sustainable sanitation alliance

Case study of sustainable sanitation projects

Urine-diverting dry toilets at Adama University Adama, Ethiopia

Fig. 1: Project location

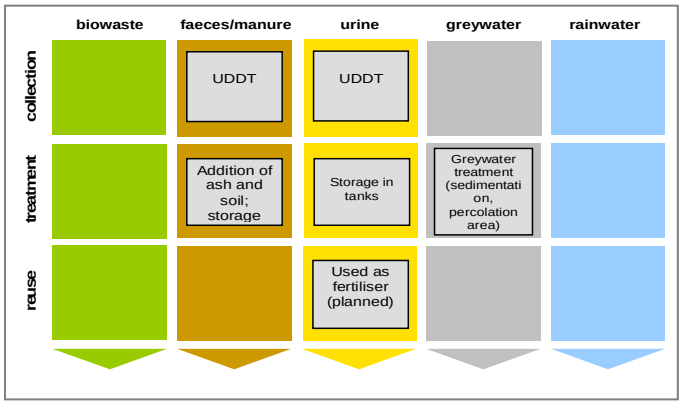

Fig. 2: Applied sanitation components in this project (UDDT stands for urine-diverting dry toilet).

1 General data

Type of project:
Urine-diverting dry toilets (UDDTs) at Adama University, Ethiopia (pilot scale)

Project period:

Start of planning:	2008
Start of construction:	June 2009
End of construction:	June 2010
Start of operation:	June 2010

Project scale:
Size: Toilet block with 24 UDDT cubicles and 6 urinals (designed for 400 users)
Number of current users: approx. 80 staff members (or less; conflicting reports), 400 male urinal users
Estimated total investment cost: approx. 41,500 EUR

Planning institutions:
University Capacity Building Program (UCBP)
GIZ International Services Ethiopia
Adama University, Ethiopia

Executing institution:
GIZ International Services, Ethiopia
OtterWasser GmbH, Germany

Supporting agency:
None (Ethiopian government)

2 Objective and motivation of the project

A major challenge for most Ethiopian universities is the insufficient water supply, and the situation at Adama University (AU) is no exception. The urine-diverting dry toilet (UDDT) is a sanitation option which is waterless, odourless, affordable and suitable for implementation at the institutional level.

Based on this, the University Capacity Building Programme (UCBP) in Ethiopia with support of GIZ International Services (formerly GTZ International Services) in Ethiopia and OtterWasser GmbH, designed, funded and constructed a UDDT complex for some (but not all) staff and students at the Adama University in Ethiopia.

Fig. 3: The UDDT block at Adama University, Ethiopia; handwash basin in the centre at the base of the stairs (source: I. Obermann, 2011).

The fact that UDDTs are waterless makes them a possible solution to both the water supply and sanitation problems. The project aimed to demonstrate a sustainable sanitation solution. It aimed to create awareness among students, staff and other stakeholders for sustainable, hygienic and economical types of toilets that do not use water for flushing.

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3 Location and conditions

Adama is one of the largest cities in Ethiopia located right above the Rift Valley, about 100 km southeast of the capital, Addis Ababa. The Adama University (AU) has 13,000 students and is located on the eastern slopes of the hills of the valley town Nazareth. The campus is spread over 60 acres of land.

In Adama University (AU), accommodation facilities (hostels and halls) on campus have toilet facilities for students. However, lecture rooms and libraries are not equipped with toilet facilities for students, and thus, there is a demand from students for toilets especially during teaching sessions.

The UDDT block is located at the south-western part of the university campus, close to the faculty buildings, which is one of the main traffic areas in the university.

4 Project history

The project was part of the University Capacity Building Programme (UCBP) in Ethiopia. The planning of the project with the various project partners began in 2008. The project started as a pilot-scale demonstration project in June 2009 and was completed and commissioned within one year.

GIZ-IS was responsible for construction, and handed the block over in mid 2009 to AU facility management who is responsible for operation and maintenance.

5 Technologies applied

The technology of UDDTs is based on the separation of urine, faeces and greywater into three different fractions, and where water is used for anal cleansing, a fourth flowstream exists. This is to ensure the proper and separate management of each material, treatment and possible reuse. The UDDT squatting pan has two outlets – one for faecal matter and the other for urine. These two outlets facilitate the separation of liquids (urine, greywater) from the solids (faecal matter) and therefore enable the toilet to operate without using water to flush excreta. The system can also produce fertiliser from the excreta for agricultural use.

Urine from the UDDTs and the urinals is transported through a pipe to two short-term collection tanks (2 m^3) near the building. This pipe is designed to have a larger diameter than necessary (110 mm) because precipitation may occur in the urine which can block a smaller pipe. The urine is stored in short-term tanks located close to the UDDT building which are connected to long-term storage tanks located near the treatment site via another pipe to enable the urine to flow by gravity.

In summary: Urine is collected in two temporary storage tanks of 2 m^3 each – one for each block. From the two tanks the urine flows to another set of long-term storage tanks (8 tanks of 5 m^3 capacity each). It is however not clear if they are actually being operated as such.

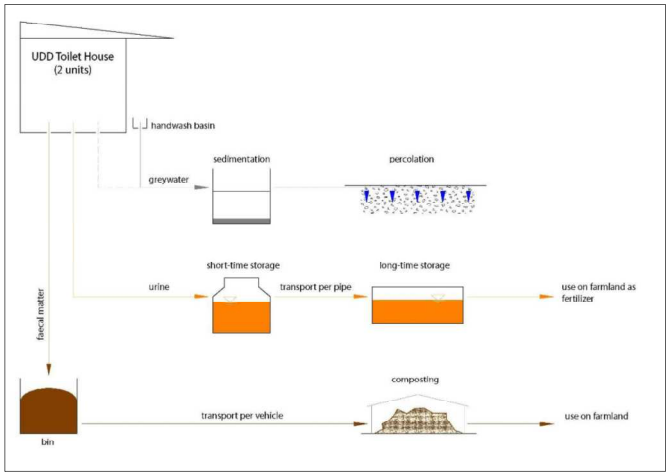

Fig. 4: Design of the UDDT system and treatment steps (source: Oldenburg et al. (2009).

The storage of urine for a relatively long time in accordance to recommendations by WHO (2006)[1], which stipulates that a storage time of one month is sufficient for treatment of urine for fertilising crops that are to be processed. Additionally, the use of the urine as a fertiliser on farmland is only possible during the two short planting seasons per year.

Fig. 5: Temporary Storage tank full with urine (source: S. Kore, 2012).

Fig. 6: Four ong-term urine storage tanks (source: S. Kore, 2012).

[1] For WHO Guidelines see: http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1004

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6 Design information

Two locations are required for successful operation of the UDDT. First, the toilet building itself which is sited between the faculty buildings on AU campus for easy accessibility. Secondly, the treatment site in the southern part of the compound, where long term urine storage and composting is meant to take place.

The design of the UDDT block is made up of a super-structure and a substructure. The UDDT block was designed for **400 users**.

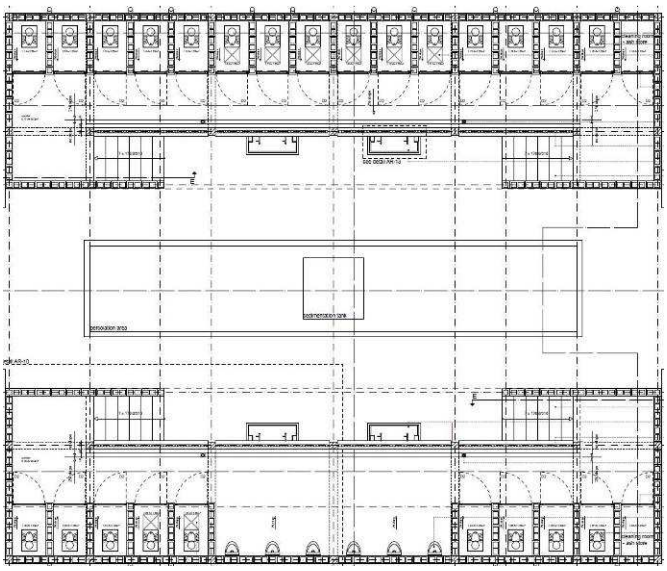

Fig. 7: Floor plan of the UDDT block. Top: female section with 15 cubicles; Bottom: male section with 9 cubicles and 6 urinals in the middle (source: GTZ-IS, 2008).

Super-structure:
The super-structure of the UDDT complex is constructed which cement blocks similar to conventional public toilets with two blocks with toilet cubicles – one block for males and one block for females. The female block has 15 toilet cubicles while the male block has 9 cubicles and 6 waterless urinals. The toilets have two entrances raised approximately 1 m above the ground and are reached by stairs.

A good ventilation system is critical for this type of toilet, and this was well considered in this case. Large vent pipes are positioned at the back of the toilet buildings (as can be seen in the photo below). The 110 mm PVC vent pipes extend from the faeces vaults to above the roof. This helps to avoid the generation of odours from the toilets. In addition there a sizable windows at the back of each unit block which improves ventilation and provides light for the toilet cubicles.

Sub-structure:
The toilet rooms are equipped with ceramic urine diversion squatting pans which have two outlets as required of UDDTs: a larger one at the back for the faeces and a smaller one in front for the urine to enable separation of the urine from the faeces. These urine diversion squatting pans have been produced in Ethiopia (see Section 14 for details).

Fig. 8: Back view of the UDDT block showing vent pipes and blue doors to faeces vaults (source: K. Sintayehu, 2010). Note the blue bins should be inside of the faeces vaults.

Six toilets in the female block and two units in the male section are equipped with a third outlet in the front. This outlet is meant for people who use water for anal cleansing due to religious beliefs (e.g. Muslims) or for other reasons. Basins for hand washing are installed in front of both the male and female buildings.

Faecal matter is collected in 120 L bins which are placed underneath each toilet cubicle. It is recommended that users add dry material (ash, soil or compost) to the vaults after defecation. This added material covers the faecal matter and prevents odour. The reduction of the moisture content additionally avoids the accumulation of flies or other insects and vermin.

Fig. 9: Urine diversion squatting pans with a third outlet in the front for anal cleansing with water (source: K. Sintayehu, 2010).

The filled bins should be transported to the treatment site and composted together with the added material (ash, soil or compost) and organic waste from other sources (kitchen, gardening etc.). The composting site is approximately 300 m from the toilet building. After emptying, the bins are cleaned and prepared for the next cycle. The faecal should be stored for approximately 6-12 months in the composting ditches to

convert organic material into compost before use as soil conditioner at the university site (it is not clear if this is really taking place).

Greywater from the hand washing, anal cleansing and cleaning is treated in-between the two toilet buildings in a percolation area. The collected water is pre-treated in sedimentation tank where solids and other materials settle down. This is necessary to avoid clogging of pipes in the following treatment steps. The pre-treated grey water is fed into a percolation field (made up of gravel beds planted with reed) on both sides of the sedimentation tank by percolation pipes. The plants as well as the bio film located on the gravel bed reduce the pollution of the grey water before its infiltration in the ground.

7 Type and level of reuse

The faecal matter and urine could be used as fertilisers in agricultural production. However, at the moment the faecal matter and urine are simply disposed off in an existing oxidation pond.

Some of the urine collected is applied as fertiliser to a papaya plantation on the university campus. The papaya plantation is close to the UDDT facility.

There are some ideas for the application of urine in cooperation with local authorities (agricultural research centre, agricultural department, farmers, etc.). This is based on first analytical results of measuring the nitrogen content in urine. The use of urine has shown approximately 38% more yield than the use of artificial fertiliser (the expectation would be to obtain the same yield).

As reported in the university's newsletter *AUdacious News* (2011), excreta from the dry toilets can be properly treated to be fertilisers and this was proven by the practical operation undertaken at the AU demonstration site[2].

8 Further project components

Awareness raising campaigns should have been undertaken before the construction of UDDTs was completed and the toilets ready for use. This is to ensure that the users and maintenance staff are made aware of the proper use and operation of the UDDT facility. By so doing, students and staff can be introduced to the sustainable sanitation concept.

It is not clear if such awareness raising campaigns actually took place and if yes, to what extent.

Monitoring activities of the systems should be performed throughout the entire process to ensure (i) proper and hygienic use and operation, (ii) long-term quality assurance of the end-product and (iii) documentation of the change compared to the original situation for research and development purposes (with respect to the environment, hygiene, user satisfaction, costs, profits, resource use, productivity, increase in harvests). Monitoring activities should consist of technical and social monitoring.

External evaluations should take place in order to evaluate whether optimisation and fundamental adjustments of operation activities and construction works should be done. These activities have so far not been carried out due to lack of interest and motivating factors for the people involved.

9 Costs and economics

During the design phase, a capital cost estimate was made for the UDDTs which came to 324,000 ETB (or 21,600 EUR at the time). This capital cost included the construction, sanitation installations, urine treatment and composting[3].

However, the actual costs were much higher due to a general price increase for building materials such as cement. According to Solomon Kore from GIZ-IS, the actual construction costs according to the last payment made was 930,000 ETB (or **41,500 EUR**).

This would translate to a very high cost of 1729 EUR per cubicle (but this is only an indication, as the costs include much more than just the UDDT cubicles, i.e. also the treatment part).

When the UDDTs were built, the focus was not on building them at a low cost. They were meant to be beautiful, long-lasting and impressive, as this was a demonstration project. Furthermore, the project was used for training courses in good design processes in the framework of the UCBP project, and this also raised the costs.

The cost of operating and maintaining the UDDT facility was estimated upfront at 954 EUR (approx. 15,180 ETB) annually. The costs included are labour, transportation and material costs. The bulk of this cost is labour cost which includes the cost for three persons for the operation and maintenance of the facility (cleaning staff). The predicted costs for routine operation and maintenance works for the UDDTs is summarised in Table 1 below. The actual O&M costs have not been determined.

[2] Adama University (2011). Sanitation systems, demo site recorded best results, AUdacious News & Views Vol. 2, No. 20. www.adama-university.net/fileadmin/user_upload /img/Vol.2_No.20.pdf

[3] For further details on this cost estimate and to see a cost comparison with a conventional wastewater treatment plant, see the presentations of Martin Oldenburg from 2008 and 2009 here: www.susana.org/library?search=adama.

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Table 1: Predicted operation and maintenance costs for the UDDTs one year (source: Oldenburg et al. (2009)).

Item	Unit	Quantity	Unit Price (EUR)[4]	Total cost (EUR)[1]
Vim	pcs	52	0.75	39
Mop	"	4	1.89	7.56
Broom	"	4	0.38	1.52
Toilet soap	"	208	0.16	33.28
Powder soap	"	12	0.16	1.92
Tissue paper	"	20	0.19	3.8
Pens	"	4	0.09	0.36
Registration book	"	2	1.13	2.26
Towel	"	4	0.63	2.52
Flit	pcs	8	1.57	12.56
Abu Jedi	Mt	12	0.63	7.56
Rag	Kg	1	0.44	0.44
Sponge	pcs	8	0.25	2
Gloves	pcs	4	0.44	1.76
Boots	"	1	3.77	3.77
Mask for nose and mouth	"	2	1.57	3.14
Uniform	"	3	7.54	22.62
Ash Bucket	"	2	1.57	3.14
Ash cup	"	2	0.13	0.26
Shovel	"	2	2.5	5
Spade	"	2	2.5	5
Hoe	"	1	2.5	2.5
Fork	"	1	2.5	2.5
Bucket for anal washers	"	2	1.57	3.14
Water jar for anal washers	"	2	0.16	0.32
Fibre Brush	"	4	0.75	3
Sanitary pad collecting basket	"	2	0.94	1.88
Spider removing mob	"	2	0.75	1.5
Wire brush	"	2	0.94	1.88
Plastic rope for tying bins	"	20	0.13	2.6
Total				179
Contingency (5%)				9
Labour cost				603
Transportation cost				163
Total				**954**

10 Operation and maintenance

The facility management of AU is in charge of the operation and maintenance of the UDDT facility. Technical and/or and administrative issues are handled and supervised exclusively by AU. The management is supposed to ensure efficient, economical maintenance and smooth operation of the facility. In doing so it must make sure that the caretaker and cleaners are efficient and responsive.

Efforts to maintain the UDDTS include recruiting one caretaker and two person as cleaning staff. Instructions and a task list for the caretaker and cleaning staff are provided in English and Amharic (national language of Ethiopia). There are also posters indication the “dos and don’ts” for the users.

At the moment, the UDDTs are only used by university staff members. On average 80 staff members use the toilets each day. All students are barred from using the toilet cubicles because of limited technical and administrative capability to manage the mass use (this information was provided by S. Kore in early 2012, see Section 13 for link to this full report). The male students are allowed to use the urinals (it is estimate that there are about 400 urinal users).

As a pilot scale project, the UDDT block was not meant to be used by all students and hence they (both the male and female students) do not rely on it.

Cleaning and maintenance:
The cleaning staff regularly cleans the toilets. Some other activities undertaken by the cleaning staff to ensure the cleanliness of the UDDT include dehydration, odour and fly control and disposal of anal cleansing materials. Maintenance problems are described in Section 11 below.

Collection and treatment of excreta:
Faecal matter is collected in bins under the squatting pans which are replaced in specified intervals or when they are full. The empty bins are lined with some organic material (e.g. compost) at the bottom to absorb the liquid from the faeces.

Fig. 10: The urinals of the UDDT block at AU (source: K. Sintayehu, 2010).

11 Practical experience and lessons learnt

There are currently significant maintenance issues with these otherwise well-designed UDDTs (the following information is based on reports by Solomon Kore and Mammo Bulbo in April 2012; see Section 13 for link to their full reports):

- The operation of the UDDTs at AU at the moment is not fulfilling the designed and targeted purposes. This is because the toilets are not used to capacity and the reuse is very minimal. Students are not allowed to use

[4] Costs have been converted to Euros with 2009 average exchange rate of 1 ETB = 0.063 EUR (computed with data from www.gocurrency.com/v2/historic-exchange-rates.php)

the toilets (except for the urinals) because of operational and administrative limitations. Some of the toilet cubicles were locked at the time of Mr. Bulbo's visit. He states in his report "*At the back side of the units all vaults are not locked and could easily be opened, some were already open. A look inside the faeces container in the vaults indicates that only some of the units have been used for only 2-3 defecations quite a while ago*".

- In the course of operations, blockage of urinal pipes occurs as a result of foreign objects as well as urine stone formation. This problem can be solved by regular cleaning and flushing of the pipes with water when necessary.
- Sometimes out of negligence or lack of knowledge some water is added to the faeces bins. This sometimes results in bad smell from the UDDTs. The immediate replacement of the bin and the provision of proper instructions will help inform users and thus reduce the occurrence of this problem.

Fig. 11: A faeces bin of the UDDT containing faecal matter (probably more ash should have been added to cover the faeces) (source: S. Kore, 2012).

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).

The expected long-term impacts of this project were: demonstration effect, wide-spread use, increased convenience and health as well as environmental protection. The observed impacts were however somewhat disappointing: no scaling-up, little interest on the side of the university administration, major maintenance problems.

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 [a]			transport and reuse [b]		
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 treatment carried out on faeces at present, only on urine

[b] Not carried out at present

Sustainability criteria for sanitation:

Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.

Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.

Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.

Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.

Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

13 Available documents and references

More photos of the project are available on Flickr at www.flickr.com/photos/gtzecosan/sets/72157625119941095/with/5679448119/

Short reports by Mammo Beriso Bulbo and Solomon Kore in 2012: Summary of the UDDT implementation (see posting on discussion forum: http://forum.susana.org/forum/categories/34-urine-diversion-systems-includes-uddt-and-ud-flush-toilet/1533-ethiopia-adama-uni-uddt-project-seems-oam-to-blame-again)

Oldenburg, M., Ayele, A. W., Hartmuth, N. (2009). UDDT at Adama University - Concept, Design, Operation and Maintenance & Construction of the Demonstration Project. www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=725

GTZ-IS (2008). GTZ (2009). UDDT complex at Adama University, Ethiopia - Overview plan of UDDTs and treatment site (BoQ and drawings). Deutsche Gesellschaft für Technische Zusammenarbeit International Services (GTZ-IS), Ethiopia. www.susana.org/lang-en/library?view=ccbktypeitem&type =2&id=665

14 Institutions, organisations and contact persons

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SuSanA 2012

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