria for sanitation (cont.):

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 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[4].

13 Available documents and references

- Kraus, S. (2004) Basisstudien zum kreislauforientierten Abfall- und Abwassermanagement in Mali. Presentation of an intern's experiences at the GTZ "Programme d'Appui aux Collectivités Territoriales (PACT)", November 2003 – March 2004 (in German). http://www.susana.org/images/documents/06-case-studies/external-documents/kraus-2004-baseline-study-on-wastewater-management-mali.pdf
- Bark, K. and Oldenburg, M. (2003) Ecosan Modules – Adapted Solutions for a Medium Sized City in Mali. In: 2nd International Symposium on ecological sanitation, Session G (Feasibility Studies). Lübeck, http://www2.gtz.de/Dokumente/oe44/ecosan/en-feasibility-studies-papers-presented-at-ecosan-symposium-2003.pdf
- Otterwasser GmbH (2003) Projekt-Kurzbericht Ecosan in Mali, German and French versions, http://www2.gtz.de/Dokumente/oe44/ecosan/de-kurzbericht-ecosan-projekt-2003.pdf (in German), http://www2.gtz.de/Dokumente/oe44/ecosan/fr-rapport-de-projet-ecosan-2003.pdf (in French)
- 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/

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

14 Institutions, organisations and contact persons

Planning:
OtterWasser GmbH
Ingenieurgesellschaft für integrierte Siedlungstechnik
Dr.-Ing. Martin Oldenburg
Engelsgrube 81
D-23552 Lübeck, Germany
E: info@otterwasser.de
I: www.otterwasser.de

Execution (local NGO):
Bureau Ouest-African d'Appui Organisationnel et de Technologies Appropriées (BOATA)
B.P. E3730, Rue 17 – Porte 260
Badalabougou, Bamakou, Mali
E: boata@afribone.net.ml
I: www.boata.de

Case study of SuSanA projects

Peri-urban urine diversion dehydration toilets (abandoned)

SuSanA 2009

Authors of original version from 2005: Christine Werner, Florian Klingel, Patrick Bracken, Jana Schlick, Tim Freese, Wang Rong (all formerly GTZ ecosan team)

Remarks added after visiting Koulikoro in March 2009: Stefan Hofstetter (independent consultant, stefan.hofstetter@ieee.org)

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

Appendix :

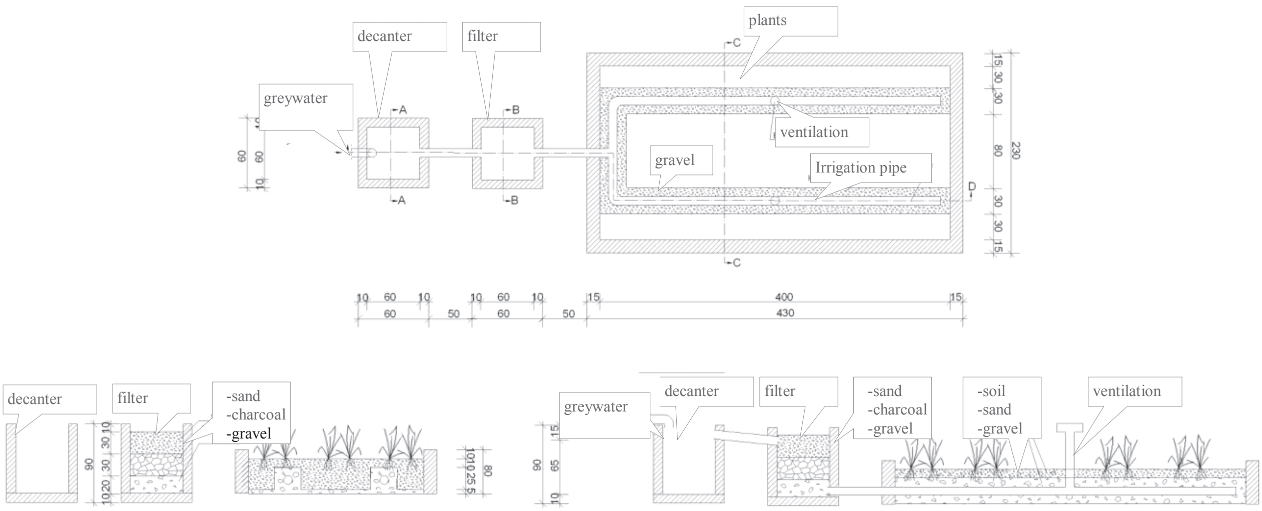

Fig. 11: Plan view and cross sections of the greywater garden (source: OtterWasser, 2003)

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

Fig. 1: Project location

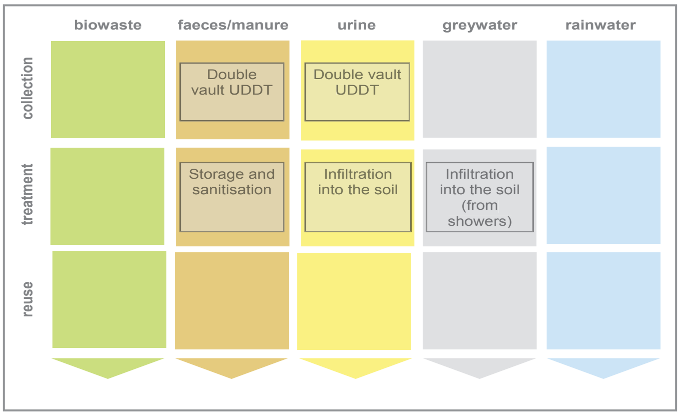

Fig. 2: Applied sanitation components in this project. UDDT stands for urine diversion dehydration toilet.

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

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

(USD converted into EUR with an exchange rate of USD 1 = EUR 0.75, as of 1 August 2002)

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).

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.

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

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).

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.

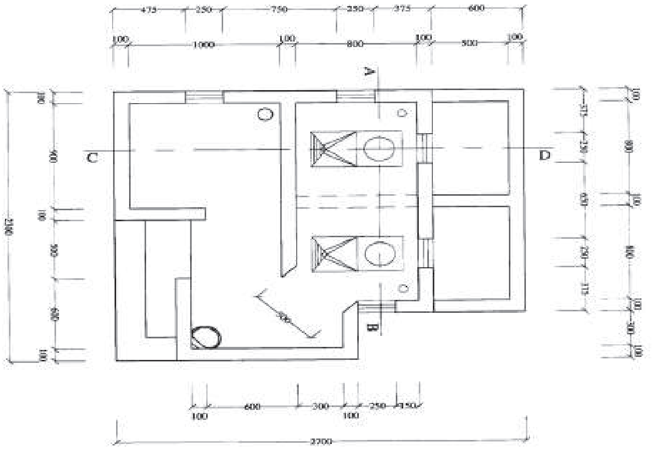

Fig. 8: Drawing of a household UDDT with a shower cubicle on the left (source: PAARSS).

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

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[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.

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 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

Fogde, M., Macario, L., Cumbana, A. (2007) When communication counts, Waterlines, Vol. 25, Number 3, January 2007 , pp. 23-26(4)

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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

Muellegger, E., Lechner, M. (2004) Ecological Sanitation - A sustainable approach to the future. Austrian Development Cooperation (ADA), http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=967

14 Institutions, organisations and contact persons

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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).

Editing and reviewing: Elisabeth von Muench, Julia Seitz (GIZ, ecosan@giz.de)

This document is available from:
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).

[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).

Otji toilets for peri-urban informal households Omaruru, Namibia

Fig. 1: Project location.

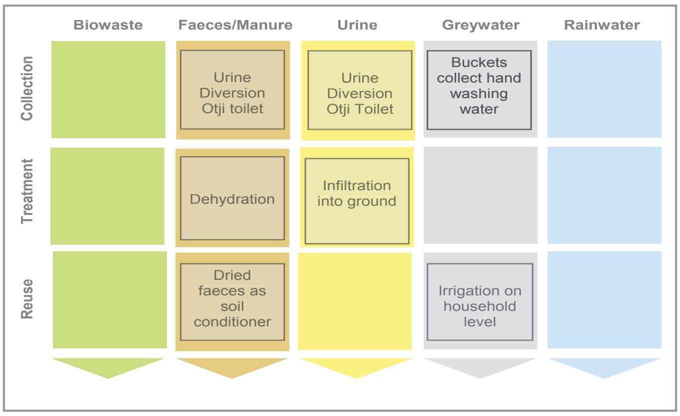

Fig. 2: Applied sanitation components in this project (Otji toilets work like UDDTs.

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, Omaruru, Namibia

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

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

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

Note: The name Otji toilet is used in Namibia, where the rights on the name "Otji toilets" (but not the rights on the technology) have been reserved by the CHP. The name is well-known in Namibia. Technically speaking it is a urine diversion dehydration toilet (UDDT).

2 Objective and motivation of the project

As Namibia is the driest country in southern Africa, a toilet system flushed 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 a 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 centralised sewage system.

Against this background, the Omaruru Basin Management Committee decided to pilot 21 Otji toilets in Omaruru. 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 season, 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.

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.

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

3 Location and conditions

Omaruru lies about 200 km northwest of Namibia's capital city Windhoek, on an altitude of 1200 m above sea level, in the Erongo region. The climate in the area is arid with a yearly precipitation of 280 mm on average. The depth of the groundwater table in the Omaruru basin varies two borehole measurements in the area reflected a depth of 2.46 metres and 3.40 metres respectively[1].

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 300 m 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. Socio-cultural conditions are diverse. Most of the white population, from different origins, live in the town itself. The majority of the black population consider themselves as Ovambo. Besides that, mostly Herero and Damara people live in Omaruru.

The under-five child mortality rate in Namibia is relatively low for a developing country at 40 children per 1000, and it has been decreasing during the last twenty years[2].

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 100 km from Omaruru, to learn about the construction of dry toilets and to have a look at examples in this town which were already built and in use.

During this exposure trip for members of the OmBMC GIZ gave a presentation on different sanitation options and discussed with the members the most feasible options. The Otji toilet was first developed in 2003 in Namibia and there are approximately 1200 installations across Namibia. The Otji toilet was the example shown in the exposure visit.
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 the project "Dry toilets - an alternative sanitation solution for squatter areas in an arid country – Namibia" which aims to promote the building of 600 Otji toilets in Otjiwarongo and all over Namibia. The funding started in February 2008 and continues to the end of 2011.

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 300 m from standpipes. There are no sewers and no septic tanks in the area which could be used as discharge points 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 construction of 21 toilets was completed by the end of 2010. Since then, the toilets are being 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 three months GIZ and the OmBMC carried out a small survey in order to assess the satisfaction among toilet users. All users were happy to have this toilet!

Only 21 pilot toilets were built in Omaruru so far, but 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. Even though 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 (which is part of Omaruru) a strategy for the reuse of the sanitation products will be developed. Persons were identified who would be willing to empty the toilets. GIZ is considering possible public private partnership (PPP) strategies[3]. The objective is to support a local business in establishing a production scheme of the Otji toilets in the area.

Additional information about the Otji toilets:
According to an email from Peter Arndt from CHP on 28 May 2011: Since the development of the Otji toilet in 2003 about 1,200 Otji toilets have been installed nationwide across Namibia[4] and about 100 self builder sets have been sold.

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[1] In the Omaruru Basin at borehole ww40139 – under the bridge in the riverbed the average depth is 2.46 m and at borehole ww40144- east of Omaruru in the riverbed the average depth is 3.40 m.
[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/).

[3] One PPP that was being investigated at the time of writing this case study was with the company Pupkewitz. This company has started as building supplier with meanwhile about 15 branches in Namibia. Later they have added many other business, like car dealing and mobile phones etc. They do not produce, nor build. See their website for more details http://www.pupkewitz.com/. Concerns were that CHP could be ruined by the involvement of a big company and mass production of the toilets.
[4] The SuSanA partner EcoSur has also built "Otji style" UDDTs in Latin America, where they are called "Inodoro Seco". The Otji toilet made its way from Namibia to Latin America since the CHP is partner

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 were built inside the houses (heat ventilated by solar radiation 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 the future the CHP will promote more the Self-Builder-Set so as to encourage local builders to create a job opportunity for themselves.

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.

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 north (in southern hemisphere). Air then circulates through the toilet into the drying area and out through the ventilation pipe, which makes the toilet odourless. The collection container (90 liter container) is situated under the toilet bowl and moved to the adjacent drying area when full. The container with the dried faeces is later emptied and moved back beneath the toilet bowl. It is estimated, that four people can use one container for about six months.

The urine diversion toilet bowl is designed in such a way that urine touching the wall of the bowl is collected in a small trough (Fig. 4), drained away through a pipe and infiltrated into the ground. No problems of blockages of the collection trough or the urine pipe, which is 20 mm in diameter, have been reported. The new urine diversion bowl has been in use since early 2010. The perforated collection container is still used but the excreta contain significantly less liquid once the urine is collected separately.

In 2009 CHP had installed some units for testing purposes and since 2010 CHP has installed it to customers (City of Windhoeck 57, Omaruru 21, Oshikoto 115, Gobabis 30, Gibeon 40 plus several individual customers).

Who manufactures them? Is it painted concrete?

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

Alternatively, the urine could 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 months ago, no containers had to be emptied until now.

The toilets were built by staff 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 by digging and painting.

There are no rights reserved on the Otji toilet technology nor on its 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 prototypes 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 installations are in Windhoek with 57 units.

of EcoSur and hence Peter Arndt from the CHP came to Latin America for several exchange visits introducing the Otji toilet technology and later also the new urine diversion bowl. EcoSur Ecuador built the first Otji style dry toilet in Latin America in 2007 (EcoSur, n.d.)
Currently over 120 dry toilets have been built in Ecuador and El Salvador and there are plans for around 300 toilets. For more details visit: http://www.ecosur.org/

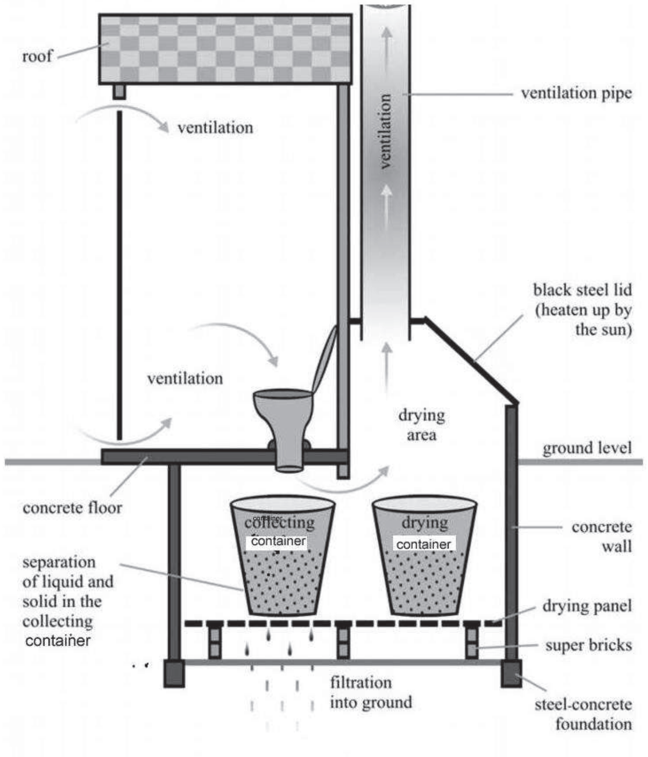

Fig. 5: Functional plan of the Otji toilet without urine diversion bowl as shown in Fig. 4 which was developed later (source: CHP, 2009b)

6 Design information

The prefabrication 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.

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 materials 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 manuals of the CHP are available under the links given in Section 13 and 14.

In previous designs CHP suggested to include a windventilator (whirlybird) on top of the ventilation pipe. This was revised since it was observed, that this additional feature brought no real benefit for the ventilation of the toilet. Only at the coast, where a constant wind blows they may have an impact and consequently the approx. 100 Euro investment coast were regarded to be a waste of money in most cases.

Can Otji toilets be located indoors?

As Otji toilets are heat ventilated by solar radiation they have only a limited suitability for indoor installations as they develop some odour nuisance during the night when the sun (heat) ventilation stops. After sunset it about 3-4 hours to cool down and from then the toilet starts to smell a bit. Indoor Otji toilets therefore would need to be equipped with electric ventilation[5]. The installation of indoor Otji toilets in an existing house is quite complicated because of the need to cut through the foundation of the house as half of the underground tank is underneath the house (under the pedestal) while the other half is outside (opening lid box). Even the inclusion of an Otji toilet in a newly constructed house does not really save costs (when compared to the construction of a separated outside Otji toilet) as the space that is needed for the Otji toilet causes additional construction cost and even more important because off the required expensive electric ventilation. Consequently, CHP currently recommends indoor Otji toilets only for middle income houses.

7 Type and level of reuse

The small scale of the project makes it difficult to establish a reuse scheme other than the use on household level. 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 the toilet owners 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 treat dried faeces, which are not reused.

There are certain design parameters of the toilet which indicate the focus on providing safe sanitation rather than reusing excreta. In the following, reuse possibilities are outlined.

Urine

The toilets currently used in Omaruru all infiltrate the urine into the ground and the urine 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 would be 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 would be 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 it is directly applied to irrigate plants.

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[5] CHP built 110 inside toilets in Otjiwarongo and equipped them with 12 Volt photovoltaic systems which costs about 250 Euro. Using a solar system was meant as an appropriate solution for poor households. However, according to Peter Arndt from the CHP (email from 26 October 2011), misuse of the solar battery (households connect radios or lights to the system) has frequently caused failure of the ventilation system. User education by the CHP was so far effective in changing this behavior.

Otji toilets for peri-urban informal households Omaruru, Namibia

8 Further project components

In addition to the construction of the toilets basic handwashing facilities were attached to the toilets. To raise awareness among the population a dry toilet and handwashing campaign was initiated.

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

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.

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).

9 Costs and economics

One Otji toilet costs about EUR 776 (see Table 1), 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.

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

Item	**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 90 l containers (2 containers)	45
Side plates	20
Dry plates 70 x 70 cm	15
Floor plate	14
Silicon, wire, etc.	5
Superbricks (what are superbricks?)	96
Cement bag	24
Sand	10
Paint	29
Total materials costs	**554**
Estimated labour and transport costs[6]	**222**
Total costs	**776**

Because the toilets are custom-made by the CHP and many parts are especially produced for these toilets, it was not possible to compare the price of an Otji toilet with market prices of other suppliers. Currently, the concrete UDS-bowls are produced in Otjiwarongo which is about 140 km from Omaruru[7]. With the establishment of a local producer (potentially a franchise of CHP) in Omaruru, it might be possible to lower the prices.

From a financial point of view, the contribution of the beneficiaries was very low in this project. However, to reach the poorest among the population, there is the need of highly subsidised facilities, as these people will not be able to save money to get a toilet in the first place.

As the price level in Namibia is quite high the Otji toilets are yet not affordable for the poor. In the future, the toilets should be built with local money as part of the general service for the inhabitants of a settlement.
Further options for cost reductions? Surely it has to be possible.

Operation and maintenance costs are very low. With four people using one toilet, it takes about six months for the 90 l container to fill up. After the first year of operation, the container with the dried faecal matter has to be emptied every six months depending on the number of people using the toilet.

10 Operation and maintenance

When investigating the toilets three months after the construction, all of them were in use and well maintained. Most owners 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 Otji 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 a general service to the people would be to instruct someone within the Municipality or a company to collect the material and bring it either to the nearby oxidation ponds, to the local dumpsite or to supply it to a local gardener. This service should attract a service fee.

[6] Obviously the transport costs are dependent on the distance from the place where the toilets are prefabricated (in this case Otjiwarongo, about 140 km).
[7] Prior to the introduction of the new (concrete) UDS-bowls the (plastic and non-UDS) toilet bowls had to be imported from where?.

For transport a pickup truck would be ideal. Because the number of toilets is relatively low so far, a wheelbarrow or a donkey cart could serve the purpose in the beginning. It is important to brief the contracted person of where to dump the material and to monitor this carefully.

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 the toilet owners were to charge for the use of their toilets, the emptying cost could also be covered. On a household level that seems not likely, though, as many people do not want other people to use "their" toilet. For small pubs, however, this 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 anywhere at short notice.

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

The 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.

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[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] No reuse is taking place.

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 the 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

CHP (2009a): Dry toilet systems, Clay House Project, Otjiwarongo, Namibia http://www.otjitoilet.org/

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

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

EcoSur (n.d.) Dry toilets in Latin America, http://www.english.ecosur.org/index.php/component/content/article/97-news/480-dry-toilets-in-latin-america

More photos:
http://www.flickr.com/photos/gtzecosan/sets/72157625326275173/with/5201186408/

Video about Otji toilets:
http://www.youtube.com/watch?v=mRXFSAdImgA

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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This document is available from:
www.susana.org

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

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

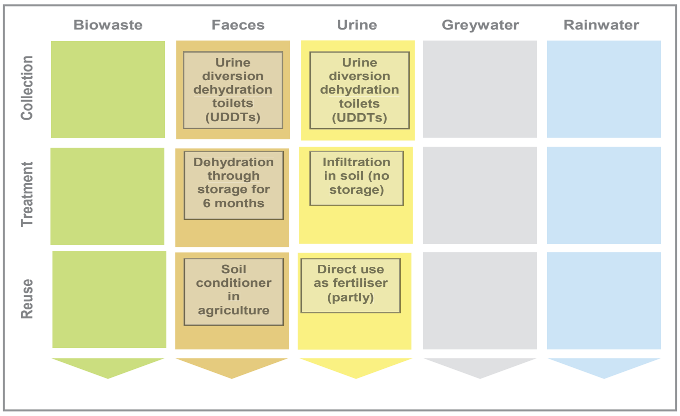

Fig. 2: Applied sanitation components in this project

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 GTZ-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.

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.

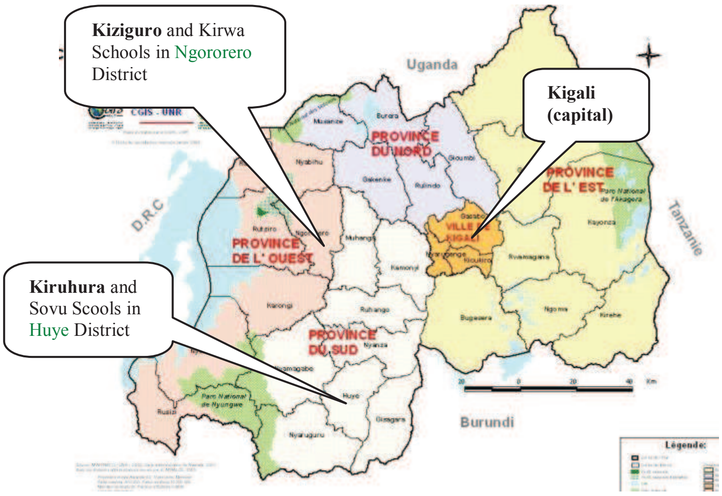

Fig. 4: Map of Rwanda, showing the location of the four schools covered by the project; in bold the two schools with UDDTs. Distance from East to West of the country: approx. 150 km (source: http://cgisnur.org/maps_admin.php3).

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.

[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/).

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. GTZ-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.

[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.

During the baseline study[7] conducted by GTZ-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].

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 GTZ, 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

GTZ-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

[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.

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).

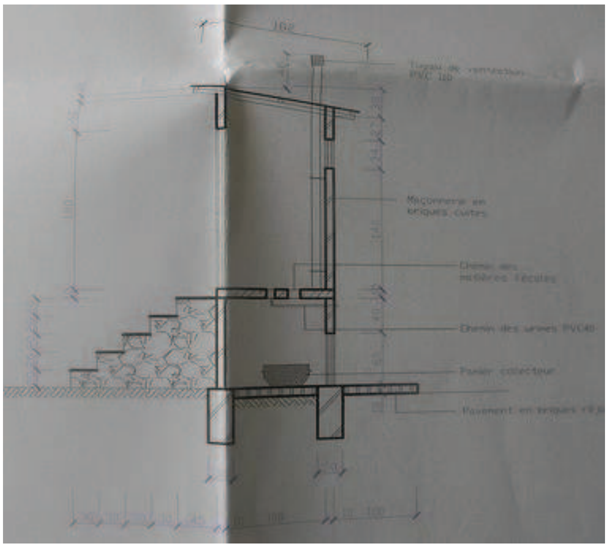

Fig. 8: Photo of a design drawing showing side view of one single vault UDDT with basket for faeces (drawing by FEA, Rwanda, Nov. 2007). More drawings are available (see Section 14 for link).

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 GTZ 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.

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 GTZ-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). GTZ-Rwanda received the funds for the initiative from the GTZ 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 GTZ (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 GTZ (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.
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14 Institutions, organisations and contact persons

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Mr. Karangwa Lambert, Fund Team Leader
Nyamagabe, Southern Province
Tel: +250 (0) 788622647/ (0) 750353800
E: kalambert2000@yahoo.fr; waterfund@rwanda1.com

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

Author: Eugene Dusingizumuremyi (consultant for GTZ, email: eugedu@yahoo.com)

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This document is available from:

www.susana.org

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

Fig. 1: Project location

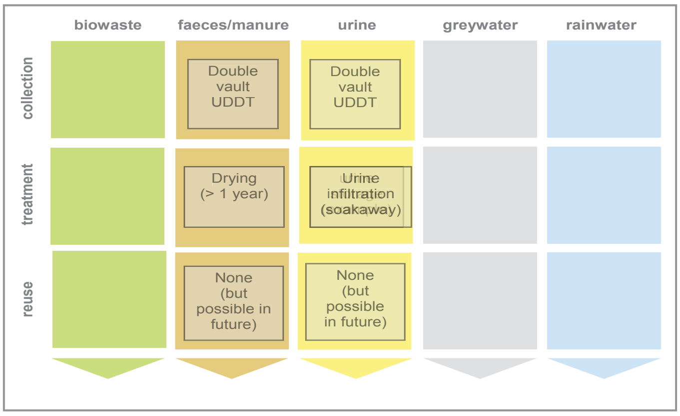

Fig. 2: Applied sanitation components (UDDT stands for urine diversion dehydration toilet).

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) Unit

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

In December 2000 the eThekwini municipal boundary was expanded from 1,366 square kilometres (km^2) with a population of 2.5 million people to 2,297 km^2 with a population of 3.5 million people. The newly included areas were predominantly rural and had little or no sanitation and water infrastructure. The eThekwini municipality had been providing Ventilated Improved Pit (VIP) latrines and 200 litre water tanks to the rural areas that were included in the municipal boundaries prior to the expansion.

The newly included areas that had to be serviced by eThekwini municipality after the expansion resulted in a “backlog” for sanitation and water. The high cost of emptying VIPs and the inaccessibility of many rural settlements due to the topography led the eThekwini municipality to rethink the manner in which they would provide sanitation and water services to these areas.

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

The development and implementation of urine diversion dehydration toilets (UDDTs) in eThekwini municipality began in 2002; this was regarded as the most cost effective technology to implement towards addressing the sanitation “backlog” in the rural and peri-urban areas. The prevention of further outbreaks of waterborne diseases among the population and the lowering of maintenance costs of the sanitation system for the municipality were the driving forces of the project. 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].

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[2] water and sanitation packages to un-served areas between 2003 and 2007. Based 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), 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.

Fig. 4: The hilly terrain in eThekwini rural areas with no road access (source: Gounden, 2008).

eThekwini Municipality, the local authority of Durban, comprises an area of approximately 2,297 km^2, 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°C to 25°C during winter (June to August) and can reach 32°C with relatively high humidity during summer (December to February). The average yearly rainfall is quite high at 1020 mm.

Fig. 5: 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, sparse housing density, inaccessible terrain (hilly) and high 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 still occurs[3].

In these peri-urban and rural areas, the average household size is 6.5 people[4]. 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)[5].

The groundwater table varies as the terrain is very hilly. On the lower slopes many streams do emerge indicating a low groundwater table. Currently groundwater is not used for drinking water in the area as water is supplied through the bulk water supply system which is cheaper than drilling boreholes for groundwater.

In 2010, the under-five child mortality rate in South Africa was 57 children per 1000, and it has been slowly decreasing during the last twenty years[6].

[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.

[2] As of 31 March 2011 the official number of registered UDDTs remained at 75,000, and the total number built is not known for sure as not all UDDTs constructed have been captured on the GPS system, primarily due to changes in project management. This is currently being investigated. There may actually be as many as 90,000 UDDTs.

[3] VIPs were chosen for the infill areas of Umlazi and KwaMashu where people had settled on land which was deemed to be unsuitable (normally too steep) for normal housing.

[4] In informal settlements there are approx 5.5 people per dwelling. In rural areas there are 6 to 6.5 people per dwelling.

[5] 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.

[6] 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/).

4 Project history

A number of factors contributed to the eThekwini municipality reviewing its strategy to deliver water and sanitation to the peri-urban and rural areas within the municipal boundary. The over-arching contributing factor was the expansion of the eThekwini municipal boundary in December 2000. In addition the 45,000 VIPs needing emptying together with the large cholera outbreak in August 2000 in the province of KwaZulu-Natal within which eThekwini is located contributed to the decision to review the strategy. The UDDT program was initiated in 2002 as a cost effective and health-promoting solution to addressing the high maintenance costs associated with emptying the VIPs, the health consequences of poor sanitation on the population and the sanitation "backlog" situation.

The cholera outbreak which occurred in the province of KwaZulu-Natal in August 2000 had 113,966 registered cases by January 2002, and 259 deaths were recorded[7]. 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, pushed the matter up the priority list of the government and gave the existing sanitation programme in eThekwini municipality a big boost.

The eThekwini Municipality 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 the waterborne sewage system. The project was driven by the need to introduce a sustainable (cost effective) approach to accelerate the delivery of water and sanitation services to the poor un-served areas of the eThekwini municipality.

A pilot project began in 2003 in the Mzinyathi area, 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 were selected on the basis of technical feasibility, financial need and human resources available as well as a health related index. Areas with a high incidence of waterborne diseases and where open defecation was still an established sanitation practice were given priority.

The following protocols were applied:

Planning protocols:

- 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 surveys.

Implementation protocols:

- Resource allocation, programming, site establishment and start construction.
- Introduction of project and project team to community by trained ISD community facilitators.
- The rule governing the number of toilets built per household was that only households with more than 8 people could have *two* toilets[8].

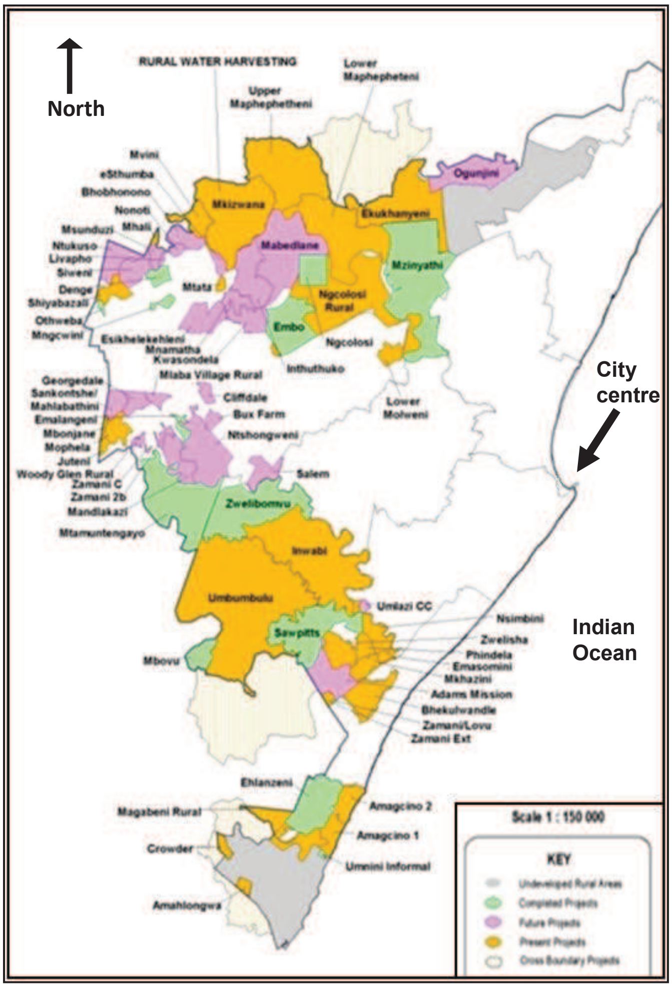

Fig. 6: Rural Water and sanitation project areas in eThekwini area (source: EWS, 2005). The municipality's coastline is 75 km in length, and the area is at its widest point 50 km wide. The colours on the map are: grey for undeveloped rural areas; pale green for completed projects; pink for future projects; yellow for current projects and white for cross boundary projects. (an updated map has been requested)

The construction began slowly as various technical components were trialled in 2003. Thereafter construction rose to 1,100 units per month (for 11 months of the year). As targets were met the rates declined again. By late 2005 the project had rolled out 13,000 water tanks and 35,000 UDDTs. The roll-out of water supply also 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

[7] The fatality rate was less than 0.2% which compares well with the World Health Organisation's accepted norm of 1% during cholera outbreaks.

[8] Prior to having toilets, the isiZulu traditional custom was to have a designated area well away from the homesteads for defecation. Traditional customary rules state that the daughter in-law may not use the same defecation area as her in-laws. Hence in some cases building only one toilet per household still leaves the daughter in-law without access to a toilet.

fee for the water, which was not charged for UDDT implementation.

Currently, in 2011, there are 75,000 UDDTs verified. As the ongoing mapping of the UDDTs by the EWS with a GIS system takes place this number is expected to increase, possibly to 90,000. The project is now being reassessed and the implementation teams are doing follow-up visits and are also providing facilities for new migrants to the area.

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 question remains what does this figure of 10% actually relate to in terms of UDDT unit numbers constructed? Is it 10% of 75,000?

5 Technologies applied

UDDTs are waterless toilet systems, where urine and faeces are separated at the source. In this project, urine is piped into a urine soak-away pit which is constructed below the ground (drawings and design specifications of this pit yet to be obtained). 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.

The double vault UDDTs have two faecal vaults: one is in use while the other full vault's faeces content is allowed to dry out and slowly decompose. Most of the pathogens die off due to the drying process. Thus, the handling of dry human excreta is relatively safe, provided that precautionary measures (such as use of gloves and hand-washing) are taken.

Several factors influenced the selection of UDDTs over other available sanitation options:

- **Financial:**
  - The provision of waterborne sewage infrastructure to rural areas is very costly. Similarly the cost of emptying ventilated improved pit (VIP) latrines is very high in this area (over 1,800 Rand per unit, approximately 188 EUR)[9]. In 2005 it was estimated that the eThekwini Municipality would have to spend approximately EUR 7.3 million for the 100,000 pit latrines which urgently needed emptying within the municipal boundaries.
  - There is no need to build a new pit and superstructure after a UDDT is filled.
- **Technical/Physical:**
  - Physical considerations (terrain configuration and inaccessible hilly locations) make VIP emptying by tanker trucks a daunting task, and the provision of a sewer system in the area impractical.
  - The volume of waste material handled in a UDDT is less than in a VIP latrine, where urine, faeces, cleansing material and possibly greywater are all mixed and collected in the VIP pit.
  - UDDTs can be built closer to the houses as they do not smell[10].
- **Health and environment:**
  - Manual emptying of VIPs is a dangerous task due to the health hazards for operators.
  - If appropriately used, a UDDT allows a safe on-site disposal of human excreta, with no need for municipal intervention.
  - 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 excreta into the soil and potentially into the groundwater (see Section 3 for details on the groundwater situation).
  - Due to low population density and no groundwater use for drinking purposes, the urine soak away pits posed no pollution risk to the groundwater.

Fig. 7: Back view of double vault UDDT showing access doors to two vaults and ventilation pipes (source: EWS).

Fig 8: UDDTs' placement[11] (front middle) in a traditional homestead (source: WIN-SA, 2006).

[9] Exchange rate for South African Rands (March 2011): 1 EUR = 9.57 ZAR

[10] eThekwini Municipality did not yet offer the option of installing the UDDTs inside the houses, due to concerns that they might damage the house while constructing the UDDT.

[11] Some UDDTs were built closer to households, but it depended on the respective households' preferences. It was observed by Jacques

6 Design information

Water supply
Until July 2010, EWS provided each household 6 kL of drinking water, from the bulk Umgeni water supply system, per month free of charge. The household plastic water tank, which holds 200 L, is automatically filled with 200 litres of drinking water per day. Municipal mains are laid along district road reserves (this is the term used to describe public land between the plots). 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. The tank is filled by an electronic bailiff unit that automatically channels water to the tanks and cuts off the water when the tank is full. With the new and higher provision of potable water, traditional yard tanks are progressively being replaced by yard taps, whilst existing traditional ground tanks, are filled more than once per day.

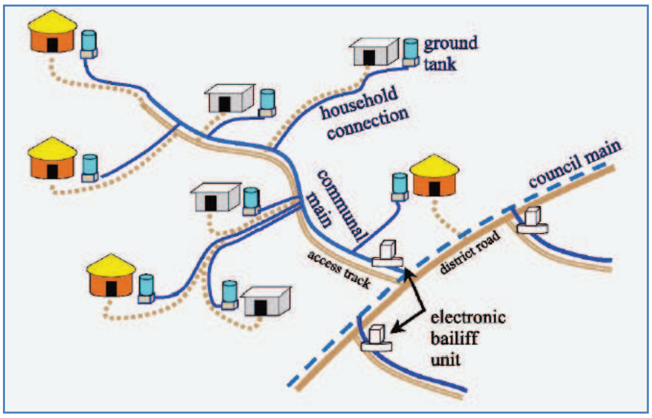

Fig. 9: Electronic Bailiff Unit

Sanitation provision with UDDTs
The UDDTs installed in this program 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 waterless urinal, for male use, also diverts urine to the soak away.

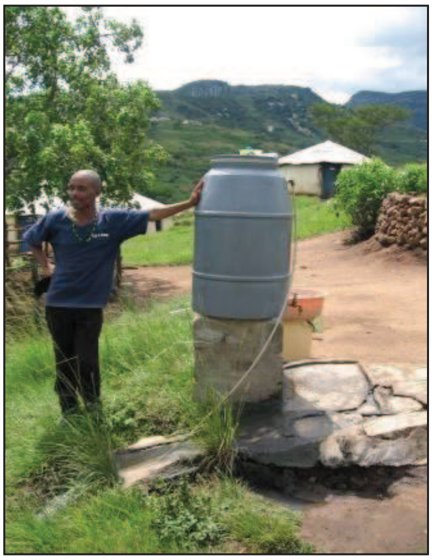

Fig. 10: 200 L yard water tank in Maphephetheni (source: EWS).

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 and moisture in the vault coming through the front wall over time.

A urine diversion plastic pedestal is located above the first vault or chamber, which collects faeces, anal cleansing material and covering materials. Users were encouraged to add dry sand or ash after each defecation event in order to cover the fresh faeces so as to facilitate drying of the organic material and act as an odour and fly control measure.

Once the first vault is full, it is sealed and allowed to rest and dry, and the pedestal is moved over to be above the second vault. During the drying 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, if the household prefers to pay for their vault to be cleared. Household members are told to bury the content of the first vault. The pedestal is then positioned back 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 size and toilet use patterns.

Rust (Envirosan) that the households who did build their UDDTs closer to their houses appeared to be better informed about UDDTs. In more rural and traditional homesteads putting a UDDT inside one house is not an option as multiple households within the homestead share the one or two UDDTs built.

Fig. 11: Inside view of UDDT: urinal for men (left), bucket containing sand or ash, cover over second vault on the left side and urine diversion pedestal on the right (source: EWS).

Fig. 12: Interior of a UDDT with sand container on the bottom left and plastic urine diversion pedestal from Atlas company at the top (source: EWS).

The pedestal used initially was a plastic pedestal from the company Atlas[12] 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.

7 Type and level of reuse

This project does not involve a nutrient recovery strategy to date. Several studies have been conducted to provide a risk assessment of the reuse of faecal material from UDDTs:

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% of samples), *Giardia intestinalis* (54%), *Trichuris trichiura* (48%), *Cryptosporydium* spp. (21%) and *Taenia* spp. (18%). The high pathogen load recorded in these areas suggests the need for further community health and hygiene education as a pre-requisite of human excreta reuse which is in line with WHO standards (WHO, 2006).

The "Valorisation of Urine Nutrients in Africa" (VUNA)[13] project is a collaborative project between the EWS, UKZN and the Swiss Federal Institute of Aquatic Science and Technology (Eawag) and is investigating the economic potential for recovering nutrients from urine. The project is funded by the Bill and Melinda Gates Foundation. By recovering nutrients from urine in decentralised reactors, the VUNA project aims to promote a dry sanitation system affordable to the poor, produce a valuable fertiliser, foster entrepreneurship, and reduce water pollution[14].

Although EWS 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, through the completion of further studies and field tests in eThekwini as well as from sensitising and informing the UDDT users about the opportunities that reuse could offer them.

Gardening activities are apparently not very popular in this area. (Why ?)

8 Further project components

Training and Capacity Building

- Training of Institutional and Social Development (ISD) consultants (by EWS) on the project's 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 councillors and 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 with the following activities:

1. Briefing on plans to provide water and sanitation to the household.

[12] See the following website for more information http://www.atlasplastics.co.za/category/sanitary_ware-7.html

[13] In the local language isiZulu the word "vuna" means harvest.
[14] See the Eawag website for more information http://www.eawag.ch/forschung/eng/gruppen/vuna/index_EN

2. Health and hygiene education.
3. Information on how to use the UDDTs.
4. Explanation on the water supply system.
5. Education on operation and maintenance of the systems provided.

The timing of these visits was carefully planned to align with the construction, usage and maintenance phases of the UDDTs, so as to optimise the knowledge transfer to the users of the UDDTs. See Appendix 1 for a detailed timeline.

Fig. 13: Street theatre for hygiene and health education (source: EWS).

Other ongoing education activities routinely undertaken by EWS include:

- 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 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:

- 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 people with disabilities. A guideline for employing facilitators was that 50% should be women, 35% youth and 15% people with disabilities.

Related water and sanitation projects

Another system used by EWS to provide sanitation facilities to poor households in the municipality's informal settlements are the Community Ablution Blocks (CABs) in urban and peri-urban areas of Durban. These are communal water and sanitation facilities with flush toilets, hand wash and laundry basins in areas connected to the sewer system. For more information please see the separate SuSanA case study titled "Community ablution blocks with sewers or infiltration, eThekwini (Durban), South Africa"[15].

9 Costs and economics

The entire program since 2003 has been financed by the eThekwini municipality and is funded through the Municipal Infrastructure Grant[16].

The households do not have to contribute at all to the capital cost. This is due to the specific political situation of South Africa post-apartheid, where free provision of basic services is enshrined in the new constitution. There is a general expectation among all un-served poor households that they should receive basic sanitation and water services for free.

The cost break-down per household UDDT is shown in Table 1. The total cost of one double vault UDDT is **EUR 585** which is quite expensive compared to other UDDT projects[17]. It should be noted that the costs of the UDDTs 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 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 systems) up to 2007 amounted to EUR 62,179,000 for 75,000 households. This is equivalent to EUR 833 per household – slightly less than what is shown in Table 1. An update to the total investment cost up to 2011 will be made as soon as the information is available.

With regard to operation and maintenance costs, these are entirely incurred by the households, see Section 10. Dry sand or soil for covering the faeces after defecation is available for free in the area.

[15] http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=792

[16] The Municipal Infrastructure Grant funding comes from the central government and is administered by Cooperative Governance and Traditional Affairs (CoGTA); it is responsible for the provision of basic sanitation for the un-served, see http://mig.dplg.gov.za/Content/Documents/Guidelines/Annex%20B%20-%20MIG%20Introductory%20Guideline.pdf

[17] 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. See other SuSanA case studies on UDDTs for a cost comparison: http://www.susana.org/lang-en/case-studies?showby=default&vbls=7&vbl_7=28&vbl_0=0

Table 1: Cost break-down for the household double vault UDDTs and water supply systems (exchange rate for South African Rands (March 2011): 1 EUR = 9.57 ZAR)[18].

Item	Cost in EUR
Reinforcing and slabs	40
Structural work (foundations, superstructure, block work)	100
Carpentry and joinery	40
Earth works	25
Concrete work	80
Metal work	20
Ironmongery (door locks)	10
Roof work	25
Plumbing and drainage (plastic urine diversion pedestal, flanges, cover lid, urinal, urine pipe, vent pipe etc)	75
Local Labour	80
Managing Contractor (local)	90
Total for one household UDDT	**585**
Project management, Institutional and Social Development (ISD) consultants, facilitation and security	75
Water supply (water tank and pipe network)	400
Total water and sanitation system (per household)	**1060**

10 Operation and maintenance

The UDDT programme by EWS places the responsibility of maintaining the toilet on household members and empowers them to manage and maintain their own systems. Thus, household members are responsible for the following:

- Regular cleaning of the toilet.
- 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 include minor repairs of the water tap (hand washing unit), vault doors (due to rusting, termites), roofing and occasional repainting. The municipality supplied each household with a rake and gloves for emptying of their UDDTs. In addition, local contractors were trained in emptying the vaults. This service is offered to those UDDT owners who do not want to empty their UDDTs themselves. It costs between 5 to 10 EUR per emptying event and the UDDT owner has to pay for this service.

Fig.14: Emptying a UDDT faeces chamber (source: EWS).).

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 put such a system in place by commissioning an independent research organisation called Human Sciences Research Council (HSRC)[19], utilising 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 began in 2003 EWS has documented the following lessons learnt:

1. Allocating responsibilities to a single unit within eThekwini municipality. Allocating responsibilities for water and sanitation service delivery into 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 trained by the programme, allowed for an on-going improvement of both construction design as well as the supporting programmes. The 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 other 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 implementation of the water and sanitation systems.

[18] The cost break down in Table 1 is intended to give the reader a general idea of the costs. During the project there have been fluctuations in the costs due to exchange rate fluctuations, general inflation, economic depression and other factors that can be expected in a water and sanitation programme that is 9 years old and on-going.

[19] See their website http://www.hsrc.ac.za/index.phtml

4. Ongoing monitoring and evaluation of the implementation approach. Monitoring and evaluation conducted by EWS officers and independent institutions have provided valuable recommendations such as:

- A number of design faults were revealed in a site visit by Richard Holden in his capacity at the time as National Operations Support Manager for the Mvula Trust[20]. The site visit took place on 8 April 2004 in the Ehlanzini district, where for example it was discovered that the UDDTs' vault access covers were made out of cement and were heavy, easily broken and could not be re-sealed after inspection or emptying (Holden, 2004). This was later remedied with a new design namely a plastic sliding door that was then retrofitted to all UDDT installations.
- The HSRC was commissioned by the EWS 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. Further design faults were discovered by the HSRC survey results.
- 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. The comprehensive survey, which began in January 2011, was completed by May 2011[21] and results will most likely be published by early 2012.
- As the greatest risk of spreading diseases is in the process of emptying the faeces vaults and burying their contents, vaults should be designed to ease the emptying process.
- Biological degradation and drying of the faeces in the UDDT vaults 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 only with mesh allowed rainwater to enter the vaults. This resulted in the bottom of the UDDT vaults being wet. A new model of flyscreen, supplied by Thermoplastic Concepts & Equipment (TCE), with an umbrella cap was thereafter introduced to solve this problem.
- The lugs on the original Atlas plastic pedestal were found to be too small and weak with the result that the pedestals sometimes collapsed through the hole in the base slab. This led to the pedestal supplier being changed to Envirosan[22]. Lugs are at the base of the pedestal and rest on the concrete. Envirosan uses a flange which is a lot more robust.
- The pedestal design was for adult users which made the UDDTs difficult to use for young children, resulting in parents discouraging their young children from using UDDTs. EWS together with Envirosan have developed a child seat adaptor[23], currently on trial, to achieve more child-friendly UDDTs.
- The willingness to retrofit existing UDDTs and to alter the design of the UDDT when design flaws were discovered illustrates the Municipality's commitment to the programme and has 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 as well.

5. Critical number of units. The fact that the programme provided demand for a large numbers of UDDTs, encouraged manufactures like Envirosan (for the pedestal) and TCE (for the flyscreen) to invest time and money into developing and adapting their product designs to function well and meet users' needs.

6. Addressing the expectations of rural communities. EWS recognises that social acceptance of the project and political will both constitute important factors for success of sanitation interventions.

- The HSRC study showed that while acceptance of water supply tanks was generally high, user satisfaction with the UDDTs was lower (Kvalsvig et al., 2003). Particularly people living in peri-urban areas close to the sewer system aspire to get flush toilets, considered a symbol of social emancipation[24]. Conversely, rural communities showed better acceptance of the UDDTs, as no households with flush toilets were nearby and thus no direct comparisons were made.
- The greatest challenge in terms of acceptance was the emptying of the vaults[25]. The establishment of local faecal vault clearing services by micro-enterprises in the respective communities was a method of mitigating this acceptance challenge.

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).

[20] The Mvula Trust is one of South Africa's leading water and sanitation NGOs, for further information see http://mvula.org.za/.

[21] The survey made use of mobile phones and local people so as to increase the sample size, response rate and speed of conducting the entire survey.

[22] It is not known when the switch to Envirosan occurred but it was most likely around 2006.

[23] See photos by Envirosan (link details are given in Section 13).

[24] According to information by Richard Holden in April 2011: "Residential areas with access to in-house, full pressure plumbing and waterborne sewage are subject to strict credit control (enforcement of payment or else services are cut off). There were two court cases recently in South Africa, 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 municipalities won their court cases and this sent the message that some people are not more privileged than others when it comes to basic water and sanitation but that people need to move to an area and service level that suits their financial means."

[25] With statements like "It is not in my culture to handle human waste" being made often by users prior to adoption (source: R. Holden, 2011).

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:

- 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 for local communities and improvement of people's privacy and safety.
- Creation of job opportunities related to UDDTs.
- Beneficial impacts on the environment since human excreta is collected and disposed of safely.

The *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 had received UDDTs and water tanks) and three controls areas, which had not received the intervention. Significant improvements in the health conditions of the population receiving UDDTs 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 for 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 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:

- http://www.flickr.com/photos/gtzecosan/sets/72157623278033491/
- http://www.flickr.com/photos/gtzecosan/sets/72157626528442017/

Video:

10-minute video about eThekwini's innovations in supplying water and sanitation to informal settlements and rural areas: http://www.youtube.com/watch?v=WZjHnkapRgg

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eThekwini Community Profile:
www.durban.gov.za/durban/wardCatalog/index_html

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Photos of these pedestals from Envirosan catalogue: http://www.flickr.com/photos/gtzecosan/sets/72157626528442017/

Case study of SuSanA projects

Large-scale peri-urban and rural sanitation with UDDTs, eThekwini (Durban), South Africa

SuSanA 2011

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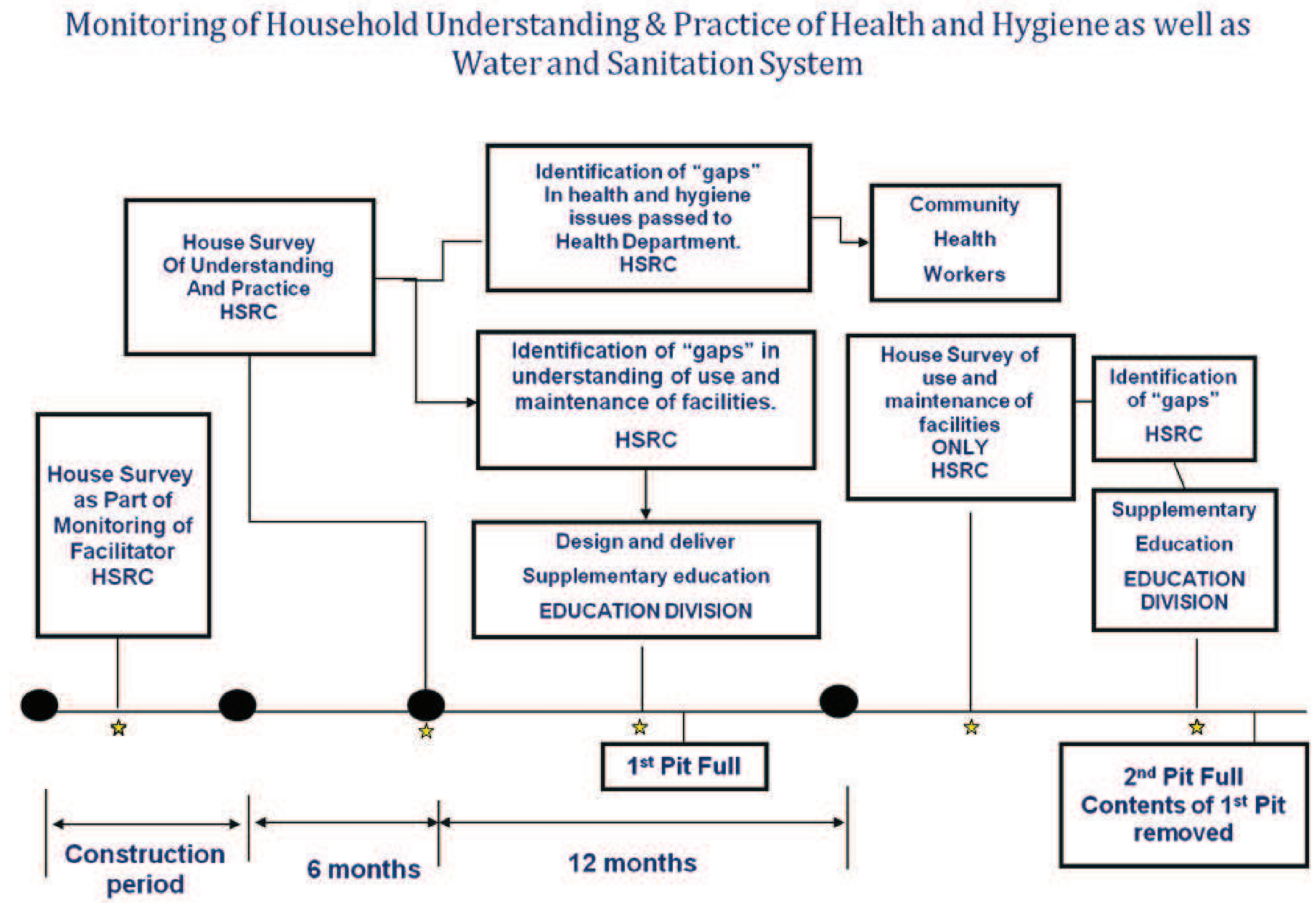
www.susana.org

Appendix 1: A detailed timeline showing the project cycle and the timing of each household visit from eThekwini Water and Sanitation (EWS) health practitioners and education officers



(source: Gounden, 2008)

The stars mark the timing of each of the five visits from the EWS health practitioners and education officers to the UDDT users' households. The larger dots mark the respective time periods. Note that only the first 12 month period is demarcated, but the timeline represents a 24 month period in total. "Pit" in the diagram actually refers to UDDT vault.

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

Figure 1: Project location.

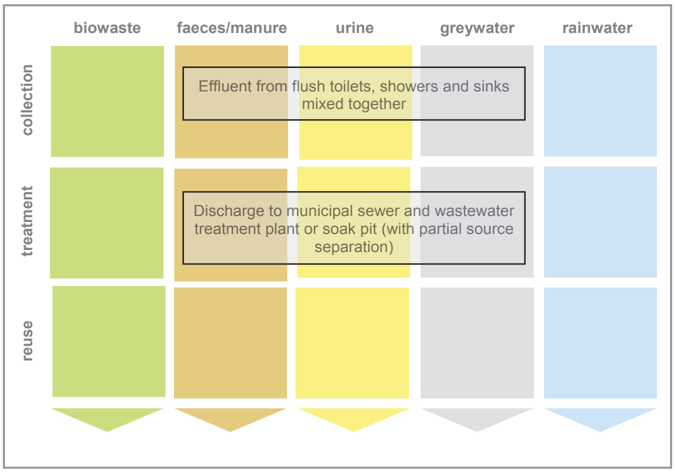


Figure 2: Applied sanitation components in this project (currently no reuse taking place).

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).

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

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 (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).

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.

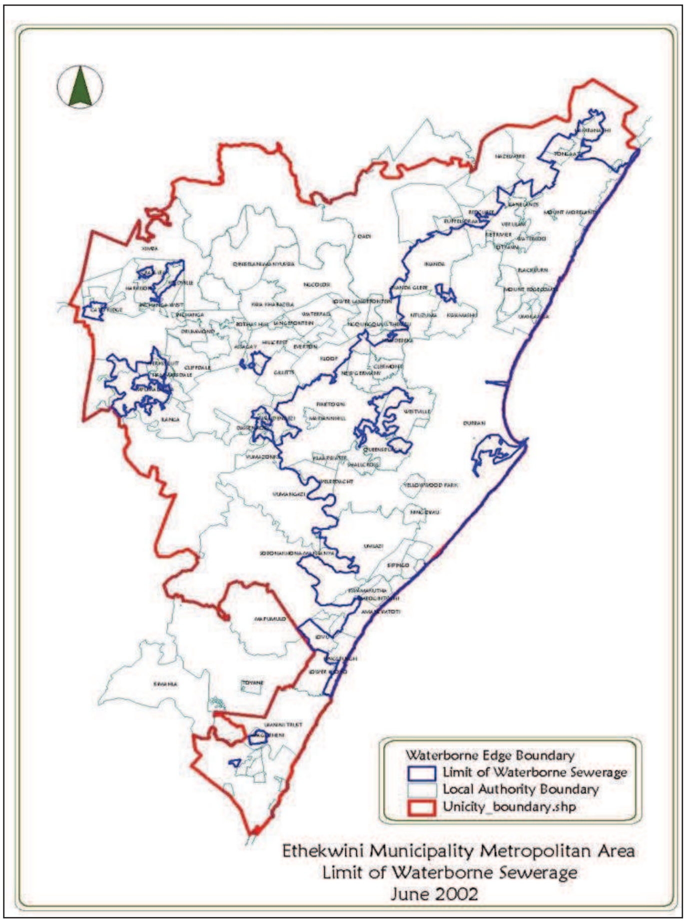


Figure 4: eThekwini waterborne edge (source**:** EWS, 2002).

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.

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

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).

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.

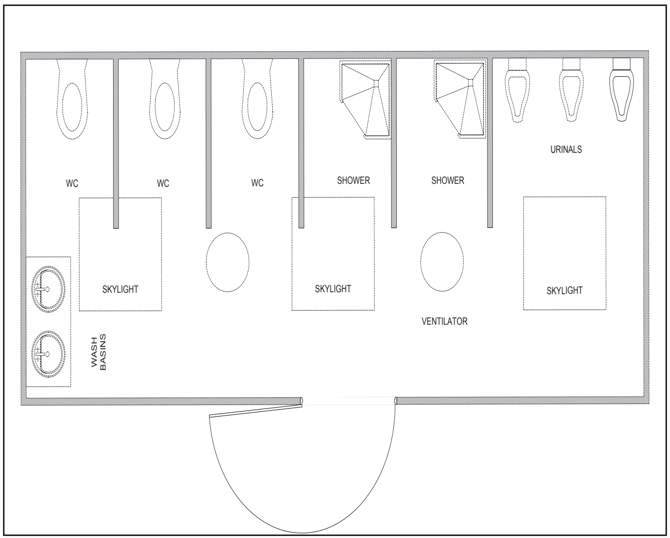


Figure 6: Typical design of a CAB (source: EWS, 2009).

Figure 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.

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.

Figure 8: Caretakers outside a CAB in Durban (source: EWS, 2008).

Figure 9: Interior of CAB, Durban (source: Roma, 2010).

Figure 10: Flush toilet in CAB (source: Roma, 2010).

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 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 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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Websites

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

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Subdivided by operational areas
Consultancies:
Northern area: SBA (Pty) Ltd
Central area: Aurecon
Western area: BKS (Pty) Ltd
Southern area: CBI Consulting Engineers (Pty) Ltd
Contractors:
North area: Icon Construction (Pty) Ltd
Central area: Sanyati (Pty) Ltd
Western Area: WBHO/IN-SITU PIPELINES JV
Sothern area: WK Construction (Pty) Ltd

Subcontractors:

Northern area:
- Nomangisi Construction
- Abangani Projects

Central area:
- Emzini Projects
- Madondo-Hughs

Western area:
- Royal Africa Trading
- Sbonisiwe Investments

Southern area:
- Old Town Investments
- Ekuhawukeni Trading Enterprise

Case study of SuSanA projects

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

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This document is available from:
www.susana.org

Case study of sustainable sanitation projects

UDDTs for teachers at a primary school Arusha, Tanzania

Fig. 1: Project location

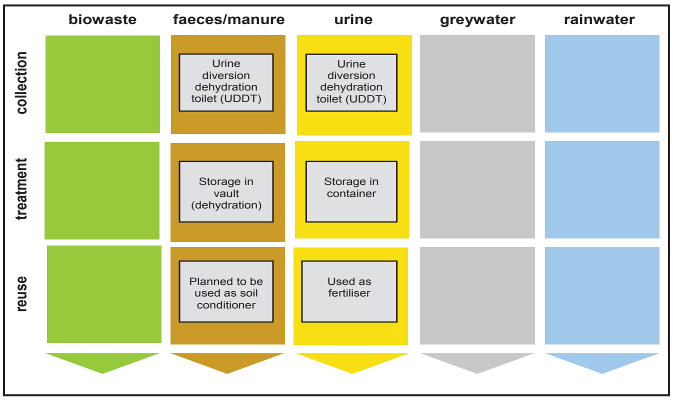

Fig. 2: Applied sanitation components in this project.

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.

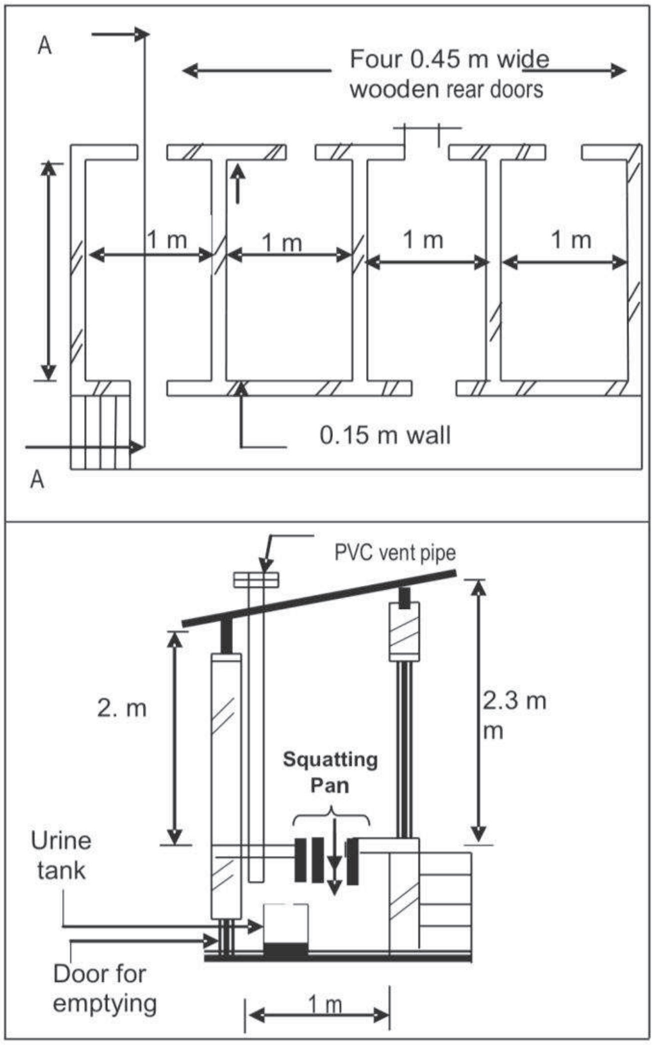

Fig. 5: Floor plan and cross section of the double vault UDDT.

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

[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/)

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 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.

UDDTs for teachers at a primary school Arusha, Tanzania

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

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Case study of SuSanA projects
UDDTs for teachers at a primary school
Arusha, Tanzania
SuSanA 2011

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UDD toilets at a rural secondary school Kalungu, Uganda

Fig. 1: Project location

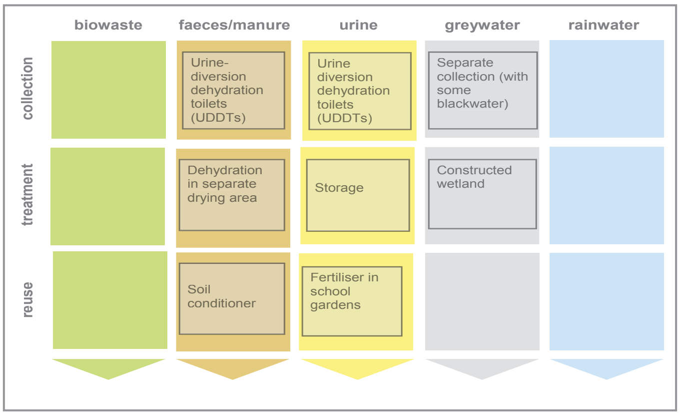

Fig. 2: Applied sanitation components in this project

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).

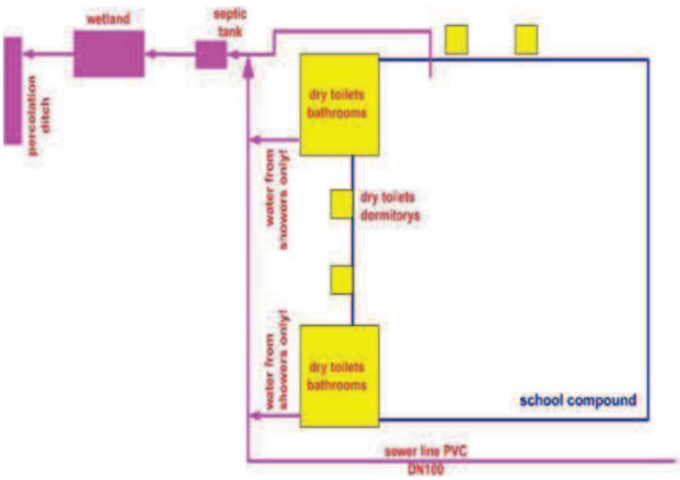

Fig. 7: Scheme of new greywater system; flow is from right to left (source: EcoSan Club).

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.

UDD toilets at a rural secondary school Kalungu, Uganda

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.

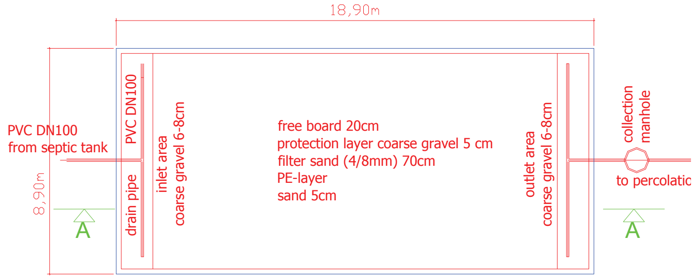

Fig. 9: Plan view of horizontal flow constructed wetland, flow is from left to right (source: EcoSan Club).

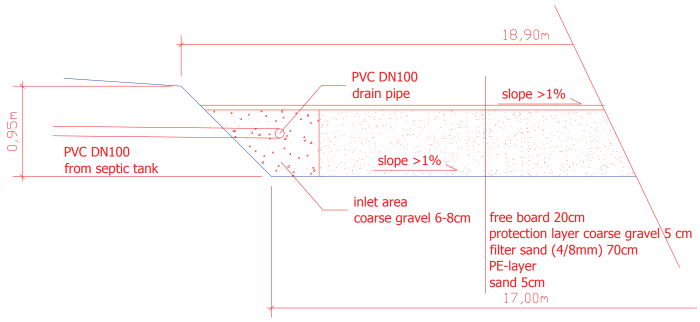

Fig. 10: Cross section A-A from Fig. 9 showing inlet area of horizontal flow constructed wetland (source: EcoSan Club)

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

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)

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).
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- 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
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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 - sanitation@gtz.de)

Large-scale peri-urban and rural sanitation with UDDTs South Western region, Uganda (draft)

Fig. 1: Project location

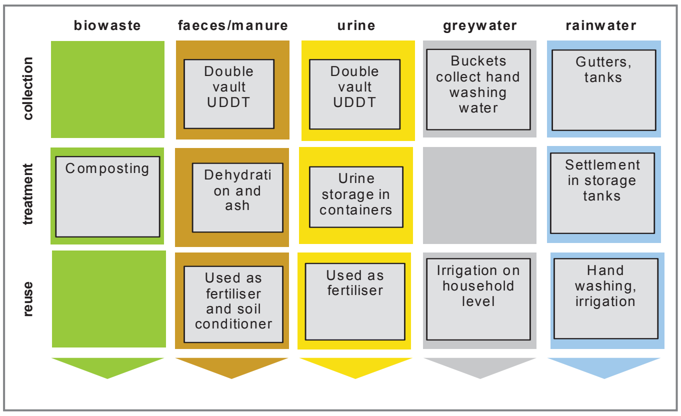

Fig. 2: Applied sanitation components in this project (UDDT stands for urine-diverting dry toilet)

1 General data

Type of project:
Large scale urine diversion dehydration toilets for peri-urban and rural households

Project period:
Start of construction: 1996
End of construction: Toilet construction ongoing process (15 days per toilet)
Start of operation: Directly after construction of each toilet
Project end: 2013?
This project has so far gone through three phases: South Western Towns Water and sanitation Project (SWTWSP):
SWTWSP I 1996 - 2002
SWTWSP II 2002 - 2006
SWTWSP III 2006 - 2013

Project scale:
Number of toilets built: 927 (6 persons per household)
Number of people covered with toilets: 5562
Total investment for sanitation part: EUR 420,000
Number of people covered with water supply: 530,093 (the total population in the project towns (regional growth centres and small towns) implemented)

Address of project location:
South Western Towns Water and Sanitation (SWTWS) Project, P.O Box 575,
Mbarara, Uganda

Planning institution:
Ministry of Water and Environment, Directorate of Water Development, Kampala, Uganda

Executing institution:
South Western Towns Water and Sanitation Project

Supporting agency:
European Union, Austrian Development Agency, Government of Uganda

2 Objective and motivation of the project

The overall objective of the SWTWS project's sanitation programme is to improve the living conditions of the population in Uganda by ensuring better sanitation practices, personal hygiene and food security through better management of human excreta.
The specific objectives of ecological sanitation promotion are:

- Equip the national and district technical staff with capacity to advocate for, plan, construct, operate, maintain, promote, sensitise the communities on the health benefits of ecological sanitation
- Build the private sector capacity in the planning, construction, operation and maintenance of ecological sanitation facilities through practical training for construction and operation and maintenance.
- Sensitise the user communities on the resourcefulness of human excrements towards food security through the recycling of sanitised faeces and urine in agriculture as soil conditioners and source of plant nutrients
- Offer as an alternative, a sanitation technology option to perennially difficult areas of pit latrine construction, areas with high water table, soft formations and/or rocky grounds.

Fig. 3: An ecosan toilet (UDDT) in a household (source: Project Album, 2005).

3 Location and conditions

Climate and geographical conditions
The project is located in rural growth centres of population above 500 but below 5,000 people and small towns with population ranging from 5,000 to 10,000 people in South Western Uganda covering 24 highland and lowland districts. The topography is mainly green, interlocking and heavily cultivated hills with spectacular valleys. The altitude of the districts ranges between 1,115 meters and 2,347 meters above sea level. This altitude makes it colder than the rest of the country. Temperatures average about 18 °C (64 °F) during the day and fall to about 10 °C (50 °F) at night.

The area topography ranges from mountainous (in the districts of Kabale, Kisoro, Kanungu, Rukungiri, Kasese, Kabarole, Kyenjojo and Bundibugyo) to the relatively small hills with swamps in the valleys and dry plains in the districts of Kiruhura Sembabule and Rakai.

Population and settlement
The project targets rural growth centres that have populations of 500 to 5000 people and small towns with 5,000 people to 10,000 people.

Type of Settlement:
The settlements are semi-urban, and concentrated along roads with buildings close to one another.

Fig. 4: Household UDDT constructed next to traditional house in semi-urban areas (Source: Hans Schattauer, 2012)

General water and sanitation situation
The project started at a time when the sanitation situation in the region was dire. Most of the towns' water sources were surface and ground water which was susceptible to contamination by poor sanitation. Furthermore, not all the households in the project towns had pit latrines either out of negligence, inaccessible rock structure, soft soils or a high water table.

For excreta disposal, there was a greater use of traditional pit-latrines, but a larger percentage of those were not sound. Various problems of the latrines included: collapsing substructures, not thatched, poorly thatched with grass, no doors and some which only consisted of substructures. Household waste was disposed in the banana plantations and surrounding bushes. Very few households in each of the towns had compost pits. The sanitation surveys included assessing the following: cleanliness at household level, ventilation of houses, animal sheds, bath rooms, the hygiene status of the water collection containers and drinking water containers.

During the sanitation surveys which involved moving from house to house; people would be advised on how best to improve their sanitation standards.

Economic situation
The people in the project area are subsistence farmers while others operate small scale retail business. Most of them are middle income earners.

Agricultural aspects, type of soil
Most people practice subsistence farming; engaging mostly in growing food crops. The soils found in the area are: oxisols, utisols and inceptsols.

Institutional and legal framework
The Ministry of Water and Environment through the Directorate of Water Development (DWD) co-ordinates funding for infrastructure development, information management and sets standards for monitoring and evaluation. The directorate promotes the provision of safe drinking water and improved personal, communal and institutional sanitation practices at national and district level. It is through this role that the DWD takes an active role in physical infrastructure development, monitoring of standards, information management and community training.

Socio-cultural conditions
People are not comfortable talking about faeces in public, let alone handling them in agriculture. The responsibility of hygiene promotion in the household is mainly done by women.

Health aspects
In Uganda, the under-five child mortality rate is currently[1] 99 children per 1000, with a clear downward trend compared to 1985 when the value was 180 child deaths per thousand.

4 Project history

The South Western Towns Water and Sanitation (SWTWS) project was created in 1995 to provide water supply and improve sanitation in 19 small towns and rural centres in South West Uganda. Implementation of the program started in 1996 with a grant from the Austrian Government.

The focus was on providing Water supply and sanitation systems with low operation and maintenance costs to ensure sustainability giving the low-income levels of the beneficiaries. Basic sanitation (at least a pit latrine with a sanitation platform (sanplat)) for each household was the mandatory requirement before supply of safe piped water.

In 1997, a hydro-geological study carried out by SWTWS Project unearthed a possibility that the Kisoro town community in the project area, that predominately utilises pit

[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/).

latrines for excreta disposal, could be contaminating their spring water source through digging pits. The study showed that the veins of their Chuho water spring were passing beneath the town. Hence a possibility that the seepage from the pit latrines was finding its way into the water veins feed Chuho spring.

Muhanga, one of the towns found in a water logged area had a problem of collapsing pits and thus not suitable for pit latrines. It was then that Ecological sanitation (Ecosan) was identified as a possible solution for both towns.

An attempt to introduce ecosan was met with stiff resistance by the communities, as it was unheard of to reuse human excreta. The very first attempts to construct ecosan units were not successful. Double vault Solar Heated Compost (DVSHC) faced on O&M challenge since it required addition of other materials like dry grass, peelings. This proved to be demanding for the communities. Introduction of Urine Diverting Double Vault Solar Heated units had challenges too: the UDDTS constructed on site, were not standard, as each mason would construct differently.

The first units that were constructed were DVSHC where shallow pits were dug, where urine and faeces were mixed, but these were later abandoned in favour of UDDT's that are totally constructed above the ground. Maintaining DVSHC was difficult for the community. Since they looked more like the traditional pit latrines, people either failed or neglected to add dry material like ash, dry grass, peelings etc. At other times ground water found its way into the chambers and affected the composting cycle.

Later in 1999, SWTWS staff in collaboration with Linkoping University and SanRes program received training in ecosan. Through the SanRes program, the SWTWS project acquired urine-diverting pans from China and a mould from Mexico. Later a private factory in Uganda (CRESTANK) started manufacturing plastic pans that made it cheaper for the community to access the pans.

After a series of experiences in the South Western region, workshops and discussions, it was agreed that Ecological sanitation concepts would be beneficial for the entire country and especially problems areas which for one reason or another would not find it easy to construct pit latrines. Measures to promote the concept countrywide started to be drawn, spearheaded by DWD and the Ministry of Health (MOH).

During 2001, DWD and Environmental Health Department (EHD) in collaboration with Water and Sanitation Programme-Africa (WSP-AF) began the process of establishing a National Advisory Committee on Ecological Sanitation (NACES), drawing members from relevant line ministries and stakeholders; Ministry of Water and Environmental (MWE), Ministry of Health (MOH), Makerere University Kampala (MUK), and the Kampala City Council (KCC). The committee on their fourth sitting developed a National strategy to promote ecosan countrywide, which was approved and adopted.

Based on the National Strategy, the team of stakeholders (DWD, MOH, EHD, MUK and KCC) came up with a programme to promote ecosan while building on and strengthening existing experiences as a starting point. These stakeholders play the major role in the promotion and implementation of ecological sanitation in the country.

The ecosan programme would eventually cover the whole country but the pilot projects would be in areas that already had ongoing ecosan activities; namely, the South Western towns. Later on drawing from the lessons, challenges and successes of the pilot project the program would spread thought the country.

Fig. 5: UDDT constructed for a household where the by products from the toilet are reused in the surrounding banana plantation. The UDDT was built a part of the Ecosan program. (Source: Hans Schattauer, 2012)

Ecological sanitation promotion thus became one of the major sanitation activities in the project towns.

The policy of the WSDF[2] (Water and Sanitation Development Facility) is 100% latrine coverage before opening the water supply and 5 demo ecosan units in each trading centre, for interested institutions (schools, mosques etc.) and private persons (ideally leaders in the community).

5 Technologies applied

The technology being promoted by the project is a double vault urine diverting dry toilet (UDDT). Most of the facilities constructed have been double vault toilets although single vault facilities have also been promoted in schools, some households and at water source areas.

[2] WSDF – see section 14 on Institutions, organisations and contact persons

In the project, two types of ecosan toilets have been promoted; the Double Vault Solar Heated Compost toilet (DVSHC) that was initially promoted and the Double Vault Solar Heated dehydrating toilet (DVSHD) that was later introduced and is still promoted to date. These have been promoted at the household, institutional and public levels.

Treatment facilities:
Treatment of the faeces is done on site by reducing the moisture content thereby denying the pathogens their basic requirements. The moisture content of the faeces is reduced to about 25% or less. Dehydration is usually achieved by drying and addition of ash (Fig. 6). However, people are advised to add dry soil or sawdust, if ash is not available. In a toilet vault the faeces are subjected to conditions that render them harmless by storing them in the toilet chamber for at least 6 months which gives time for disease causing micro-organisms to die.

Fig. 6: (Top) Doubled chambered UDDT with only one chamber in use at a time. The other source separation pan is kept covered. (Bottom) Ash and toilet paper used for drying material. (Source: Hans Schattauer, 2012)

Collection and application requirements:
Faecal manure is then removed from the chamber, put in a shallow pit and covered for at least 2 weeks. This allows for further decomposition into humus. The decomposed material is then removed from the pit and applied to the gardens by incorporating it in the soil during land preparation or at planting.

Transportation distances:
The transportation distances are usually short (less than 0.1km) because treatment is done on site and most households have their gardens close by.

Justification of technology (Why the technology has been chosen):
UDDTs are preferred over the traditional pit latrines that have been common in the area because they do not contaminate ground water sources, faeces can be recycled for use in gardens and they do not smell or attract flies.

How were future users involved in the process?
The future users are sensitised about the technology; construction, use, management, and its advantages over other technologies, and asked to select seven households where demonstration toilets are constructed. They also select two masons in each town who are given practical training such that skilled capacity to construct these toilets remains in the towns once the project ends.

6 Design information

Design information that has been used in planning for the project:
Basic design parameters:

- Structures are sited as close to the house as possible
- In sloppy areas, slopes are used instead of having steps going up to the toilet entrance
- Proper plumbing is done to avoid urine leaking into the chambers
- Ramps instead of steps are built for the disabled and the elderly to easily access the facility
- Structures are made watertight, and putting a damp proof membrane is a must
- Urine discharge pipe of ¾" or 1" work well to avoid blockage due to uric acid build up in the pipe
- A vent pipe is put for aeration
- Solar heating is added to fasten pathogenic die off and quick drying of faecal matter

Assumptions

- There is an average of six persons in each household.
- Each person defecates about 50kgs of faeces per year.
- Faeces are stored for at least six months before emptying the vault.
- The sun is always available for heating the black metallic sheet at the box of the toilet.
- Ash for adding in toilet is readily available.
- People are willing to recycle the excreta and use it in gardens.

Applied design and construction methods:
For constructing a brick masonry UDDT unit, most care has to be taken when constructing the substructure**.** Two watertight vaults of the same size are constructed above the ground to allow easy emptying and to prevent water from getting into the vault. This also prevents the contamination of groundwater. The vaults are constructed on a concrete (1:3:6) floor which should have a damp proof membrane. The vaults sizes should have already been determined by this time. The brick walls, measuring 150mm (6 inches) are bonded with a cement and sand mortar mixture in the ratio of 1:5 and are then erected. Thereafter the reinforced concrete (1:2:4) slab is cast

and the UDDT pans fitted at least 75mm above the slab to avoid water entering the vault during cleaning.

The superstructure walls are 150mm thick. They are constructed using clay or stone masonry. The roof consists of Corrugated Iron Sheets supported by Timber purlins of 100 x 50mm (4 x 2 inches), on Timber Rafters 100 x 50mm (4 x 2 inches), on 100 x 75mm (4 x 3inches) Wall plate and fascia board 225 x 25mm (6 x 1inches). A vent 100mm (4 inches) diameter PVC pipe is installed such that it is at least 600mm above the roof. Generally, the vent pipe should be slightly higher than the roof ridge or the highest point of the roof, such that the flow of air is not impaired. The vent pipe should have a mesh at the top to trap flies as well as a cover to prevent rain from entering the vaults through the pipe. The solar heaters consisting of a metallic sheet painted black and are placed in such a way as to trap as much sunshine as possible.

Choice of materials:
The toilets are usually constructed with naturally existing or manufactured materials depending on the economic status of the owner; thus, the technology caters for both the poor and the rich.

- For low income earners one could construct a UDDT entirely from locally available natural materials like stones, mud, clay, water, tree poles, logs, reeds, ropes and grass for thatching (mud and wattle structure).
- For middle income earners, one could construct the structure using stones/hardcore, crushed aggregates, sand, bricks, cement, steel bars, PVC Vent pipe, plastic pipes for urine diversion, door (timber or steel), iron sheets, nails, timber, steel covers for the solar heating, polyethylene paper (damp proof membrane).
- For the rich, the structure could be roofed with tiles and the floor and walls made up of tiles, terrazzo etc.

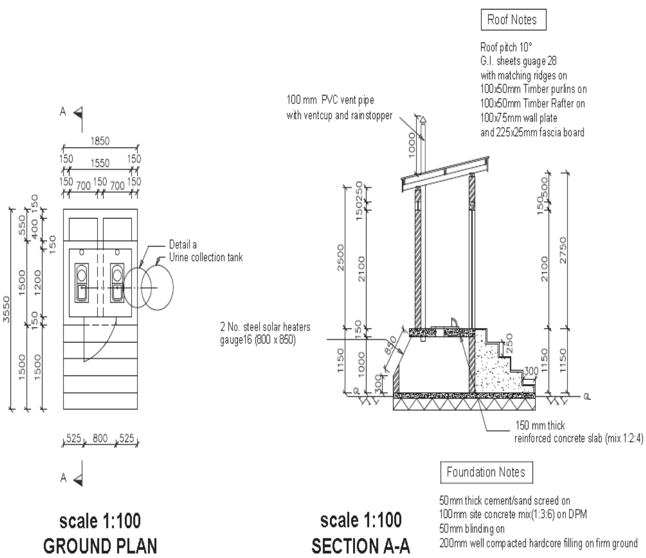

Fig. 7*:* Drawing: Design of an ecosan toilet (Source: WSDF-SW)

7 Type and level of reuse

Application of urine as a pesticide and fertiliser:

Urine is used as a pesticide and fertiliser. Urine is first stored in an airtight container (Fig. 5) for at least a week, before use. For use as a fertiliser, it is diluted: 1 part of urine to 2-5 parts of water depending on the level of soil fertility. For insect pest control, a higher concentration is required. The diluted solution is sprinkled around the plants/crops in the root zone for plant uptake and in case of bananas; it is sprinkled around the banana stem. The appropriate concentration is applied once every week.

Fig. 5: Urine collected in a urine tank and used as pesticide and fertiliser on crops

Faecal manure on the other hand is used in agriculture although the quantity collected in a year is too little to sustain the volume of agriculture activities in that particular year.

Experiences in the use of ecosan products
Ecosan products have been used in experimental gardens at the office and in the project areas and they have shown improvements on the growth and yield of some crops. Examples are:

- Sorghum (Kabale 2003)
  Use of urine on sorghum resulted in larger stems than those of the control group that grew under natural conditions. Urine also enhanced the growth rate by early flowering (90 days after planting) with the control flowering after 101 days. However, birds ate all the grains hence yield could not be evaluated.
- Cabbage (Kisoro 2002/'03)
  The maximum cabbage head weight for the urine test and control plots were 6.6 and 6.05kgs respectively while the mean cabbage head weight for the test and control plots were 3.09 and 2.27kg respectively.
- Beans (Rukungiri 2002)
  Beans were planted in September 2002 in Rukungiri in 3 plots, each measuring 9m^2. In one, urine was applied as a fertiliser, the other one faecal manure and the control was only watered. Yield results were as follows:
    a. Urine test plot 3.07kgs (3.4 metric tonnes/ha)
    b. Faecal manure test plot 2.80kgs (3.1 metric tonnes/ha)
    c. Control plot 2.40kgs (2.7 metric tonnes/ha)

Conditioning effect of faecal manure:
At harvesting time (97 days after planting) most of the bean plants in the faecal manure test plot were still with green foliage. This confirms the conditioning effect of faecal manure on the sandy soil, by improving its water holding capacity.

These cases show that treated human waste improves agricultural productivity.

Faecal-phobic attitudes in communities are fading. People are now ready to eat food which they know has been grown using treated human wastes. Examples include:

- In Rukungiri, maize from an ecosan demo garden was stolen and eaten before harvesting.
- In Kisoro, farmers shared cabbages grown with ecosan fertiliser and appreciated the use of this fertiliser in crop production.

So far, no studies have been carried out to find out how much reuse is actually taking place in the households.

8 Further project components

As part of the up-scaling activities, apart from promoting the technology in the project area, ecosan training was also held for organisations like Plan International, Kampala City Council and Wajir Township in Kenya. Technical officers from 56 districts countrywide were also trained in ecosan design, construction and usage.

Two masons per rural growth centre/town have been trained in UDDTs design, construction, use and management to remain promoting in the area even after project completion.

Promotion of UDDTs is now a country-wide affair and all the water and sanitation development projects set up (Northern, Eastern and Central Uganda) have an ecosan promotion component.

9 Costs and economics

The total investment for the sanitation part in this project was EUR 541,000. This includes training of the users and masons, drama shows for awareness raising of the benefiting community, and construction. This is approximately equivalent to EUR 584 per toilet (with project overheads and software). The capital cost per UDDT is EUR 453 as shown below in Table 1.

Table 1: Average construction costs and annual operating costs for a household UDDT (based on a household of 6-7 people with the emptying done every 6 months[3])

	Expenses in EUR
Construction costs	
Materials	313
Labour (15 days @ EUR 9.4 per day)	141
Average total construction costs	**453**
Operating cost per annum	
Ash (50kg/month at 0.03 EUR/50kg)	0.36
Emptying (twice per annum/ one hour of workforce needed per emptying at 0.63 EUR per hour)	1.26
Average total operating costs per annum	**1.62**

Can we get the cost break-down for the construction costs? Do you regard Eur 322 as expensive or cheap compared to people's incomes? Have you experimented with lower cost versions? This is a cost for the middle income H/hold, it is considered affordable as per the income and house structure.

[3] Costs have been converted to Euros with an average exchange rate of 1EUR= 3200 UGX

10 Operation and maintenance

Every user has got a responsibility to ensure faeces go into the squat hole and urine goes into the urine diversion. After defecating, the user adds about two plastic cups of ash into the faecal chamber. A bucketful of ash is usually kept inside the toilet. When the faecal contents are dry, a cone builds up and this is levelled to ensure maximum use of the chamber. After the chamber has been filled, the contents are left to dry and users start using the empty chamber. After a minimum period of six months, the contents in the first chamber are dry and are then removed to be applied in the gardens.

Cleaning and maintenance:
Women and children manage the household toilet more than men. Women's primary responsibilities of housekeeping also include toilet management.

Collection of tariffs:
Using these toilets has no cost attached because they are basically on household level, ash is free, and the toilet is used by members of the household. They manage them and empty them when they are full. For public toilets constructed at water offices in the towns they charge about 100 UGS (One hundred Ugandan Shillings or 0.03 EUR).

11 Practical experience and lessons learnt

The technology was at first met with resistance as users were used to the conventional systems like the drop and store and wanted nothing to do with having faeces above the ground and recycling them for agricultural purposes. This was countered through continued sensitisation and community involvement together through demonstration gardens.

The applicability of the UDDTs for the Moslem communities was difficult, because they are anal washers. This was countered by making a design that fits their religious requirements and allows for anal washing with water.

Designs for the aged and people with disabilities had to include a ramp instead of steps only.

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).

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). The costs are not high as per the level of income and the type of unit constructed. too optimistic, e.g. the costs are high and it should not have a plus there

Table 2: Qualitative indication of sustainability of system

	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 the country wide coverage of ecological sanitation toilet promotion programmes, and other sanitation programmes there will be improvement of health by reducing the sanitation related diseases, however there are no studies that have been done on this.

13 Available documents and references

Photos are available here:
http://www.flickr.com/photos/gtzecosan/sets/72157631001526388/

- Project documents (The Project Document, Ecosan training manual, Ecosan Toilet Design, Cost Estimates) (any of these available digitally, to be put online?)
- SUSAWARES (2005). Analysis and Documentation of Ecological Sanitation Experiences.

14 Institutions, organisations and contact persons

Ministry of Water and Environment
The South Western Towns Water and Sanitation Project was a government programme implemented under the Ministry of Water and Environment. The Ministry was thus responsible for planning for investments, setting standards, providing guidelines and quality assurance.
Web site: www.mwe.go.ug

Austrian Development Agency
Funds for implementing projects under the South Western Towns Water and Sanitation Project were from the Austrian Development Agency. For phases I and II the ADA were the sole donors, and for phase III it was ADA and a co-funding from European Union. Through all the phases of the project the Programme Officers Water and Sanitation from ADA have always been available to provide technical backstopping.
Website: www.entwicklung.at;
E-mail: kampala@ada.gv.at; info@ada.gv.at;
(Contact Person, Hans Schattauer e: mail address hans.schattauer@ada.gv.at; hans.schattauer@gmx.at)

WSDF-SW
WSDF is a funding mechanism through which funds are channelled to develop water supply and sanitation systems for rural growth centres and small towns. SWTWS III is a project implemented under WSDF-SW.
Contact : Hillary Mutabazi, manager at WSDF-SW hillary.mutabazi@mwe.go.ug
E-mail address: wsdf-sw@mwe.go.ug

Case study of SuSanA projects:
Large-scale peri-urban and rural sanitation with UDDTs, South Western Province, Uganda (draft)
SuSanA 2012

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Editing and reviewing: Cynthia Kamau and Elisabeth von Muench (GIZ, sanitation@giz.de)

Household composting of organic waste and faeces Kitgum Town, Uganda

Fig. 1: Project location

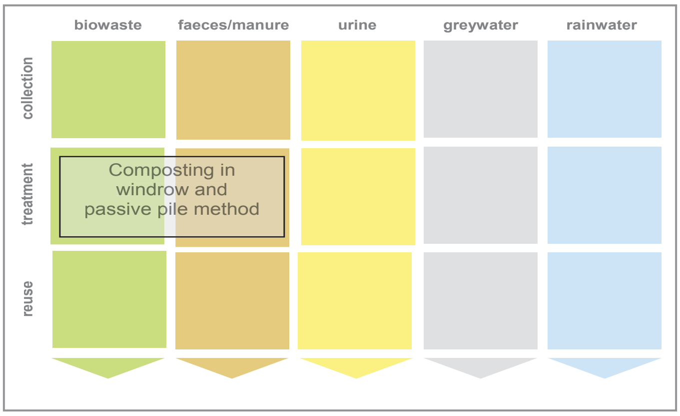

Fig. 2: Applied sanitation components in this project

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:

1. to contribute to the current efforts for promoting resource-oriented sanitation concepts as a route to sustainable sanitation and to fulfil the UN MDGs,
2. to research the gaps for the implementation of resource-oriented sanitation concepts in peri-urban areas,
3. to develop a generally applicable adaptable framework for the development of participatory strategic sanitation & waste plans (SSWPs), and
4. 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).

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.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 °C 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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Case study of SuSanA projects

Household composting of organic waste and faeces

SuSanA 2011

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Greywater tower gardens at household level Kitgum, Uganda

Fig. 1: Project location

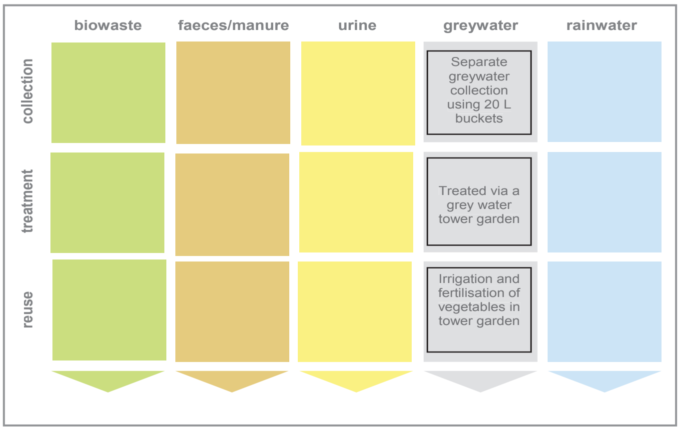

Fig. 2: Applied sanitation components in this project

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:

1. to contribute to the current efforts for promoting resource-oriented sanitation concepts as a route to sustainable sanitation,
2. to research the gaps for a successful implementation of resource oriented sanitation concepts in peri-urban areas,
3. to develop a generally applicable and adaptable framework for the development of participatory strategic sanitation & waste plans (SSWPs), and
4. 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).

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 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.

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)

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 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 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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