Technology Review of Urine-diverting dry toilets (UDDTs)

Summary

This technology review deals with a type of toilet designed specifically for dry excreta management called the urine- diverting dry toilet (UDDT). It is a sanitation system for households and public facilities as well. The functional design elements of the UDDT are: source separation of urine and faeces; waterless operation; and ventilated vaults or containers for faeces storage and treatment. UDDTs may be constructed with two adjacent dehydration vaults or one single vault with interchangeable containers. This publication offers a complete overview of UDDT functions, design considerations, common operation and maintenance issues and generalised installation costs. Its focus is on applications in developing countries and countries in transition, although UDDTs are also applicable in developed countries.

The UDDT technology was originally promoted in connection with safe reuse of excreta. However, the primary focus of UDDT implementation has gradually shifted from that of excreta reuse to the broader objective of creating an odourless, dry and versatile toilet that is applicable across wide range of geographic and economic contexts. Many successful examples of large-scale UDDT programmes, such as those found in Lima, Peru and eThekwini (Durban), South Africa, dispose of treated excreta instead of reusing it, as it is considered more practical, convenient or acceptable to the users.

The primary advantage of UDDTs, as compared to conventional dry latrines like ventilated improved pits (VIP) latrines, is the conversion of faeces into a dry and odourless material. This leads to an odour and insect free toilet which is appreciated by users and to the simple removal and less offensive and safer handling of the faecal material once the toilet has filled up. Moreover the risk of water pollution is minimised through the safe containment of faces in aboveground vaults which also allows the toilets to be constructed in locations where pit-based systems are not appropriate. The faeces are however not entirely sanitised when removed from the toilet, so precautious handling is obligatory. In scenarios with reuse of excreta in agriculture, a post-treatment of faecal matter and storage of urine is advisable to ensure adequate sanitisation.

This publication provides comprehensive design guidelines for all functional UDDT components, including urine diversion (UD) pedestals, benches and squatting pans, dehydration vaults, single vaults with interchangeable containers, and urine piping and storage systems. Possible design modifications are discussed to ensure the toilet's suitability for small children, the elderly and persons with disabilities. Additionally, all relevant aspects of excreta management are described including treatment, disposal, reuse and maintaining hygienic quality standards.

Emphasis is placed on recent technical innovations that allow the UDDT to be integrated in a wider range of applications. The bench design, a sitting type of UD interface that minimises the need for stairs leading up to the toilet, is presented as a possible solution for indoor

A gardener next to his ecosan toilet at home
Photo: Abdoulaye Fall

Ceramic UDDT and wash bowl in private household

Inside of UDDT vault,Initao municipality

installations and means of providing barrier-free access. Other designs are presented for a variety of contexts, including indoor and outdoor installations, schools and public toilet blocks, flood prone areas and floating villages.

This technology review also describes common O&M problems, such as blockages in urine piping systems, wet conditions in the dehydration vaults and faulty construction. Possible fixes and preventative maintenance routines are emphasised as a means of ensuring the toilet's sustainability.

This publication challenges the common perception that UDDT installation costs are prohibitive for the poorest members of society. A number of low-cost UDDT designs are available that take advantage of locally available construction materials and can help tailor the toilet technology to available budgets.

Background

According to the Joint Monitoring Program (JMP), approximately 2.5 billion people lack access to improved sanitation facilities, with 1.1 billion still practising open defecation (UNICEF and WHO, 2012). Knowledge and practice of critical hygiene behaviours, such as hand washing after toilet use, are also widely lacking. Consequently, the ingestion of faecal pathogens from contaminated food and water resources as well as faecal- oral transmission are a leading cause of disease and preventable death, especially in children under five years.

The effects of inadequate sanitation, hygiene and resulting diarrhoeal disease are dramatic: in 2010, the World Health Organization (WHO) reported that worldwide the impact of diarrhoeal disease on children is greater than the impacts of HIV / AIDS, tuberculosis and malaria combined.

Due to their relative affordability and simple and waterless operation, pit latrines are common in developing and transitional countries. However, pit latrines can spread faecal contamination to water resources, especially in associated with faecal sludge removal or excavation of new pits when emptying is not feasible.

Increasingly, limited water supplies and the high cost of construction of wastewater infrastructure make sewer- based sanitation impractical in many regions. Water-based systems dilute excreta and create large waste water streams that necessitate the construction of technologically complex and expensive treatment facilities. It is estimated that 90% of all wastewater in developing countries is discharged untreated directly into water bodies (Corcoran et al., 2010), a clear indication that sewer-based sanitation is not a viable solution for many parts of the world. Moreover, pharmaceutical residues in treated wastewater could have negative impacts on human health, and lead to the evolution of resistant strains of microbes.

Expectations and attitudes surrounding sanitation are widely variable and influenced by both societal norms and personal preference. While improved hygienic standards, reduced contaminant impact and minimisation of water usage may be the goal of sanitation practitioners, toilet users generally strive to improve their current sanitation situation with regards to odour, insect infestations, privacy, comfort and 'prestige'.

The UDDT is a dry excreta management system that, since the late-1990s, is seen as a viable alternative to pit latrines and flush

doors of feaces chamber

Mozambique public toilet

Pumping operation

The urine diverting dehydration toilet (UDDT)

toilets in developing countries and developed countries respectively. However, significant barriers to more universal acceptance of this technology remain. To date, a general lack of awareness, a limited supply of prefabricated UDDT components and a low interest in financing sanitation services, have all acted as impediments to the construction of UDDTs.

Historical development

The earliest documented dry toilets with urine separation were installed in multi-storey houses in Yemeni towns and were, until recently, used continuously for hundreds of years. The UDDTs with double dehydration vaults that we know today were originally designed around 1950 in the Kanagawa Prefectural Public Health Laboratory in Japan and further developed in Vietnam in the 1960s as a means of increasing the hygienic safety of excreta reused in agriculture.1

Since the 1990s, modifications of this design have been promoted in countries like Mexico, Guatemala, El Salvador, India and Sweden. Ventilation pipes in the faeces vault were gradually integrated and allowed for the installation of UDDTs inside houses. More recently, prefabricated ceramic or plastic UD squatting pans and pedestals have become available on the market, generally increasing the durability and perceived prestige associated with the system. The design was further adapted in India and West Africa to accommodate anal cleansing with water, by including a separate anal cleansing pan with a drain to divert wash water into a dedicated disposal or treatment system.

As early as 2000, the bench UDDT, which is a design that allows the user to sit directly on the vault, began to be promoted in Ecuador and Peru. This model is easily incorporated into existing housing structures and has emerged as a popular design for indoor installations (see Section 10.2).

UDDTs have also been commercially produced in Sweden since the mid-1990s. These commercial products are often installed in locations where piped sewerage is not available, such as remote summer cottages.

In 2001, the EcoSanRes Programme was initiated at the Stockholm Environment Institute (SEI). This was followed shortly thereafter by the establishment of the ecosan program at GIZ. Together these two government-funded programmes have helped to disseminate knowledge of UDDTs and have triggered the promotion of this technology in developing countries and countries in transition.

The exact number of UDDT users is impossible to determine, but a rough estimate based on known projects in 84 countries puts the number at approximately 2 million worldwide.

7 Questions

The authors on planning of the new publication, building and maintaining UDDTs, beneficiaries of the publication etc

Why did you decide to write yet another document about UDDTs, and how long did it take you?

When we started this work, we were not planning a new publication but merely wanted to update an existing publication by GTZ (now GIZ) called "Technical Datasheet of UDDTs", which was written in 2005.

Trainees inserting the eco plates

Transportation of urine using the tricycle

UDDT withstanding Cyclone Aila 2009

Urine diversion squatting pan Model from Tabor Ceramics, Ethiopia

We worked on revising this document over the course of 2009 and 2010, but realized that a major overhaul was needed. This took us another two years (2011 and 2012) to complete. The end result is a completely new document which has undergone an intensive, international review process. The names of the international reviewers are listed in the acknowledgement section.

How much practical experience do the authors have with building and maintaining UDDTs?

Christian Rieck's practical experience with UDDTs stems from the time he worked in Nairobi for the GTZ Water Sector Reform Program (2006 to 2010), on a project funded by the European Union and Sweden, where UDDTs were built for 10,000 users in rural areas and schools. More than 1000 double-vault UDDTs were implemented via CBOs and the Water Services Trust Fund in South Nyanza, Western Kenya and other provinces of Kenya. One of the other authors, Heike Hoffmann, has extensive experience in building UDDTs in Peru where about 800 have been built under her guidance in the Coastal, Andean and Amazon regions. She works for a private company called Rotaria do Brasil and the consulting company AKUT. Currently, AKUT is working within a GIZ program which is working together with Peruvian water and sanitation utilities. She is responsible for the integration of service models for "dry sanitation" into the urban sanitation management, with the aim of offering an adequate sanitation service in urban areas without sewers as well.

Who in particular would benefit from reading this document?

The target audience for this publication is engineers, NGO staff, local government, staff, consultants, trainers, lecturers and other persons possessing some basic technical background, who want to:

- Obtain an overview of the function, design and operational requirements of UDDTs;
- Understand how a UDDT may provide a possible sanitation solution for a given context and
- Finance or implement sanitation systems and wish to discuss UDDT options with consultants and suppliers in an informed manner.

4. The photos are very nice – are we allowed to copy them for our own documents or presentations?

Yes, you can use any of the photos, provided you cite the source correctly. You can download them in their original size here: http://www.flickr.com/photos/gtzecosan/sets/72157628912448797/

How is this document different to previous documents about UDDTs?

There were four main flaws with many previous documents on UDDTs which we wanted to overcome:

- **Too much "propaganda"**: UDDTs are often represented as the "magic bullet" for sanitation, the "one and only" solution, and as a system that can easily achieve complete pathogen kill. We stress that UDDTs are only one amongst a range of sanitation options with certain areas of application; that one should not expect a "complete" pathogen kill; and that a multi-barrier approach is needed to achieve a high level of safety for users and service staff.
- **Too much emphasis on reuse**: Often, UDDTs are described as a sensible solution only when coupled with re-use activities. We emphasize that re-use is in principle good and desirable but that there are also other reasons for building UDDTs which are not necessarily connected to any plans for reuse (mainly reduced odour and easier handling of the dried faecal matter).
- **Confusion about the differences between single-vault and double-vault UDDTs**: Unlike previous documents, our document gives very clear guidance on the advantages and disadvantages of "single vault" versus "double vault UDDTs", and explains why there is a greater need for post-treatment for the single vault systems.
- **No consideration of up-scaling and of sustainable service provision at a large scale** (see also next question)

Where do you see the challenges of UDDT implementation in the future?

UDDTs have become better known of late and are now closer than ever to becoming "mainstream". On the other hand, there is still lack of knowledge about them, while prejudices and controversies over technical details prevail even among experts. Also, the number of UDDTs realized so far is still small and often only in isolated, heavily-subsidized pilot projects. Therefore, we wanted to analyze in a "neutral" way the status quo and the required

directions for up-scaling of UDDTs.

A critical point for up-scaling of UDDTs is how to offer sustainable service models for their management, particularly in urban areas. What we need now is a broad acceptance of UDDT technology, mainly at the political and institutional levels (we all know stories of mayors promising flush toilets and sewers for all, even if it makes no sense for financial and technical reasons!). The decision for or against UDDTs in a specific area, and the organization of suitable management and emptying services, should no longer be seen as the responsibility of households or NGOs, but needs to be organized and supervised by the local government authorities. It is critical that service providers begin to include 'dry excreta management' options in their list of services, including the supply of cover material, removal and sanitization of excreta, and the sale of fertilizers from post-treatment procedures.

Another challenge is to make use and maintenance of UDDTs simpler and thus more acceptable. The difficulty of adjusting toilet habits should not be underestimated, and may be best approached with intuitive toilet designs and comprehensive user training.

Dense urban areas present a number of impediments for UDDT construction, including limited space and unclear land ownership. Consequently, UDDTs with single vaults and interchangeable containers, or even mobile UD solutions, may be better options and subsidies may be required.

Questions to the Water Sector Reform Programme Sanitation Team Nairobi-Kenya

How did you hear about this document?

We got information about the book form our GIZ colleagues based at GIZ head office in Germany.

Which parts of it did you find most useful?

The whole book is very useful. We found chapters 3) Design of the urine diversion toilet seat, squatting pan, urinal and the toilet cubicle 4)Faeces vault design and function 5)Urine collection system design and function 6) Additional design considerations and 7) Disposal, treatment and reuse of faecal matter and urine very useful in our work since we were designing UDDTs for urban low income areas of Kenya.

If you could give any advice for a future edition, what would it be?

The Use of UDDT in Urban low income areas should be more elaborated especially with regard to best practices in sludge reuse /disposal. Knowledge and good practices applied on large scale still missing worldwide.

Should the authors have put more attention on certain issues?

The books document the UDDT very well. The use of UDDT in dense urban areas needs more attention and more successful best examples done on a large scale. This may be tailored to meet the demands for different regions since the dense urban areas vary from region to region (Africa, Asia and South America). The spatial setup varies also within a country.

Who in your opinion should read this document?

This document has very important information on UDDT. All those stakeholders involved in improving rural and urban sanitation should read it. This includes relevant government departments, NGOs, Water Services Regulatory Authority, Water Services Trust Fund, and National Environmental Authority.

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On behalf of

BMZ Federal Ministry for Economic Cooperation and Development

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