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Assessment of Options for Public Toilets for a Market Centre in Chora, Afghanistan

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Table of Contents

Acknowledgements 4
Abbreviations 5
Abstract 6
1.0 Introduction 7
1.1 Description of Area and Sanitation Situation 7
1.2 Existing Experiences in Public Toilet Implementation 9
1.2.1 Afghan Development Association 10
1.2.2 Kabul Public Toilets 10
2.0 Selection of a Public Toilet System 13
2.1 Selection Criteria 13
2.2 Proposed Options for a Public Toilet System 14
3.0 Urine-Diverting Dehydration Toilet System 15
3.1 Theory of a Urine-Diverting Dehydration Toilet System 15
3.1.1 Source-Separation of Excreta 15
3.1.2 Treatment Processes 16
3.2 System Description 18
3.3 On-Site Component: UDDT 19
3.3.1 General Toilet Description 19
3.3.2 The User-Interface 20
3.3.3 Urine Collection 21
3.3.4 Faeces Collection 24
3.3.5 Ventilation 26
3.4 Transport of Collected Excreta for Off-Site Treatment 27
3.5 Off-Site Component: Treatment and Product Storage 28
3.5.1 Urine Treatment: Storage 28
3.5.2 Faeces Treatment: Storage 28
3.5.3 Faeces Treatment: Co-Composting 29
3.5.4 Storing the Products 30
3.6 Product Use in Agriculture 30
3.6.1 Demonstration Plots 32
4.0 Hygiene Component and Greywater Treatment 33
5.0 Operation and Maintenance 34
5.1 Instructions for the Toilet Users 34
5.2 Daily Maintenance of the Toilet 34
5.3 Long-term Maintenance Measures 35
5.3.1 On-Site Collection and Transport 35

5.3.2 Off-Site Treatment ... 35
5.4 Trouble Shooting: Bad Smell Occurs in the UDDT ... 36
6.0 Comparison of System Component Options ... 37
7.0 Sustainability ... 38
7.1 Sustainability Checklist ... 38
7.2 Institutional Sustainability ... 39
7.3 Financial Sustainability ... 40
8.0 References ... 41
Appendix A: Information Links for the Design, Construction, and Use of UDDTs ... 43
Appendix B: Worldwide List of Suppliers of Urine-Diverting Squatting Pans ... 44
Appendix C: Pictures of Good and Bad Construction Examples ... 49

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ABBREVIATIONS

ADA	Afghan Development Association
GTZ-IS	Deutsche Gesellschaft für Technische Zusammenarbeit- International Services
NGO	Non-governmental organisation
SuSanA	Sustainable Sanitation Alliance
UDDT	Urine-Diverting Dehydration Toilet
UNICEF	The United Nations Children's Fund
UPDP	Uruzgan Provincial Development Project
WECF	Women in Europe for a Common Future
WHO	World Health Organisation

ABSTRACT

The Uruzgan Provincial Development Project is constructing, together with the Municipality of Kalacha Bazaar, a market centre in Chora town (Uruzgan Province, Afghanistan). An element of the new market centre and bazaar upgrading initiative is public sanitation. Currently, the only public toilets in the bazaar are found within the hospital compound. To this end, an assessment was carried out to identify suitable systems for public toilets that can be constructed in the vicinity of the new market centre.

The criteria used to identify options for public toilets were as follows: health protection, groundwater protection, a dry sanitation system, technically easy construction, non-technical maintenance, user-friendliness, and hygiene integration. Based on these criteria, the single-vault and the double-vault urine-diverting dehydration toilet (UDDT) systems respectively, were selected as possible public toilet systems.

The components of the complete sanitation chain for the two types of UDDT are the on-site toilet units, which primarily collect the excreta; a method of transporting the collected excreta to an off-site treatment area; the off-site treatment processes; and the use of the excreta for agricultural purposes (urine as a liquid fertiliser and treated faeces as a soil conditioner). It is recommended that agricultural demonstration plots should be made showing the proper use of urine as a liquid fertiliser and thus also creating demand for the product.

The process options for the single-vault and double-vault UDDTs are the same – excreta streams are collected separately at source, the faeces can be treated by storage and/or co-composting with biowaste, the urine is treated by storage, and the products are used for agricultural purposes. The main difference is that the double-vault toilet unit not only serves to collect the excreta but also allows part or all (depending on the design) of the treatment process for the faeces to take place within the on-site toilet unit.

Hygiene is a critical component of sanitation. Therefore, handwashing facilities with water and soap must be available in the public toilets. The greywater produced from handwashing (and also from cleaning the toilet cubicles) can be treated via gravel filter beds made outside the toilets.

Operation and maintenance of the UDDT system is essential to keep the toilets functional for the public, to protect public health and to benefit from the products. Sustainable use of the system can be promoted by looking at steps that should be taken for each of the sustainability criteria in sanitation; these criteria are health and hygiene, environment and natural resources, technology and operation, financial and economic issues, and socio-cultural and institutional aspects.

1.0 INTRODUCTION

The Uruzgan Provincial Development Project (UPDP, a project of GTZ-IS), on behalf of the Dutch Government, is constructing together with the Municipality of Kalacha Bazaar, a market centre ("caravanserai") in Chora. Chora, besides Dehrawud and Tirin Kowt, the provincial capital, is one of the three main settlements in Uruzgan Province of Afghanistan. The market centre is part of a larger framework to improve the storage and subsequent marketing of agricultural products from the district. It is meant to function as a flexible trans-shipment point, enabling farmers and traders to re-group and process goods, and manage their transport more independently from the fluctuations of market prices.

This market centre will be located behind the main street of Kalacha Bazaar and will house about 50 shops and stockrooms around a quadrangular inner courtyard. UPDP is keen to have a public toilet system as a part of the new market centre and its bazaar upgrading initiative, especially considering that at the moment there is only one set of public toilets in the town centre; these toilets are attached to the hospital located at the end of the main street, at the lower end of the bazaar.

The public toilets are envisioned as a model construction that is simultaneously suitable for the local conditions and culture. The type of toilet that will be constructed will depend on the possibility of implementing it. In Chora, factors that have to be taken into account include time of construction and the level of technical skill required. It is a volatile area with security risks and therefore systems have to be simple and quick to implement.

An assessment was carried out to identify suitable systems for public toilets in the vicinity of the new market centre. A field visit was made to Chora on Dec. 8th, 2009 to assess the on-ground situation. During this visit, information was obtained from the local shopkeepers, the mayor, the imam of the mosque, and the owner of the public bath. Moreover, meetings were held separately in the provincial capital Tirin Kowt with the Director of Agriculture, with representatives of the Afghan Development Association (ADA) and with staff of UPDP. Public toilet systems in Kabul were also looked at to see existing systems.

This report presents the findings and proposes options for a public toilet system that would be most suitable in the existing environment. Importantly, the conditions needed for these systems to be successful in the long-term are also highlighted.

1.1 Description of Area and Sanitation Situation

Uruzgan, located in south-central Afghanistan, is one of the poorest of the 34 Afghan provinces. Once famous for its fruit and horticultural sector, the province today suffers to a high extent from the past 30 years of war and armed conflict. Most of the people in Uruzgan still live in traditional Pashtun societies and work in farming. Due to an almost non-existing public education system, close to a 100 per cent of the women and 90 per cent of the men are illiterate. The local provincial and district governments face great difficulties in meeting public demand of public goods and services. These difficulties are reflected in Chora town. The link road from the capital Tirin Kowt to Chora is a dirt road. There is no city power but private generators are used and some bazaaries are selling electricity to neighbouring shops. Equipment and materials that are available in Chora bazaar are few and basic, and it is difficult to find expertise and people with specialised skills in the market.

The River Darwishan runs through Chora and supplies the irrigation water for the fields adjacent to the river. Kalacha Bazaar is located behind the fields on one side of the river. The soil under the bazaar is said to be a mixture of compacted clay, sand and gravel and the water table is estimated at between 15 and 20 m below the surface. In and around the main street of the bazaar are five water supply wells that have been constructed by UNICEF and provide the water for the bazaar. The climate of Chora consists of cold winters (average temperatures around 0 degrees Celcius) with most of the precipitation during winter and spring and the summers are hot (temperatures above 30 degrees Celcius) and dry.

The bazaar has 750 shops out of which 550 are in use. When asked their opinion, the shopkeepers were keen to have a public toilet in the locality. When asked about the need for a public toilet for women, they responded that a toilet would be useful for women but in the areas that are visited by them. Women generally do not roam in the bazaar; they go either to the hospital or stop at the restaurants for food when they are travelling. These restaurants are located towards the upper end of the bazaar and currently do not have a toilet. The restaurant keeper confirmed that it would be useful to have public toilets there for men and women.

Surprisingly, the main mosque in the bazaar (a few minutes walking distance from the new market centre) also did not have a toilet. People used a sloping piece of land on one side of the mosque compound as an open air toilet. The imam of the mosque was also keen to have proper sanitation facilities in the compound.

Pic. 1 - 2: The local dry toilet from outside (*left*) and inside (*right*) at the Dept. of Agriculture. (source: N. Khawaja, 2009)

Typically, people in the area practise open defecation or they use a local dry toilet constructed outside their homes. This toilet is an above-ground raised vault, 1 – 3 m high. The upper level of the vault is the floor of the toilet and has a hole for defecation. Users normally use loam for anal cleansing and do not add any covering material into the toilet after defecation. The bottom base of the vault is open ground and liquid gathered in the vault can flow into the soil and ground water. These containment units have an opening on one side of the vault and are emptied out manually by labourers or family members. The collected excreta are used on agricultural fields as fertiliser. These latrines attract a lot of flies, are malodorous and are also visually unappealing for the user.

The hospital in Chora was the only place where public toilets could be found. It is located at the lower end of the bazaar. The gate of the hospital was locked at the time of the assessment visit; however, shopkeepers described that the public toilets in the hospital compound were the traditional dry system.

A critical aspect in making public toilets is maintaining them in the long-term. The shop keepers explained that this would be the responsibility of the municipality but they would help if required. The hotel keeper said that hotel staff would take responsibility for maintaining a public toilet if it was constructed next to the hotel.

The municipality has the responsibility of collecting and disposing the garbage of the bazaar. According to the mayor of Chora, municipality workers take the garbage to an area at the end of the bazaar and dump it in a hole that has been dug for the purpose. The material is burnt periodically. The mayor stated that if public toilets were constructed, the municipality would provide staff for their daily maintenance. Also, if the local dry system was installed, the excreta from the toilets would be given for free to farmers.

While Chora does not have any public toilets, it has a public bath. This bath is situated directly adjacent to the construction site of the new market centre. The water is extracted from a well located behind the bath. It is heated in a boiler and supplied to a series of bath cubicles. The wastewater is drained via a pipe that runs a few hundred metres underground from the public bath, underneath the bazaar and out to the fields beyond.

1.2 Existing Experiences in Public Toilet Implementation

The existing experiences in the construction and operation of public toilets provide a useful guideline of sanitation options that are feasible in the area. Lessons can be learnt from the public toilets constructed by the NGO Afghan Development Association (ADA) in Uruzgan and from municipality-maintained public toilets in Kabul city. Interestingly, all these systems are a form of productive sanitation in which there is a reuse element of the waste streams.

1.2.1 Afghan Development Association

The Afghan Development Association has constructed public toilets for villages in the District of Dehrawud in Uruzgan. The model they construct is an adjustment of the local dry system. It is a single-vault urine-diverting dry toilet. This toilet has an above-ground substructure, which is a single chamber for the collection of faeces, and a superstructure above that for the user interface. The ceiling of the chamber is the toilet floor and is made of a concrete slab with a hole for the deposition of faeces and with a channel leading off from the front of the hole to drain away the urine. The urine drainage channel connects to a pipe outside the wall of the substructure, which leads into the soil, and the urine is drained into the soil. People use loam to clean themselves and do not add any dry material into the faeces collection chamber after use. A ventilation pipe leads out from the faeces collection chamber to above the roof in order to reduce smell and flies.

There are no handwashing facilities attached with these toilets because people traditionally wash their hands in nearby streams after defecation.

The faeces are considered very valuable by the farmers. They are removed when the vault is full and mixed with soil and allowed to dry. In the summer, the drying time is usually one week, and in the winter, it is usually one month. This material is then spread on to the agricultural fields at the time of cultivation. People use animal manure and household organic waste in a similar manner.

ADA explained that farmers also dig out the soil where the urine is soaked from the urine-diverting dry toilets and spread the soil onto their fields because it increases the fertility of their soil.

At the time of construction, the local people are trained in how to make the toilets and how to use them. In the experience of ADA, the urine-diversion mechanism has not caused any problems and is being used properly. The defecation hole is a trapezoidal shape, being larger at the back and narrower towards the front and even first-time users automatically place themselves in the right direction so that urine flows into the channel rather than into the hole (pers. comm. Said Salam Agha, ADA Uruzgan, Dec. 2009).

1.2.2 Kabul Public Toilets

Kabul city has 41 public toilet blocks that are operated and maintained by the municipality. Five of these toilet blocks are named Sulabh Toilet Complexes after the Indian organisation that introduced and supported these facilities. They are pour-flush squatting toilets attached to a biogas sanitation system. In this system, all the toilet waste is collected in an underground digestion chamber where the material is degraded anaerobically (without oxygen). In the process, biogas is produced, which is used for energy and a digested slurry is produced, which is further treated by a series of filtration and other steps and the resulting effluent is used as irrigation water. The greywater is treated in a soakage well.

The energy from the biogas is tapped in different ways. The biogas is used directly to light gas lamps outside the toilet complex and to fuel a gas stove which is used by the guard for cooking. The gas is also used to produce power via a generator that converts the gas to electricity, which is used for the lights inside the complex (pers. comm. Mohd. Yasin Hellal, Kabul Municipality, Dec. 2009).

The 36 public toilet blocks other than the Sulabh complexes in Kabul also have pour-flush squatting toilets; however, the sanitation process is different and the toilets are attached to a sewage holding tank. When the holding tanks are full, they are emptied out by the municipality using a pump. The waste material is transported by truck and used on agricultural fields outside the city.

All the public toilets in Kabul are operated by a user-pay system. Users have to pay 2 Afs (4 US cents) to use the toilets. The Sulabh complexes also have bathing facilities and users have to pay 5 Afs (10 US cents) per visit. This money is collected by the municipality and becomes a part of their annual budget. The municipality is in turn responsible for cleaning and maintaining the toilets. It is not known whether the income covers the maintenance costs of the facilities (pers. comm. Mohd. Yasin Hellal, Kabul Municipality, Dec. 2009).

The functioning of these toilets was ascertained by a visit to one of the Sulabh complexes, through talks with the guard of the Sulabh complex, and from second-hand information about the other public toilets. The toilet systems can be looked at from two aspects – the user interface, i.e. the toilet block, and the complete sanitation process, i.e. the treatment and subsequent processes.

The user-interface of both types of toilet systems was the same – a pour-flush toilet - yet there was a sharp contrast in the state of these toilets. The toilets in the Sulabh complexes were clean, with no smell and hence user-friendly. Municipality caretakers were present full-time and cleaned the toilets. The other public toilets were on the other hand dirty and smelly. Reportedly, users did not always pour water into the toilet after use and hence left an unsightly and malodorous condition for the following users, which was not rectified by municipality workers. It was not clear whether municipality caretakers were present full-time at these toilets. The difference in maintaining cleanliness may be due to a higher status associated with the Sulabh toilets, which were foreign-funded and highly publicised at the time of inauguration. Even in the Sulabh toilets, however, some sanitary items such as sink faucets were in disrepair, which shows that the municipality was not following up with regular repairs required for the toilet.

The sanitation processes of both the systems appear to be feasible options for public toilets in Kabul. Both systems, however, had gaps in sustainability aspects of the complete process chain. The biogas system was not functioning optimally in all the toilet complexes as per its design; biogas was either not being produced or the generator that converts a part of the biogas into electricity was out of order. This was because spare parts for the generator were not available in the market (they had to be purchased from India) and there was insufficient technical monitoring and follow-up of the biogas digesters and pipe network.

The holding tank system is a simple system with no technical processes taking place on-site and within the capacities of the municipality in that they are able to organise the tanker trucks to empty out the holding tanks regularly. Comments cannot be made on the robustness of the on-site structures because it is not known whether the holding tanks are well-sealed and whether they are checked for leakages to prevent contamination of the groundwater. The off-site process is, however, likely to be dangerous to health because the raw sewage is used for agricultural purposes. Raw sewage has a high pathogenic content and even though farmers are known to mix the sewage with soil and dry it in the sun before spreading it on the fields, it is being handled in a dangerous form.

2.0 SELECTION OF A PUBLIC TOILET SYSTEM

2.1 Selection Criteria

A sanitation system comprises the complete flow chain of sanitation, i.e. from collection and storage to transport, treatment, and reuse or disposal. The Sustainable Sanitation Alliance[1] has identified five broad criteria that should be addressed to make a system effective and sustainable. These are: health and hygiene, environment and natural resources, technology and operation, financial and economic issues, and socio-cultural and institutional aspects.

Based on the on-ground situation in Chora, on the habits and culture of the people, and on the experiences of existing public toilet systems, further specific criteria were identified that should be met by a public toilet system implemented in Chora. Table 1 shows these criteria and also the reasons why the criteria are important.

Table 1: List of criteria for selecting a public toilet system for Chora market centre and the basis for the criteria.

System selection criteria	Basis for the criteria
Health protection	• Public sanitation has a critical role in helping to prevent the spread of disease.
Groundwater protection	• The groundwater in the area is not far from the surface (15 -20 m) and five wells tap into the groundwater to supply water for local needs. This water should not get contaminated from the pathogens and nitrates that can leach down through the soil from a public sanitation system in the long-term.
Dry system	• The local people are used to it. • People generally do not use water for anal washing in the toilet. • It will be possible to demonstrate a model system that people can adopt relatively easily in their own homes. • The system does not become unusable or unsightly if people do not flush away excreta with water (as is the case with most of the pour-flush toilets in Kabul). • People are willing to reuse the faeces; indeed the faeces are considered very valuable.
Technically easy construction	• The level of skill available in the market is low. • Specialised construction materials are difficult to obtain in the market.

[1] The Sustainable Sanitation Alliance (SuSanA) is an open network on sustainable sanitation (www.susana.org).

Non-technical maintenance	• Spare parts are difficult to obtain in the market. • The municipality should have to do minimum repair work (because even in well-equipped Kabul, maintenance was neglected). • The system maintenance has to be economically feasible for the municipality.
User-friendliness	• The toilet should be comfortable to use, i.e. minimal odour and flies.
Hygiene integration	• Handwashing and soap facilities are necessary to break the faecal – oral cycle in order to protect health.

2.2 Proposed Options for a Public Toilet System

Two versions of a dry sanitation system are proposed as public toilets for Chora based on the criteria listed in Table 1. These are as follows:

1) Single-vault urine-diverting dehydration toilet system
2) Double-vault urine-diverting dehydration toilet system

The other main options in a dry toilet system are the ventilated improved pit, the fossa alterna and the arborloo[2]. In all of these systems, however, the excreta are open to the soil below the toilet. Since a public toilet is used by a large number of people, contaminants accumulate in a small area. There is then a high risk that nitrates and pathogens may leach down through the soil and into the groundwater of Chora town in the long-term.

A note on health aspects related to a sanitation system: the aim in making a sanitation system is not to have a completely sterilised system but rather to follow a multi-barrier approach in reducing risks to health. This means following precautionary measures to reduce risk from pathogens at several steps of the sanitation chain – i.e. at the user interface, collection and transport, treatment and reuse steps - and in various ways – e.g. washing hands and wearing protective clothing when handling excreta or excreta products, covering excreta during transport, selecting a fertilising method that minimises exposure, avoiding freshly fertilised fields, not using excreta to fertilise crops that grow close to the ground or are eaten raw, etc. Importantly, following a multi-barrier approach allows greater flexibility in treatment and reuse of excreta and thus it is possible to benefit from excreta as a resource rather than disposing it as a waste.

It is recommended that the public toilets should have cubicles (separately) both for men and women. Even though women reportedly do not wander through the bazaar, and usually only visit the hospital (which has a local toilet) or the restaurants at the upper end of the bazaar, they may find the area of the market centre useful for its sanitation facilities.

[2] See Tilley et al. (2008) for VIP toilet and Morgan (2007) Toilets that make Compost for the fossa alterna and arborloo toilets.

3.0 URINE-DIVERTING DEHYDRATION TOILET SYSTEM

3.1 Theory of a Urine-Diverting Dehydration Toilet System

3.1.1 Source-Separation of Excreta

In a urine-diverting dehydration toilet (UDDT) system, the urine and faeces excreta streams are separated at source and collected, treated and reused separately[3,4]. The waste streams are separated at source for several reasons.

Firstly, faeces are the most dangerous component of excreta; they include almost all the pathogens and are the main source of disease transmission. In contrast, urine from a healthy person is sterile. Even for a sick person, the pathogens in urine are very few as compared with faeces and very few diseases are transmitted through urine. Therefore, keeping these streams separate means the aspect of hygienisation of urine becomes much simpler.

Secondly, urine has a high content of nitrogen in the form of urea, which naturally decomposes to the end product of ammonia. Ammonia is a volatile gas and escapes to the air from the liquid phase very easily, leading to a loss of valuable nitrogen from the urine. Ammonia also smells. Thus if urine is allowed to remain in the open air, the ammonia formed quickly escapes into the atmosphere, causing an unappealing odour. Moreover, the breakdown process of urea into ammonia is accelerated if faecal matter is mixed into the urine (again, causing stench and loss of nitrogen). A separated urine stream can be easily diverted to a sealed container where the nitrogen loss in the form of ammonia is low and odour is minimised.

Lastly, if the faecal and urine streams are kept separate, their end-use can be more targeted and efficient. Urine is a liquid fertiliser with a high content of nitrogen and significant amounts of phosphorus and potassium, and faecal matter is a good soil conditioner and contains phosphorus and potassium.

Water is also kept out of this system for several reasons. If water is added to faecal matter, it creates anaerobic conditions (i.e. no oxygen) and the faeces cannot decompose as easily and quickly in anaerobic conditions as in aerobic conditions (i.e. with oxygen). Pathogens also survive better in wet environments. Moreover, anaerobic degradation generates odours whereas aerobic degradation is odourless. Similarly, if water is added to the urine stream, the diluted urine is not as effectively treated.

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[3] This section has been written based on information from Winblad and Simpson-Hebert (2004) and lecture notes of the 2008 Summer course on Sustainable sanitation- decentralised, natural and ecological wastewater treatment, at UMB, Norway.
[4] If the users require water for anal cleansing, this water is also collected and treated separately.

3.1.2 Treatment Processes

Having the separate material streams, the aim of treatment is to firstly, minimise dangers of disease transmission, and secondly, to make them into a usable product. Several factors play a role in reducing pathogens in excreta. As explained in Section 3.1.1, the process of separating the faeces and the urine is already the first step in treatment because the faeces contains most of the pathogens while urine is usually sterile; only a few disease organisms are passed through urine. Treatment of pure urine is also necessary, however, because of possible cross-contamination from faecal matter while using the toilet.

Faeces

Factors that kill pathogens in faeces include temperature, ultra-violet radiation, moisture reduction, alkalinity (high pH), competing natural soil organisms, and time (Winblad & Simpson-Hebert, 2004).

The two treatment design parameters (which encompass one or more of the above factors) that are possible to use in Chora for the treatment of faeces are storage time and co-composting together with organic waste.

Looking at the option of storage, according to the World Health Organisation's guidelines for the safe reuse of excreta, in warm environments (20°C - 35°C) storage times of less than one year, and in ambient temperatures (2°C - 20°C) storage times of 1.5 - 2 years, will be sufficient to eliminate most bacterial pathogens and substantially reduce viruses, protozoa and parasites. Some soil-borne ova (e.g. *Ascaris lumbricoides*) may however persist (Muench, 2009a).

In Chora, considering that the temperature ranges from just below 0 °C to above 30 °C, one year (after the last faeces deposit) should be sufficient as the storage treatment design time for faeces. The high temperatures in the dry summers would compensate for the cold winters. Additionally, if ash or lime is used as the dehydrating material, the pathogen reduction will be enhanced.

The second treatment option for faeces is co-composting the faeces with biowaste (green waste, biodegradable organic waste) from the town of Chora. Composting is an aerobic degradation process in which oxygen consuming micro-organisms break down organic matter into a carbon-rich, stabilised humus material, producing carbon dioxide and water vapour during the process. This is an exothermic process, i.e. heat is released during the aerobic degradation, and this heat helps to kill germs in the input material.

The main factors that affect the composting process are C:N ratio[5], moisture, aeration, temperature and pH. Faeces cannot be composted alone because the carbon content of faecal matter is too low - faeces has a C:N ratio of between 5:1 and 10:1 (Oldenburg, 2009), whereas composting requires a C:N ratio of between 15:1 and 35:1 (Fischer, 2007). Therefore, biowaste with a high amount of carbonaceous matter has to be added to the faeces.

[5] The ratio of carbon to nitrogen in the input material.

If the process parameters are optimised, a composting heap reaches temperatures of >50 °C during the initial degradation period. This hygienises the input material, considering that all types of pathogens (except bacterial spores) die within hours at temperatures of 55 – 65 °C (Winblad & Simpson-Hebert, 2004). The conversion of the input material into humus however is a longer process, taking ten weeks to six months (depending on whether the material is turned or not turned) (Fischer, 2007). For co-composting faeces with biowaste in Chora, a total composting period of at least six months is recommended[6]; this would take into account un-optimal conditions and give time for further pathogen die-off.

Urine

The factors that kill pathogens in urine are alkalinity resulting from the rapid conversion of urea to ammonia, increased ammonia concentration together with the increase in pH, and time.

The design parameter used for treatment of urine is storage time. The WHO guidelines adopted for reuse of urine in agriculture recommend a storage time of 1 - 6 months, depending on the temperature and type of crop to be fertilised (Schönning & Stenström, 2004) (see Table 2).

Table 2: Recommended guidelines for storage time for a urine mixture (urine that may be mixed with water) (Schönning & Stenström, 2004).

Storage temperature	Storage time	Possible pathogens in the urine mixture after storage	Recommended crops
4°C	> 1 month	Viruses, protozoa	Food and fodder crops that are to be processed
4°C	> 6 months	Viruses	Food crops that are to be processed, fodder crops
20°C	> 1 month	Viruses	Food crops that are to be processed, fodder crops
20°C	> 6 month	Probably none	All crops

For Chora, one month storage time is recommended in conjunction with other risk-mitigation actions such as not using the urine for crops to be eaten raw. Importantly, the urine has to be stored in tightly-sealed containers. The count-down for the time of storage starts after the last filling with fresh urine.

[6] Based on empirical evidence (source: Elisabeth von Muench, Jan. 2010).

3.2 System Description

The components of the complete sanitation chain for urine-diverting dehydration public toilets proposed for Chora are shown in Figure 1. The on-site component comprises the toilet units, which primarily collect the excreta. The following components – the transport of excreta to the off-site treatment area, the treatment processes, and the use of the products – are just as important, however, to have an effective and sustainable sanitation system.

The process options for the single-vault and double-vault UDDT are the same – as explained in Section 3.1.2, the excreta streams are collected separately at source, the faeces can be treated by storage and/or co-composting, the urine is treated by storage, and the products are used for agricultural purposes. The main difference is that the double-vault toilet unit not only serves to collect the excreta but also allows part or all of the treatment process for the faeces to take place within the on-site toilet unit. The level of treatment that takes place within the toilet unit depends on the toilet design and is explained further in Section 3.3.4.

After establishing the toilet system, it is recommended that a test phase should be carried out to monitor the processes and make any necessary adjustments to the collection and transport system and to the management of the off-site treatment and product dissemination steps. The test phase is also important to establish a proper operation and maintenance system.

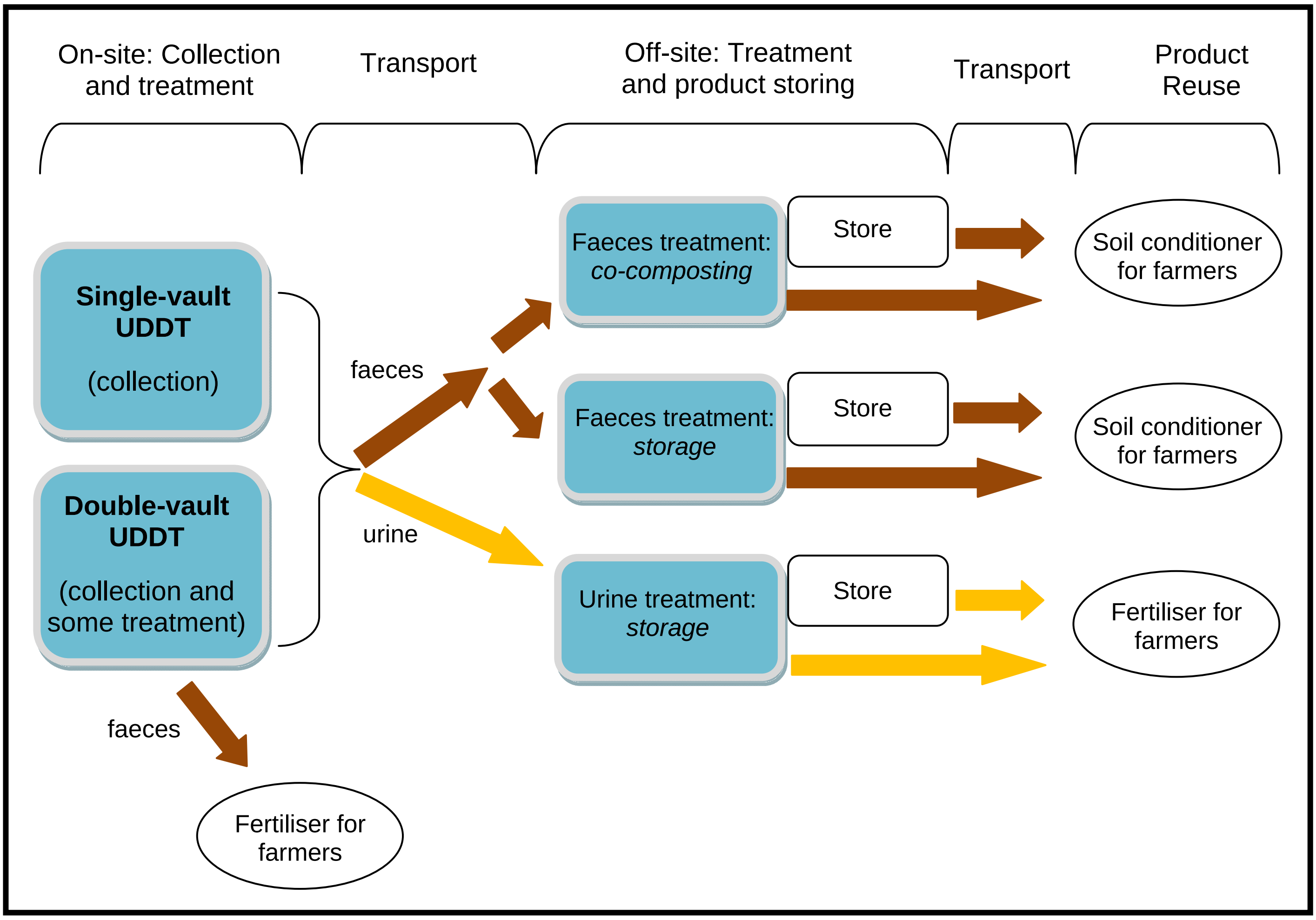


Figure 1: Schematic of the components of the urine-diverting dehydration public toilet system for Chora.

3.3 On-Site Component: UDDT

3.3.1 General Toilet Description

The UDDT consists of an above-ground substructure in which the faeces and urine streams are collected and a superstructure on top of that which houses the user-interface. The user-interface in the case of a public toilet in Chora town would be a squatting pan or a moulded concrete slab. Such a pan or slab has two outlets for the excreta - a hole for the deposition of faeces and a hole or a channel to divert the urine. The UDDT is constructed on a solid base made of concrete, bricks or clay, elevated around 10 cm above ground level, so as to avoid flooding during a rain event.

Faecal matter and dry anal cleansing material such as toilet paper or loam are deposited directly through the hole in the squatting pan or slab into a collection chamber below. Absorbents such as lime, ash, dry soil or saw dust are added to the chamber after each defecation to absorb excess moisture, make the pile less compact and make it less unsightly for the next user. The addition of absorbents also reduces flies and bad odours. Moreover, if lime or ash is used as the additive, the pH also increases and hence enhances bacterial pathogen die-off. However, as breakdown of organic material in dehydrating conditions is slow, toilet paper or similar objects placed in the chamber do not disintegrate quickly. The faeces deposition hole is covered with a lid after use to reduce odour and flies.

The substructure has either a single faeces collection chamber (a single-vault UDDT) or it is divided into two faeces collection chambers (a double-vault UDDT). In a double-vault UDDT, the chambers are used alternatively – at any point in time, only one vault serves as the active collection chamber. When the active collection chamber becomes full, it is closed and put into a hibernating treatment mode. The second vault is then used as the active collection chamber. When it becomes full, it is covered up and switched to hibernation mode, and the first chamber is emptied out and reused. The collection chambers are individually accessible through doors at the sides to be able to remove the dried faecal material. A ventilation pipe leads out from the faeces chambers and extends above the highest point of the roof of the superstructure. This helps to dry the material and reduces smell in the toilet.

Pic. 3 - 4: A double-vault UDDT in India (*Left*, source: ESF India) and in Sinalac School, Philippines (*Right*, source: Sayre & Muench, 2009).

Urine flows through the urine outlet in the squatting pan or slab, via a pipe, into a urine collection container placed within or outside the substructure. A container with an inlet for inserting the urine pipe is used to collect the urine. The urine container has to be closed at all times to prevent odour and loss of ammonia into the air. In a double-vault UDDT, the space for urine collection has to be completely isolated from the faeces collection chambers so that no urine (e.g. from spillage or overflow) can flow into the faeces chambers.

3.3.2 The User-Interface

As explained earlier, a UDDT has separate outlets for urine and faeces. The difference between a double-vault and a single-vault UDDT is that a double-vault design needs two holes for faeces deposition, one above each faeces collection chamber, whereas a single-vault design only has one hole for collecting the faeces. The double-vault UDDT may have one or two outlets for the urine depending on the design of the toilet floor and the urine piping system (see Pic. 5 and 6 showing a pan with one urine outlet and two single pans with separate urine outlets for a double-vault UDDT, respectively). A single-vault toilet is made with only one urine outlet.

The user-interface (the toilet floor) can be made on-site as a moulded concrete slab (Pic. 8) or it can be inserted as a pre-fabricated plastic (fibre-glass reinforced) or ceramic pan (Pic. 5 – 7). It should be noted that if a concrete slab is used, it should be painted with a waterproof, resistant floor paint to ensure hygienic conditions (minimise the risk of bacteria surviving on a rough surface), to make the toilet easy to clean, and to have a smooth, non-sticky surface that minimises ammonia odours. Metal components (except for stainless steel) cannot be used since urine is corrosive (Muench & Winker, 2009).

The advantages of a pre-fabricated pan could be its image as a more modern toilet and it would be easy to clean. These elements can however also be developed in a moulded concrete slab with appropriate finishing touches. As yet, pre-fabricated pans do not appear to be available in Afghanistan and they would have to be purchased from external suppliers in countries such as India (see Appendix B for a list of suppliers).

Pic. 5 - 6: *Left.* A single plastic squatting pan for a double-vault UDDT, with two holes for faeces collection and one hole for urine collection (source: GTZ). *Right.* A double-vault UDDT in a school in Armenia showing one plastic squatting pan out of use and covered with a lid and a bucket of sawdust and one pan in use (source: Deegener et al., 2009).

Pic. 7 - 8: *Left.* A ceramic urine-diverting squatting pan from a supplier in India. *Right.* A moulded concrete slab, also with an area for anal washing in the forefront (source: GTZ).

An important element to consider in making the user-interface is the durability of the toilet. A pre-fabricated plastic pan would be lighter to transport, especially from another country, but may not be as durable as a ceramic pan. The long-term maintenance perspective should also be considered in deciding between the options of a moulded slab and a pre-fabricated pan, e.g. the possibility to replace a pre-fabricated pan if it were broken.

If a concrete slab is used, a urine-diverting channel can be made instead of a urine-diverting hole. While a urine-diverting channel may be easy to make in a moulded toilet floor, it would probably cause odours because of ammonia evaporating from the urine. It would also be unsightly for the users. On the other hand, it may not get blocked as easily as a small hole connected to a urine-diverting pipe (especially if people throw unwanted materials into the urine outlet) and would perhaps be easier to maintain.

Pic. 9: A moulded concrete slab of a single-vault UDDT with a urine-diverting channel (source: UPDP).

3.3.3 Urine Collection

The aim of urine management in a UDDT is to collect the urine in a sealed container in a way that minimises nitrogen loss (via ammonia volatilisation), prevents odours in the toilet, and is practically manageable. The main challenges in collecting urine are taking into account the urine precipitates that form and handling the large volumes of urine generated in a public toilet.

Collection network

At the time of toilet use, urine is diverted to a small hole in the toilet squatting pan or slab from where it flows into a pipe that runs horizontally underneath the toilet floor up to the connection point with the urine collection container. In case a channel has been made in the design of the toilet floor to divert the urine, it is connected to a pipe at the exit point from where the urine flows into a collection container.

Precipitation reactions in urine lead to the formation of hard incrustations or soft, viscous, paste-like deposits. The hard incrustations tend to form on the inner walls of pipes and pipe bends. Soft deposits occur in containers and tanks (where they form a sludge at the bottom of the tank) and in near-horizontal urine pipes (Muench & Winker, 2009).

To prevent flow restrictions from urine precipitates, Muench and Winker (2009) give the following recommendations:

- Flow restrictions in the pipelines, such as sharp 90° bends, should be avoided as much as possible.
- The minimum recommended diameter of urine pipes is 50 mm, but the optimum range is from 75 mm to 110 mm.
- For individual toilet collection systems, the slope of urine pipes should be at least 4%, and for several toilets connected to one urine tank, the slope of the pipe should be at least 1% to minimise urine precipitation.

To control odours, care needs to be taken that the pipe leading into the urine collection container fits well with the joint. Importantly, the incoming pipe into the collection container should go down almost to the bottom, so that a liquid seal is formed, preventing undue gas movement through the piping system (Muench & Winker, 2009). If the pipe is too short (i.e. it ends just as it enters the container), ammonia gas will be able to travel up the pipe and cause odours in the bathroom and loss of nitrogen.

Pressure equalisation of the pipes and collection containers needs to be taken care of to allow the replacement of the headspace air in a container by urine flowing into the tank and vice versa when emptying the tank. This also ensures proper drainage of the urine downwards to the tank. Pressure equalisation is best done by a small hole in the collection container. Further details for small and large collection systems are explained in the Technology Review on urine diversion components (Muench & Winker, 2009).

Urine is corrosive. Therefore, urine collection pipes should be made of durable plastics such as polyethylene (PE) or polyvinyl chloride (PVC). Similarly, the urine collection containers should be made of plastic. Metal parts cannot be used (except stainless steel) (Muench & Winker, 2009).

Volume management

It is difficult to calculate the volume of urine that will be generated in the public toilets in Chora (since people are used to open defecation and the number of potential users is unknown) and hence to design a collection system based on exact volume numbers.

However, some assumptions can be made. In designing the system, these assumptions can be used as a guide in conjunction with the most practical solutions on-site. Importantly, the system should be monitored closely after the toilets become operational for any adjustments that may be necessary.

Table 3 shows some assumptions about the number of users visiting the toilet for urination and the calculations of the daily and weekly volumes of urine generated based on these assumptions. It is assumed that the shopkeepers based in the new market centre would use the toilet regularly. In addition, people visiting the shops would probably use the toilet (assumption No. 1) and perhaps shopkeepers and visitors from the main bazaar area behind the new market centre would also use these toilets (assumption No. 2).

It is difficult to make any assumptions about the number of women users because the information from people in the main bazaar revealed that women generally only visit the restaurants at the upper end of the bazaar (some distance from the new market centre) or the hospital nearby at the lower end of the bazaar (which has its own toilet). However, if the new public toilets function well, they may become known as a suitable sanitation facility for women and may be frequented by women coming to Chora.

Table 3: Calculations estimating the daily and weekly volumes of urine produced based on different assumptions about the number of users urinating in the toilet per day.

	Assumptions about the number of users visiting the toilet (for urination) per day	**Total visits**	**Volume per visit**	**Total daily volume**	**Total weekly volume**
	Men users				
1	c. 50 shopkeepers from new market (@ 3 visits/day), plus 50 visitors to new market centre	200	0.2 L[7]	40 L	280 L
2	c. 50 shopkeepers from new market (@ 3 visits/day), plus 200 visitors from bazaar and new market centre	350	0.2 L	70 L	490 L
	Women users				
3	50 women visitors	50	0.2 L	10 L	70 L
4	100 women visitors	100	0.2 L	20 L	140 L

The urine can be collected in several ways in a public toilet, and the most suitable option has to be selected. Large collection tanks can be used or several small jerry-can type containers can be used; the containers, especially large tanks, can be placed underground and combined with a pumping mechanism to empty out the tank or the containers can be located aboveground; each toilet unit can be attached separately to its own collection container placed within or outside the substructure or the urine collection pipes can be directed to one or two combined collection vessels; the urine can also be transported with a pipe directly to the place of treatment if it is not located at a distance of more than 200 m[8].

[7] Assumption based on empirical evidence (source: Elisabeth von Muench, Jan. 2010)

[8] Longer horizontal pipes face the problem of sludge accumulation in the continuously wetted side of the pipe (Muench & Winker, 2009).

Within the context of Chora town, a simple, low-maintenance system would be the most practical option. This would be a system with aboveground collection, using several smaller containers that can be easily shifted (c. 20 to 40 L). Two or more containers could also be connected together to be able to collect more volume and/or to have a safety mechanism for overflow (see Fig. 2).

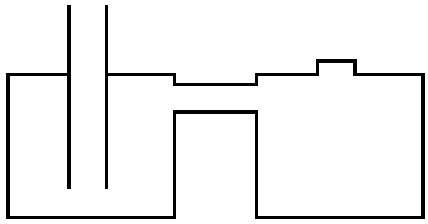


Fig. 2: Schematic of two urine collection containers joined together

The containers can be placed inside the substructure to keep them away from public view and disturbances. In this case, it would be recommended to place the containers in a plastic collection tray to hold any spillage. Also, as pointed out in Section 3.3.1, in a double-vault UDDT, the area with the urine containers should be physically isolated from the faeces collection chambers to prevent the faecal matter from getting wet in case of spillage. The other option is to place the collection containers outside the substructure, in which case it may be easier to monitor when they become full.

The volumes of urine that would have to be dealt with would depend on whether the urine containers are checked and replaced daily or weekly (any longer time interval would probably make the management of the urine difficult) and on the number of toilets that are constructed and hence the estimated volume that will be produced per toilet. The number and size of containers used and the frequency of replacement should be optimised based on monitoring results after the toilets have been made functional. There should be extra empty containers within the toilet, however, in case a filled container has to be replaced outside the scheduled period.

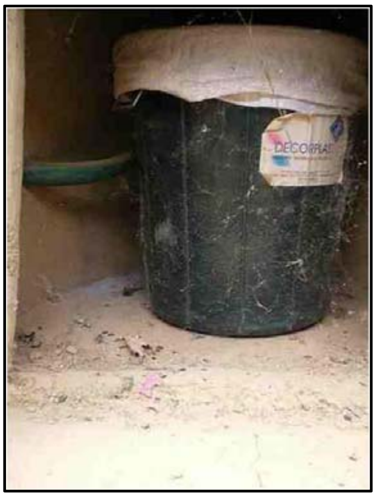
3.3.4 Faeces Collection

Faeces and dehydrating material are dropped through the toilet squatting pan or slab and collected in the chamber(s) directly below. The single-vault UDDT has a mobile collection container, while a complete chamber of the double-vault UDDT serves to first collect and subsequently store the faecal and additive materials.

As with the collection of urine, it is difficult to design a faeces collection system based on calculated volume numbers, largely because of the assumptions that have to be made about the number of users frequenting the toilet for defecation. Faeces collection should be designed using the most practical options available and the estimations of faeces and dry material volumes (Table 4) should only be used as a guide. As with the urine collection, the system should be monitored after it becomes operational and adjusted if necessary.

The assumptions about the number of user visits for defecation are based on the same scenarios (1 – 4) that are given for urination (see Table 3 and explanation in Section 3.3.3), with the difference that people are assumed to defecate once per day. In calculating volumes for faeces collection, it is important to note that fresh faeces is 80% moisture, and with time and the assistance of desiccating materials the moisture dries up (see n value in Table 4).

The movable faeces collection container in a single-vault UDDT can be of different sizes and made of different substances, depending on the local availability of materials. Importantly, the inner part of the container should be lined with a plastic bag to prevent faeces from sticking to the container and padded with leaves and soil at the bottom to absorb moisture. Materials used for UDDTs in different countries include plastic drums (Ethiopia), steel drums (Bolivia) and wooden boxes (Uganda). Examples of container sizes for public toilets vary from 50 L (Burkina Faso) to 120 L (Ethiopia).



Pic. 10 - 12: *Left.* 120 L plastic drum for faeces collection proposed in Ethiopia (Source: Oldenburg, 2009). *Centre.* Wooden faeces collection basket in Uganda (Source: EcoSan Club, 2005). *Right.* Large, plastic faeces collection bucket in Burkina Faso (source: GTZ).

The container size suitable for single-vault UDDTs in Chora would depend partly on the number of toilet units that will be made, the time interval of replacing the collection bins[9], and the estimated volumes of faeces and dry material (Table 4); it would, however, largely depend on the size that is manageable in operating the toilet. A conveniently-sized container could be used at the start and the container size or the frequency of replacing the collection bin could be altered after observing user behaviour once the toilets are opened to the public.

Pic. 13: Faeces collection in a steel drum by a private company in Bolivia (source: GTZ).

In the construction of a double-vault UDDT, the important design parameter for sizing one chamber is the storage time for the faeces within the UDDT (while one chamber is used for defecation, the second chamber is closed and used to store the faeces, which is a process for treating the faeces). In order to make the faeces suitable for reuse in agriculture, the complete storage time for treatment has to be one year or the material has to be additionally processed by co-composting (see Section 3.1.2).

[9] Daily or weekly; monthly is not recommended because of the large volumes that would have to be handled and higher risk of maintenance issues.

The faeces can be stored for the complete one year within the UDDT, which would require large collection chambers, or the treatment time can be divided between on-site storage within the UDDT and off-site storage or co-composting at a separate location, which would reduce the size of the UDDT faeces collection chambers. Table 4 can be referred to as a guide in designing the volume of the faeces collection chambers for one month, three months, six months or one year storage time. It should be noted that one chamber is normally used until it is two-thirds full, and hence additional volume has to be incorporated into the design.

An alternative method of designing the double-vault UDDT with respect to the faeces collection chambers is to make a standard chamber size. Typical size values for one chamber are 1 – 1.5 m^3. The length of time it takes to fill one chamber would then have to be observed and either the balance storage time (from a total of one year) or co-composting would need to be carried out at an off-site location.

In a similar manner to the single-vault collection container, the floor of a double-vault toilet model has to be covered with a 3 cm thick layer of dry powdered earth to absorb moisture from the faeces and to prevent faeces from sticking to the floor.

Table 4: Calculations estimating the volumes of faecal and desiccating material produced for different time intervals, based on assumptions about the number of users defecating in the toilet per day[10].

	Total user visits	Vol. of faeces per visit	Vol. of dry matter per visit	Total daily vol.	Total weekly vol.	Total monthly vol.	Total 3-monthly vol.	Total 6-monthly vol.	Total yearly vol.
				The n value shows % volume reduction of faeces due to dehydration[11]					
	Men users			n = 0%	n = 30%	n = 60%	n = 75%	n = 75%	n =75%
1	100	0.15 L	0.2 L[12]	35 L	214 L	825 L	2,138 L	4,275 L	8,669 L
2	250	0.15 L	0.2 L	88 L	534 L	2,063 L	5,344 L	10,688 L	21,672 L
	Women users								
3	50	0.15 L	0.2 L	18 L	107 L	413 L	1,069 L	2,138 L	4,334 L
4	100	0.15 L	0.2 L	35 L	214 L	825 L	2,138 L	4,275 L	8,669 L

3.3.5 Ventilation

A ventilation system is important for the function and comfort of a UDDT. This consists basically of a pipe that leads from the faeces collection chamber(s) to the outside and ends well above the toilet roof. The wind can then draw moist air and odours from the chamber through the pipe. The air that flow out of the pipe is replaced by air passing down the squatting hole. This is most efficient when the faeces hole in the UDDT slab or pan is covered and the head of the pipe is not surrounded by trees.

[10] These assumptions match the scenarios presented for urination in Table 3, except that average defecation for each person is once per day (i.e. the shopkeepers from the new market centre visit the toilet for defecation only once per day).
[11] Assumptions based on empirical evidence (source: Elisabeth von Muench, Jan. 2010).
[12] WHO (2006). Assumption is that this material does not compact.

The ventilation pipe diameter should be at least 110 mm, better 150 mm, to create a drought effect. The pipe should be as vertical as possible with as few bends and curves as possible. It should extend 300 mm above the highest point of the roof to avoid odour in the surroundings. The outlet should be sealed with a mesh to trap flies and prevent them from spreading germs, and it should be covered with a roof to prevent water from coming in to the faeces collection chamber(s). The ventilation effect can be enhanced by using a T-shaped attachment at the top of the pipe or by a wind-propelled or electric fan. The ventilation pipe must not freeze, and hence should be placed inside or outside the UDDT based on local climatic conditions (Muench, 2009; Deegener, 2009).

3.4 Transport of Collected Excreta for Off-Site Treatment

A necessary part of the flow chain of the public UDDT sanitation system is the transport of excreta from the on-site collection component to an off-site treatment location. The most suitable transport medium in Chora town would be a donkey-cart, and if the off-site treatment location is not far, manually driven carts may also be feasible. In case the municipality takes responsibility for the toilet, their existing method for collecting and transporting the garbage of the bazaar may also be an option for transporting the excreta (this would have to be checked).

Pic. 14 - 15: *Left.* Faeces collected in a self-made cart by a private company in Bolivia. *Right.* Transport of urine-filled jerry cans in Burkina Faso (source: GTZ).

In a single-vault UDDT system, the urine and faeces have to be transported regularly. The frequency of transportation depends on the length of time it takes to fill up the collection containers within the UDDT. Similarly, in a double-vault UDDT system, the urine also has to be transported regularly. The transport frequency for faeces in a double-vault is less often, however, and depends on the design calculation of the storage time for the faeces within the UDDT – transport may be required accordingly, at a one-month, three-month, six-month, or yearly interval. The excreta collection containers must be covered at the time of transport.

3.5 Off-Site Component: Treatment and Product Storage

The purpose of the off-site component in the UDDT system is to process the collected excreta so that it is safe enough and in an appropriate form for reuse. The treatment processes are explained in Section 3.1.2. Since large quantities of urine and excreta are collected in a public toilet, it may also be necessary to make arrangements for storing the products (i.e. the treated excreta streams) in case they cannot be supplied to farmers for use immediately after treatment.

3.5.1 Urine Treatment: Storage

The arrangement for processing the urine has to consist of sealed containers with sufficient volume to store the collected urine for one month. The count-down of the one month period starts after the last input of freshly collected urine into a storage container. The containers must be sealed to minimise loss of valuable nitrogen and prevent odours.

Pic. 16: A urine storage tank in Burkina Faso (source: GTZ).

3.5.2 Faeces Treatment: Storage

The most simple and passive method of treating faeces is by storing the faeces in a dry environment for one year. In order to this, a covered structure should be made that keeps out water from precipitation and any other source and also isolates the faecal matter from contact with animals and humans while it is in a dangerous state. The faeces collected from the single-vault UDDT has to be stored in such a structure for one year, and the faeces from the double-vault UDDT needs to be stored for the balance amount of time (out of one year) when taking into account the storage duration that has already passed within the UDDT chamber. As with the urine, the storage system has to be arranged in a systematic way so that the count-down for the storage time starts after the last input of freshly collected matter.

Pic. 17: Covered drying area for faeces collected from UDDTs in Uganda (source: EcoSan Club, 2009).

3.5.3 Faeces Treatment: Co-Composting

The second option for treating faeces from the public toilets in Chora is co-composting the faeces with carbonaceous biowaste collected from the town, for a period of at least six months (see Section 3.1.2). The municipality reportedly collects the garbage of the town and disposes it in a dump where it is periodically burnt. The pre-condition for creating a composting procedure would be sorting out the organic waste from the total garbage. This is easiest if the garbage is separated at source into compostable biowaste and non-compostable waste and if the biowaste is collected separately and taken to the composting treatment site.

The materials that can be included in the biowaste are: green waste (leaves, wood chips, branches), vegetables and fruit waste, animal waste, straw materials, paper and cardboard. The important factor in mixing the biowaste with the faeces is increasing the carbon content to the required C:N ratio (see Section 3.1.2). The materials that should not be included in the biowaste are: plastics, metals, orange and lemon peels, meat and bones and animal products. These latter elements cause problems with flies and rodents (Oldenburg, 2009).

The composting process can be carried out in the form of windrows on raised, cemented platforms or it can be carried out in shallow ditches. The height of the windrows is limited by the need for aeration. If the windrows are turned regularly, they can be made up to 2.5 m high. If the windrows are not turned, they should not be higher than 1 m. Similarly, the ditches should not be deeper than 1 m to ensure sufficient aeration. The width of the windrows and ditches should be a practical size such that all the material can be accessed from the sides (usually 1 – 2 m); the length of the compost heaps can be of any magnitude (Fischer, 2007).

In addition to aeration, moisture management of the compost heaps is important. If the composting material becomes too wet (>75% moisture), the process becomes anaerobic and smelly, and if it becomes too dry (<20%), the bacteria stop working. A moisture content of about 55% is required for an optimal composting process. It is useful to have a form of protective covering over the windrows or the ditches to prevent uncontrolled exposure to water and rather to regulate the moisture content by spraying the compost heaps with water periodically. A covering also prevents excessive water percolation from precipitation and minimises leachate generation. The windrow system should have a drainage channel to remove any leachate (Fischer, 2007).

The two main phases in the composting process are initial biodegradation (intensive, high heat generating process) and a curing phase (slow degradation process). The first phase takes three weeks to one month, during which it is important to maintain the process parameters of moisture (c. 55%) and aeration (by turning or by making a compost heap with a low height). Here, turning also plays an important role in homogenising the material which is critical for hygienisation of the compost. The inner core of a compost heap has the highest temperature and the outer surface has the lowest temperature with heat loss from the surface. Turning ensures that all the material goes to the inside core of the heap for some time and so can be heated up enough to kill off pathogens. Since the rate of degradation slows down during the curing phase (minimum five months is recommended, Section 3.1.2), the need for moisture and aeration also reduces.

The process steps for an off-site co-composting facility should include the following:

- Sorting biowaste material (removing unwanted materials such as plastic and metal scraps)
- Mixing biowaste with collected faeces
- Forming compost heaps (windrows or ditches)
- Managing the compost heaps (water spraying, turning)
- Sieving the end product for impurities
- Organising storage and packaging, if needed (e.g. filling into bags or storing in windrows in separate covered area).

The calculation for space is such that the composting procedure reduces the input organic material down to about 40% of the original material.

The co-composting treatment option applies to faeces collected from both the single-vault and the double-vault UDDT. The composting time for faeces from the double-vault could probably be reduced, depending on the storage time that has passed within the UDDT (however, it should be noted that with the right moisture level, the composting procedure requires a minimum of 2.5 months with turning and 5 months without turning to transform organic inputs into humus).

3.5.4 Storing the Products

Arrangements for storing the treated products beyond the time of the treatment processes need to consider similar aspects as for treatment. The treated urine must be stored in sealed containers until the time of use. The dehydrated faeces should be kept dry until it can be used. It can be exposed to the sun, which would ensure further pathogen kill. The compost should also be kept dry during storage.

3.6 Product Use in Agriculture

The UDDT sanitation system chain is completed with the use of the treated products – urine, dehydrated faeces, and/or compost - as fertiliser and soil conditioner for agricultural purposes. In Uruzgan Province in general, crops are the main source of livelihood and any fertiliser input is highly valuable. In fact, human and animal excreta are used to fertilise soils in local farming practices. Furthermore, the experience of ADA with urine-diverting public toilets in some villages in Uruzgan Province has shown that farmers also use the faeces and the urine soaked soil from the public toilets to fertilise their fields (Section 1.2.1).

The principal difference between the existing sanitation and reuse practices and the UDDT associated mechanisms is that in a traditional toilet, the excreta are collected together in an open chamber and thus much of the valuable nitrogen in urine is quickly lost to volatilisation. Moreover, the excreta matter has high pathogen content and it is not in a stabilised form when it is applied to the soil.

Here it should be clarified that urine can be soaked into the ground as a way of completing the sanitation chain. However, the large volumes of urine that will be produced in the Chora public toilets should not be soaked in one place because the nitrates will leach through the soil and contaminate the ground water. Use of the urine in appropriate quantities as a liquid fertiliser for crops will instead ensure that the nitrates are taken up by plants before they can leach into the ground water.

The benefits of treated urine and faeces as a fertiliser and its application methods and application rates have been well documented in SuSanA (2008), PuVeP (2008), Morgan (2007), WHO (2006), Jönsson et al. (2004), EcoSanRes (2008) and Oldenburg et al. (2009). The basic properties of these products are summarised here.

Pic. 18: Dried faeces after several months of storage (source: PUVeP, 2008).

The product from the co-composting process is an earthy, humus-rich material. The product from the faeces dehydration process, a crumbly, powdery material, is not compost but rather a kind of powder which is rich in carbon and fibrous material, phosphorus and potassium. Both compost and dehydrated faeces are used as a soil conditioner which increases the organic matter of the soil, hence improving soil structure and water-holding capacity, and acts as a slow release fertiliser (Muench, 2009).

Urine is a quick acting, nitrogen-rich fertiliser which also contains the macro-nutrients P, K and S (phosphorus, potassium and sulphur[13]) as well as sodium and chloride. The fertilising effects of these nutrients in urine are the same as those of artificial mineral fertiliser if the same amount of N, P and K is applied. The composition of urine makes it well suited as a fertiliser for crops thriving on nitrogen (such as maize) and especially for crops also enjoying sodium, such as chard (similar to spinach). Care should be taken when applying it for crops sensitive to chloride (e.g. potatoes and tomatoes), although yields of these crops can also be much improved by appropriate urine application (EcoSanRes, 2008).

Pic. 19: Stored urine available for re-use (source: PUVeP, 2008).

It is important to note that in line with the multi-barrier approach, good personal hygienic practices should be followed when using these products, such as, wearing

[13] Sulphur is an important macro-nutrient, needed in approximately the same amount as phosphorus, and often lacking.

protective boots and gloves and washing hands after handling the products. Moreover, application of both treated urine and faeces must be stopped one month before harvesting the crops to minimise exposure. A final protection barrier is not to eat the crops raw.

3.6.1 Demonstration Plots

Although local farmers traditionally use excreta to improve their soil quality, they do not know the value of using urine separately as a liquid fertiliser. Moreover, using appropriate methods and rates of application can enhance the fertilising effects and improve crop yields. Equally important in using excreta products as a fertiliser and soil conditioner, is following the WHO guidelines in application and taking measures for health safety (WHO, 2009).

Demonstration plots with short season crops could be used to show farmers first-hand, the application methods and rates for, and the fertiliser effect of, urine as well as health protection measures that should be taken in handling the fertiliser[14]. This would help to create demand for urine as a liquid fertiliser and hence it would be a crucial element in the functioning of the UDDT sanitation system. Such demonstration trials could be done in Chora with a local partner organisation or with the Agriculture department.

[14] If faeces products are ready, they can also be used in the demonstration plots. Literature shows that the best effect on crop yields is when both faeces and urine products are used together - dried faeces or compost are used to enhance the organic matter of the soil and urine is used as a nitrogen-rich nutrient fertiliser.

4.0 HYGIENE COMPONENT AND GREYWATER TREATMENT

Hygiene is a critical component of sanitation. Therefore, handwashing facilities with water and soap must be available in the public toilets and the greywater then produced from handwashing (and also from cleaning the toilet cubicles) has to be handled properly. The greywater has to be managed in order to avoid damage to buildings and surrounding areas from inundation, waterlogging and freezing, and to avoid the creation of bad odours, stagnant water and breeding sites for mosquitoes and other insects (Winblad & Simpson-Hebert, 2004).

The volume of greywater will be low (c. 0.3 – 0.5 L per handwash) and it will contain mostly soap and low amounts of organic matter, nutrients and pathogens. This can be suitably handled through a gravel filter bed in the ground outside the toilets. A filter bed of 0.5 m x 0.5 m width, filled with a 20 cm depth of gravel should be sufficient per handwashing sink[15]. The drainage pipe should enter the filter bed below the soil surface. Optionally, the filter bed can be beautified with plants.

[15] Assumption from empirical evidence (source: Elisabeth von Muench, Feb. 2010).

5.0 OPERATION AND MAINTENANCE

Operation and maintenance of the UDDT system is essential to keep the toilets functional for the public, to protect public health and to benefit from the products. Here it should be noted that health safety measures should be taken during all maintenance activities. Rubber gloves and closed shoes should be worn and hands should be washed after maintenance and operation activities. Also, the operation and maintenance of the women's toilets should be managed in a culturally sensitive way.

5.1 Instructions for the Toilet Users

- Each part of the squatting pan should be strictly used for its respective purpose.
- The users should position themselves properly on the toilet.
- Solid material for anal cleansing should be put into the faeces collection hole.
- After each defecation, a bowl or shovelful (c. 200 ml) of dry absorbents should be sprinkled over the faeces.
- Any other materials (e.g. sanitary napkins) should be placed in a waste bin.
- After each faecal deposit, the lid should be replaced on the hole.
- Hands should be washed with soap after using the toilet.
- The door of the toilet should be kept closed.

Pic. 20: A urine-diverting squatting pan in a public toilet in China showing the direction of sitting with foot marks (source: GTZ).

5.2 Daily Maintenance of the Toilet

- Checking the faeces collection hole and adding dehydrating material if needed (especially if users do not add enough dehydrating material or if the vault is unusually moist).
- Cleaning the squatting pan or slab with a damp brush or cloth (i.e. **no** pouring of water into the urine and faeces outlets).
- Replacing consumable items: soap, toilet paper, dehydrating material.
- Cleaning the complete toilet unit (e.g. floor, hand-washing area).
- Emptying out the waste bins (and taking the waste to the municipal garbage collection point).
- Checking the level of the urine collection containers and replacing with an empty container, if needed outside the planned replacement schedule.
- Checking faeces collection container of single-vault UDDT and taking measures for replacement, if needed outside the planned replacement schedule.
- Checking for odours and taking necessary measures (see Section 5.4).

5.3 Long-term Maintenance Measures

5.3.1 On-Site Collection and Transport

- The ventilation pipe should be dismantled and cleaned when needed. Cobwebs especially hinder the flow of air.
- Before the first use, the faeces collection chamber of the double-vault UDDT should be covered with a 3 cm thick layer of dry powdered earth to absorb moisture from the faeces and to prevent faeces from sticking to the floor.
- The squatting pan/faeces collection hole in the slab of the 'hibernating', out-of-use chamber of the double-vault UDDT should be covered up and temporarily sealed so that people do not use it.
- The filled excreta collection containers should be replaced in the UDDT as per need, and the excreta should be transported to the off-site treatment location.
- Urine collection containers should be emptied out completely; urine sludge can especially accumulate in containers which should not be wasted.
- A single-vault UDDT should be washed down once a week. For this procedure, the urine container has to be disconnected, the movable faeces collection container removed, and the squatting pan and collection chambers washed down with water and detergent. They should be then allowed to dry and the collection containers put back into place.
- The urine pipes should be checked for any leaks.
- The urine collection pipe should be rinsed out once a week to prevent blockages. For this procedure, the urine container has to be disconnected and a bucket placed at the end of the collection pipe. If possible, the pipe should first be cleaned mechanically with a drain auger. Precipitated material in the pipes should then be washed out by pouring 1 – 2 litres of water down the urine bowl and collecting it at the other end of the pipe with the bucket. If blockages are not cleared out, harsher chemical cleaning should be done with strong solutions of caustic soda (2 parts of water to 1 part of soda) or acetic acid (> 24%), followed by a water rinse to remove the accumulated materials.

5.3.2 Off-Site Treatment

- The emptying out and management and treatment of the freshly collected urine and faeces has to be done so as to properly complete the treatment processes of the excreta (i.e. batches of faeces or urine undergoing treatment should not be contaminated with freshly collected material).
- The urine storage containers should be emptied out completely after each treatment phase to remove any accumulated sludge and use it as fertiliser.
- The main activities that have to be carried out for co-composting faeces with biowaste are: sorting of biowaste, mixing the biowaste with faeces, forming composting heaps (in ditches or windrows), managing the composting heaps (turning, watering), and sieving the material after the composting process has been completed.
- Information on problems that can occur during composting and mitigation measures are given in Oldenburg (2009, p. 23).
- The ready products have to be made accessible for farmers.

5.4 Trouble Shooting: Bad Smell Occurs in the UDDT

Oldenburg et al. (2009) advise the following measures in case bad smells occur in the UDDT:

1. Check if dehydrating material has been added in all faeces collection containers- If NO, add a cupful of ash in the faeces collection container.
2. Check if the urine diversion system is blocked. - If YES, unblock mechanically or chemically and flush water down the urine pipe.
3. Check if the faeces collection chamber contents are damp or wet. - If YES, inspect source of water and repair and add extra dehydrating material.
4. Check if the UDDT pan is unclean. - If YES, wipe with a soapy and damp piece of cloth.
5. Check if there is poor ventilation - If YES, clean out the ventilation pipe. In addition, ensure that the vent pipe is in the correct position and erect.
6. Check if there are any leaks in the urine pipe.

6.0 COMPARISON OF SYSTEM COMPONENT OPTIONS

In addition to the differences between the single-vault and the double-vault alternatives of the UDDT, options have been discussed for some other parts of the toilet system also. The disadvantages and advantages of the various options are summarised in Table 5.

Table 5: Advantages and disadvantages of options for system components.

System Components	Advantages	Disadvantages
Double-vault UDDT	- no handling of fresh faeces - if storage time within collection chamber is one year, the dried faeces can be taken for reuse directly from the toilets - need less time for collection, transport and treatment processes	- if the system is used or maintained wrongly and the faeces chambers get very wet, it will smell and attract flies - need larger area for one toilet cubicle on-site than for a single-vault
Single-vault UDDT	- if the faeces collection container becomes wet, it can easily be remedied by replacing the container - need smaller area for one toilet cubicle on-site than for a double-vault - can wash down the toilet pan or slab regularly and clean out entire cubicle	- handling of fresh faeces - need more time for collection, transport and treatment processes - off-site treatment of faeces is mandatory
Moulded concrete toilet slab	- local experience exists	- may have a crude appearance - difficult to clean if the proper finishing coat has not been applied
Pre-fabricated squatting pan	- has a modern appearance - easy to clean	- not available in local market - difficult to replace
Channel in moulded slab for urine diversion	- easy to clear away blockages occurring due to misuse - most likely will still be operational even if materials are thrown in the channel	- has a crude appearance - more smell likely with open flow of urine in channel
Hole in pre-fabricated pan for urine diversion	- easy to clean pan - modern appearance	- blockages may occur if not maintained properly - most likely will not be operational if materials are thrown into the outlet
Composting faeces for treatment	- can manage organic waste of town simultaneously - can reduce treatment time	- need more time for operation and maintenance of composting process - more complicated process - need off-site treatment facility
Storing faeces for treatment	- simpler process to manage - need less time for operation and maintenance - in a double-vault UDD, can be done without off-site treatment	- need longer treatment time

7.0 SUSTAINABILITY

7.1 Sustainability Checklist

The Sustainable Sanitation Alliance looks at sustainability of sanitation systems from five aspects. A checklist has been made for the proposed UDDT public toilet system showing the steps that should be carried out to promote sustainability within each of these five criteria (Table 6).

Table 6: A checklist for sustainability of the UDDT public toilet system in Chora according to the five sustainability criteria of the Sustainable Sanitation Alliance.

Sustainability criteria	Collection and transport	Treatment	Transport and reuse
Health and hygiene	- collection units are contained - containers are covered during transport - protective clothing are used and hands are washed after maintenance activities - hand washing facilities are provided for users - toilets are cleaned	- treatment structures are contained - treatment processes are followed - protective clothing are used and hands are washed after handling activities	- WHO reuse guidelines are followed - protective clothing are used and hands are washed after product handling
Environment and natural resources	- urine is not dumped on-site to prevent nitrate leaching into groundwater - units are contained to prevent contamination of groundwater	- urine containers are kept tightly sealed to avoid odours - urine is not dumped into the soil	- WHO reuse guidelines are followed
Technology and operation	- toilets are used properly - faeces chambers are kept dry - toilets are cleaned - consumable items are replaced - collection containers are replaced and transported - urine and ventilation pipe blockages are cleaned out - a test phase is done to adjust the collection schedule and system	- freshly collected excreta is kept separate from excreta under treatment - treatment processes are followed	- demonstration plots are made to show proper use of products - products are made accessible to farmers
Finance and economics	- source of finances for maintenance and operation of toilet is found (municipality funds, user-pay system, tax etc.)	- source of finances for implementing treatment processes is found	- demonstration plots are made to create demand for the products - cost-free system of disseminating/ obtaining products for reuse is made
Socio-cultural and institutional	- operation and maintenance is carried out by permanent body (municipality, private sector etc.) - local development organisation provides technical backstopping and monitoring	- operation and maintenance is carried out by permanent body (municipality, private sector etc.) - local development organisation provides technical backstopping and monitoring	- demonstration plots are made together with the agriculture department or a local NGO to promote the use of urine as a fertiliser

The steps listed under the first three criteria (health and hygiene, environment and natural resources and technology and operation) have been largely addressed in the previous sections. The financial and institutional aspects have not been touched upon, however, and thus these are explained below.

7.2 Institutional Sustainability

An institutional mechanism is necessary to implement the operation and maintenance tasks (see Section 5.0) so that the toilets are kept functional for public use – essentially an operator of the system is needed. Typically, the municipality of the town would have the responsibility (e.g. as is the case in Kabul). To this end, the mayor of Chora gave his assurances that the municipality would be willing to take the responsibility for the upkeep of the public toilets and provide staff for the daily cleaning activities and any maintenance tasks. Despite these statements, it remains questionable whether the municipality will take the ownership for the operation and maintenance of the toilets with a long-term commitment. In the situation of Chora, there are several risk factors, which include the following:

- The mayor may not follow through with his assurances.
- The mayor may not have staff in the long-term to carry out such tasks.
- The municipality staff may not work without added incentives.
- The future mayors may not be interested in such a commitment.

Alternatively, institutional sustainability may be possible through the private sector. For example, a farming family from the locality could operate the toilet system. They could provide the service of maintaining the UDDTs in return for a cash income (see Section 7.3) and they could transport the excreta to a treatment area near their fields and subsequently use the products as fertilisers for their crops. A second option could be handing over the system to an entrepreneur. Lastly, the public toilets could be constructed near the restaurants at the upper end of the bazaar where the restaurant owners could operate them.

In addition to finding an operator for the system, it would be beneficial to nurture a local development organisation (e.g. the Afghan Development Association) to monitor the operation and maintenance of the toilets and provide any necessary technical backstopping for a defined period of time after the toilets are opened to the public. This period should be at least one complete collection-treatment-reuse cycle. This organisation should be involved from the planning phase onwards and have a role in carrying out the test phase of fine-tuning the collection and transport system and off-site treatment methods after the toilets start being used.

7.3 Financial Sustainability

Financial resources are needed for the upkeep of the toilets and for managing the whole system. In particular, money is needed for replacing consumable items, for making repairs, and for services provided. Services may be provided by municipality staff or by the private sector.

Options for obtaining financial resources can be as follows:

- User-pay system, for each visit to the toilet or for consumable items such as toilet paper (this would require a person to be on-site at the toilets all day, which would mean more costs in terms of labour but would also mean that this person could keep the toilets clean and in good shape).
- A tax levied on the surrounding shopkeepers.
- Income from selling the urine as fertiliser (this would only work however if urine is experienced to be as valuable as chemical urea fertiliser and if it is possible for the farmers to collect and transport large volumes of liquid to their fields).

8.0 References

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http://puvep.xu.edu.ph/publications.htm or
http://www2.gtz.de/Dokumente/oe44/ecosan/en-philippine-allotment-garden-manual-2008.pdf

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APPENDIX A: INFORMATION LINKS FOR THE DESIGN, CONSTRUCTION, AND USE OF UDDTS

Design and Construction Guidelines

- Information on urine piping and storage tanks has been compiled by Muench and Winker (2009).
  http://www.gtz.de/en/dokumente/gtz2009-en-technology-review-urine-diversion.pdf

- Information on how to construct a UDDT is given by Deegener et al. (2006)
  http://www.susana.org/images/documents/07-cap-dev/a-material-topic-wg/wg04/deegener-et-al-2006-urine-diverting-toilets-wecf-en.pdf

Technical Drawings

- Several links to technical data sheets and drawings of single- and double- vault UDDTs are available through the SuSanA website.
  http://susana.org/lang-en/cap-dev/visual-aids-drawings/technical-drawings

- Selected construction plans of UDDTs are given from projects around the world.
  http://www.gtz.de/en/dokumente/en-ecosan-tds-02-c1-dehydration-toilets-plans-2006.pdf

Posters

- Several links to posters on operation and maintenance of a UDDT are available through the SuSanA website. In line with the Afghan culture, the posters showing human body parts should not be used.
  http://www.susana.org/lang-en/cap-dev/visual-aids-drawings/poster

Videos

- A video link on the construction of a double-vault UDDT is available on the SuSanA website.
  http://susana.org/lang-en/videos/ecosan-udd-toilet-construction-video

- A video link showing the opening of the hibernating faecal chamber (to remove and use the dehydrated faeces) is available on the SuSanA website.
  http://susana.org/lang-en/videos/uddt-first-opening-of-the-collection-chamber

APPENDIX B: WORLDWIDE LIST OF SUPPLIERS OF URINE-DIVERTING SQUATTING PANS

This excerpt of squatting pan suppliers has been taken from the worldwide list of suppliers of waterless urinals, UD pedestals and squatting pans (Muench & Winker, 2009).

Manufacturer name	Urine-diversion squatting pan model name and photo[16]		Materials, indicative costs[17] and other information
Burkina Faso: TCMP Bandé Abdulaye +226-70705497 +226-78841983 reseaucrepa@reseaucrepa.org (CREPA headquarters) Further info also: linusdagerskog@yahoo.fr (CREPA, Burkina Faso)	Squatting pan 2 hole + 3 hole UD-seat inset Water less urinals (male/female)	 	• Material: mold is in fibre glass to make squatting pans in concrete (mold costs 38 EUR); squatting pans can also be in fibre glass • Used in large-scale Ecosan-UE project in Ouagadougou (2006 to 2009) • Indicative costs: Three hole squatting pan: EUR 30; two hole squatting pan: EUR 23; UD seat inset: EUR 23; waterless urinals : EUR 19 • Units sold: ~ 300 units of the squatting pans (200 for Togo) • Countries sold in: Burkina Faso, Togo and other West African countries
China: Nanning Da Di Qiu Eco san Products Co. No answer received yet Mr. Lin Jiang E: linjiang93@hotmail.com or Ms. Hu Zhen Ying E: huzhenying2006@126.com	Squatting pan	 	• Material: sanitary porcelain or plastic • Sliding lid offers hands free operation • Indicative cost: EUR 6 for plastic version? • Number of units sold? • Countries sold in: China, Ukraine and other CIS countries (?)
China: Beijing Zhongke Longtai Biotechnology Co. Ltd., Beijing No answer received yet E: sales@zhongkelongtai.com I:			

[16] More photos are available in the GTZ-ecosan photo collection, see beginning of Appendix for website link.
[17] Costs are current for March/April/May 2009, without freight, for single units bought by individuals. Costs tend to be lower when higher number of units are ordered, and are also lower for traders compared to individuals placing orders.

Manufacturer name	Urine-diversion squatting pan model name and photo[16]	Materials, indicative costs[17] and other information
http://www.zhongkelongtai.com/ (website in Chinese only)		
Congo: CREPA Congo Samuel ADJETY, Head of workshop : tél 00242 538 15 12 : 00242 669 73 16, crepa_cncg@yahoo.fr Further info also: linusdagerskog@yahoo.fr (CREPA, Burkina Faso)	Slab for UDDT 	• Material: concrete • Further information on request
Ethiopia: Ethio Fiber P.O. Box 6550 Addis Ababa Ethiopia E1: ethfibre@ethionet.com E2: ESE-PPP@ethionet.et I: No website available Further contact: Martin Oldenburg info@otterwasser.de	Urine diversion squatting pan 	• Material: glass fibre[18] • Was supported by a PPP scheme with GTZ: GTZ paid for construction of the master form to incorporate GFK mats • Indicative cost: EUR 15 • Numbers of units sold: 50 • Countries sold in: Ethiopia
(as above)	Urine diversion squatting pan 	• Similar model as above
Ethiopia: Tabor Ceramics Products Share Company Awassa Ethiopa E1: taborceramic@ethionet.et E2: ESE-PPP@ethionet.et	Squatting pan "turkish ecosan toilet 	• Material: ceramics • 2-hole squatting pan • Was supported by a PPP scheme with GTZ: GTZ provided material to manufacture the moulds (gypsum) • Units sold: 50 • Indicative unit cost: EUR 25 • Countries sold in: Ethiopia

18 Manufacture requires more manual labour than ceramic toilets and is less automated (hence quality of workmanship can be variable) but allows for changes to be incorporated quite easily.

Manufacturer name	Urine-diversion squatting pan model name and photo[16]	Materials, indicative costs[17] and other information
India: Mythri Sarva Seva Samithi (NGO which obtains its pans from a private supplier) No answer yet Anselm Rosario msss@vsnl.com www.ecosanindia.org	Squatting pan 	• Material: glass-fibre reinforced plastic or PVC • "3 in 1 model" – meaning it has a separate outlet for anal cleansing water • Number of units sold? • Indicative cost: EUR 10 • Countries sold in?
India: Shital Ceramics Works (state of Gujarat) Jayesh Sompura shitalcera@yahoo.com http://ruralsanitation.net/	Eco San Indian style 	• Material: ceramics (PVC faecal cover and nozzle) • "3 in 1 model" – meaning it has a separate outlet for anal cleansing water • Indicative cost: EUR 11 • Number of units sold: 115 in Yemen, 300 in India • Countries sold in: Yemen, India
India: EEDS NGO Energy, Environment and Development Society (EEDS) Ajit Kumar Saxena saxena.ajitkumar@gmail.com Email: eeds@rediffmail.com, eedsngo@gmail.com	3-hole ecosan pan 2-hole ecosan pan  3-hole ecosan pan	• Material: lightweight concrete, in various colours • Indicative costs: o Onsite casting 3-hole ecosan pan (local cast: EUR 15 (INR 1000) including squatting plate o Squatting type pre-casted - micro concrete/fly ash 3-hole ecosan pan: EUR 2 (INR 130) o Squatting type pre-casted - micro concrete /fly ash 2-hole ecosan pan: EUR 1.5 (INR 100) • Number of units sold: received few enquiries from India and outside too but not yet supplied (see further notes for EEDS in Table 3)
India: **Sustainable Technologies in the Community** No reply yet **Trivandrum, Kerala, India** **Paul Culvert** ecopans@eco-solutions.org **www.eco-solutions.org**		

Manufacturer name	Urine-diversion squatting pan model name and photo[16]	Materials, indicative costs[17] and other information
India – Prakash Ceramic (in Gujarat state) Vagadia Road, Thangadh 363530 Phone: +91(02751)220856 Mobile: 9825231856 Fax No.:+91(02751)220859 prakasceramic@yahoo.in	EcoPan and RuralPan   Washset	• Material: ceramics • 2-piece Model: urine diversion squatting pan and washset for anal washing • Indicative cost: EUR 5 (including ecopan and washset for anal washing). • Units sold: awaiting information • Countries sold in: India
Ivory Coast Artisan : TIOYE BE Entreprise : APAP : Atelier de Polyester et des Arts plastiques 04 BP 64 Abidjan 04, Côte d'Ivoire Telephone : 00(225) 07 40 26 14 crepa-ci@reseaucrepa.org Further info also: linusdagerskog@yahoo.fr (CREPA, Burkina Faso)	Squatting pans (polyester and concrete) UD seat (polyester and concrete)  	• Materials: fibre glass, polyester, concrete • Indicative costs: o UD squatting pan in fibreglass: EUR 13 o UD seat in polyester :EUR 19 o UD seat in concrete: EUR 13 • Units sold: not known • Countries sold in: Ivory Coast
Kenya - Kentainer Embakasi Rd. Off Airport North Road, Nairobi T: +254-20 8235136 www.kentainers.com Mrs. Fara Waliji M: 0721 306 127 I: fara_waliji@kentainers.com	Urine-diverting squatting pan (for double vault UDDT)  	• Material: plastic • Squatting pan for double-vault-UDD toilet (two holes for faeces) • Production was initiated through PPP project between Kentainer and GTZ • Indicative cost EUR 35 (KSH 3,500) for squatting pan incl. two lids and urine pipe • Units sold: not known • Countries sold in: Kenya
Mali Mr Boubacar Coulibaly Bamako, Mali tél. : (00223) 66 91 66 19 crepa-mali@reseaucrepa.org Further info also: linusdagerskog@yahoo.fr (CREPA, Burkina Faso)	Three hole squatting pan 	• Material: ferro cement • 3-hole squatting pan (3rd hole for anal waswhater) • Indicative cost: EUR 15 • Units sold: not known • Countries seved: Mali

Manufacturer name	Urine-diversion squatting pan model name and photo[16]	Materials, indicative costs[17] and other information
Nepal: Kayo Fiber Glass Udyog, Kathmandu Name: Manoj Siddi Email: kayo@wlink.com.np Further contacts: Nam Raj Khatri namraj@enet.com.np Han Hijnen hanheijnen@gmail.com		• Material: fibreglass • In Nepal so far 1000 ecosan UDD toilets have been constructed since 2000[19]. • Indicative cost: awaiting information • Units sold: numbers not available from supplier • Countries sold in: Nepal
Uganda: Crestanks Ltd. P.O. Box 11381 Kampala Uganda Mobile: Plot No 86/96 6th Street Industrial Area T: 256-41-235470/348973 256-772-766574 F: 256-41-234184 E: scs@crestanks.co.ug E 2: janet@crestanks.co.ug E3: crestank@africaonline.co.ug I: www.kentainers.com	LS-100-EKO Urine-diverting squatting pan 	• Material: PET • Toilet slab with urine diverting squatting pan • hole for vent pipe included • Size for LS 100: 121 x 106 x 11 cm (length by width by height) • Indicative cost: EUR 70 (180,000 USH The following information applies to all models in this range: • 15% discount possible if linked to gtz PPP projects • Number of units sold: information not disclosed by supplier • Available also in Kenya,Tanzania, Ethiopia, Rwanda, Southern Sudan and Burundi but for different costs (applies to all models in this range)
(as above)	LS-180-EKO Urine-Diverting sub structure (incl. slab, chamber and steps) 	• Material: plastic • Urine diverting slab inclusive chamber for urine/faeces and steps • Indicative cost: EUR 130 (USH 338,000)
(as above)	EcoPan 	• Material: polyethylene • Size: 70 x 32 cm (length by width) • Indicative cost: EUR 10 (USH 25,000)

19 At the begining the pan was fitted in the slab itself. Then after urine diverting cement pan was produced in Kathmandu. Since 2005 (approx) fibre glass pans are being produced (for urine diverting wet toilet, i.e. faeces is flushed into pit and urine is utilised.

APPENDIX C: PICTURES OF GOOD AND BAD CONSTRUCTION EXAMPLES

(Source: Ecosan Services Foundation, India)

Good Constructions

Pic. C1; Placement of the bifurcating ventilation pipe in a double vault toilet.

Pic. C2: Connection of urine collection pipe to sealed urine container

Pic. C3: Proper diameter and slope of urine collection pipe

Poor Constructions

Pic. C4: Ventilation pipe too short. It should extend 20 – 30 cm above the roof.

Pic. C5: Urine collection pipe too narrow and too many bends

Pic. C6: Improper discharge of washing water

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