Sustainable Sanitation

Practice

EcoSan Club

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- Simple UDDTs from recycled materials
- Innovative UDDT designs
- Experiences UDDTs in EECCA countries
- Elegant yet Economical UDDTs in Ecuador
- Technology review „Composting Toilets“

Toilets

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Sustainable Sanitation Practice (SSP) aims to make available high quality information on practical experiences with sustainable sanitation systems. For SSP a sanitation system is sustainable when it is not only economically viable, socially acceptable and technically and institutionally appropriate, but it should also protect the environment and the natural resources. SSP is therefore fully in line with SuSanA, the Sustainable Sanitation Alliance (www.susana.org). • SSP targets people that are interested in sustainable sanitation systems and the practical approach to it. • Articles are published after blind review only. • Sustainable Sanitation Practice is published quarterly. It is available for free on www.ecosan.at/ssp.

Sustainable Sanitation Practice (SSP) hat zum Ziel praxisrelevante Information in hoher Qualität im Zusammenhang mit „sustainable sanitation" bereit zu stellen. „sustainable" also nachhaltig ist ein Sanitärsystem für SSP wenn es wirtschaftlich machbar, soziokulturell akzeptiert, technisch als auch institutionell angemessen ist und die Umwelt und deren Ressourcen schützt. Diese Ansicht harmoniert mit SuSanA, the Sustainable Sanitation Alliance (www.susana.org). • SSP richtet sich an Personen, die sich für die praktische Umsetzung von „sustainable sanitation" interessieren. • Artikel werden nur nach einer Begutachtung veröffentlicht. • Sustainable Sanitation Practice erschient vierteljährlich, kostenlos unter: www.ecosan.at/ssp.

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Medieninhaber: EcoSan Club, Schopenhauerstr. 15/8, A-1180 Vienna, Austria • Obmann: Günter Langergraber • Gegenstand des Vereins: Der EcoSan Club wurde 2002 als gemeinnütziger Verein von einer Gruppe von Personen gegründet, die in Forschung, Entwicklung, Planung und Beratung in der Siedlungshygiene - Sammlung, Behandlung oder Beseitigung flüssiger und fester Abfälle aus Siedlungen - tätig waren und sind. Das Ziel des EcoSan Clubs ist die Umsetzung kreislauforientierter Siedlungshygienekonzepte (EcoSan Konzepte) zu fördern, um einen Beitrag zum Schutz der Umwelt zu leisten.

Editorial

The first part of a sanitation system is the „user interface“, i.e. the toilet, pedestal, pan or urinal. It is an important part of the sanitation system because this is the part the user comes in contact with. Acceptance of a sanitation system therefore often mainly depends on the acceptance of the user interface.

With issue 6 of Sustainable Sanitation Practice (SSP) on „Toilets“ we wanted to give an overview on developments of different technologies for user interfaces. However, only contributions on Urine-diverting Dry Toilets (UDDTs) and urinals could be collected. The contributions present developments in different geographical regions: South America, East Africa and the Eastern Europe, the Caucasus and Central Asia (EECCA) countries. To imply another toilet technology, an abstract about a recently published technology review on compost toilets has been included.

The thematic topics of the next issues are „Planning Tools“ (issue 7, April 2011) and „Solutions in mountain regions“ (issue 8, July 2011). Information on further issues planned is available from the journal homepage (www.ecosan.at/ssp). We would like to encourage readers and potential contributors for further issues to suggest the topics from this list of highest interest (as well as other topics) to the SSP editorial office (ssp@ecosan.at). Also, we would like to invite you to contact the editorial office if you have suggestions for additional topics and volunteer to act as a reviewer for the journal. SSP is available online from the journal homepage at the EcoSan Club website (www.ecosan.at/SSP) for free. We do hope that SSP will be frequently downloaded and further distributed to interested people.

To reach a wider audience we also set up the facebook sites www.facebook.com/SustainableSanitationPractice and www.facebook.com/EcoSanClubAustria. Feel free to invite your friends who might find our work interesting!

With best regards,
Günter Langergraber, Markus Lechner, Elke Müllegger
EcoSan Club Austria (www.ecosan.at/ssp)

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Simple urine-diverting dry toilets built with recycled or readily available materials

This paper describes how UDDTs can be made very economically, using easily accessible things, like plastic bottles, sacks, buckets, and planks

Author: Christopher Canaday

Abstract

Three different models of simple and inexpensive Urine-diverting Dry Toilets (UDDTs) are described: a portable one for squatting made from a barrel, another portable one made from wood and linoleum, and a permanent one for squatting made with palm wood. A simple, portable urinal made from two plastic bottles is also described. These can be made at very low cost, with abundant natural materials, salvaged post-consumer waste, and items that are readily purchased almost anywhere. They may be especially applicable in poor communities, slums, farms, disaster relief camps, and temporary events, plus they may be used to train and screen users before building more elegant UDDTs. With these designs, conversion to UDDTs may be more a matter of paradigm shift than capital investment..

Introduction

Diseases transmitted via faeces, including diarrhea, hepatitis, typhoid, and intestinal worms, constitute one of the biggest threats to human health (Conant and Fadem 2008). Especially vulnerable are the people who live in large agglomerations under unsanitary conditions. In Developing Countries, most wastewater goes straight into the environment without treatment and many people do not even have access to the piped water needed to make such wastewater, so the fecal contamination of their environment is even more direct. Globally, an estimated 40% of people live without basic sanitation (UN-Habitat, 2003).

Urine-diverting Dry Toilets (UDDTs) have much to contribute in improving this situation, especially if they are:

- Very low in cost
- Easily made from abundantly available (often recycled) materials
- (in some cases) Portable

The UDDT is one technechnology often used in Ecological Sanitation (EcoSan), a concept in which excrement can be used as a resource for improving the soil, while applying natural processes to control the potential transmission of diseases (Winblad et al. 2004, Esrey et al. 1998). One of the least logical aspects of modern life is that of taking and purifying huge amounts of water, defecating in a large proportion of it, spending great sums of money to then try to purify it again, but never returning the nutrients to farmland, thus depending more and more on chemical fertilizers that are made and transported with non-renewable fossil fuels. To make things worse, pathogens develop resistance to the chemicals used to treat sewage and substances like antibiotics and artificial hormones cannot reliably be removed or degraded. These are the results of an irrational fear of our own excrement that leads us to do irrational things with it. In contrast, EcoSan is a way to control the real risks involved, and make our excrement safe to be added to the soil. In the case of water, everyone wants it clean, so it is best to simply not contaminate it with excrement.

The goal of this paper is to show that conversion to using UDDTs can be more a matter of shifting paradigms than capital investment. People can learn the concept and apply it on their own, with materials that they already have access to.

Key factors:

- Urine may be diverted with standard plastic funnels or with ones cut from plastic bottles
- Urine may be stored in bottles for later use as fertilizer or it can be dispersed immediately via perforated hoses (at least in the Amazon)
- Faeces may be collected in sacks or buckets

The simple, and economical models presented here may have wide application in:

- Poor communities, including slums (especially those applying Community-led Total Sanitation, CLTS)
- Farms
- Disaster relief camps
- Temporary agglomerations of people from any economic strata (e.g., fairs, conferences, summer camps, sporting events)

They could also be provided temporarily to families scheduled to receive more permanent and elegant UDDTs, as a means of educating and screening them to make sure that they understand the concept and will use the toilets properly, before building them, thus greatly reducing the number of units that are later abandoned or misused.

Technical Principles of the UDDT (Winblad et al. 2004)

- Urine and faeces are kept separate to reduce smell and to facilitate appropriate management of each.
- Urine is normally sterile and, even when not, transmits no diseases if dispersed on the soil (my conclusion). It is also a nitrogen-rich fertilizer for plants. (If there is concern for possible fecal contamination of the urine, it may be stored for a number of months before use.)
- Faeces transmit numerous diseases and therefore should be contained for treatment, which consists of being covered with a dry absorbent material and stored long enough for disease organisms to die of desiccation and destruction by soil organisms (or they can be composted). Afterward, the decomposed faeces may be used to enrich the soil or to cover freshly deposited faeces in the UDDT.
- In order to keep the fecal chambers dry, they are usually established aboveground, unless the soil is dry and absorbent.
- Ventilation may be arranged to take any minor odors away from the users.

Urine Management

Urine is kept separate via a strategically placed funnel toward the front, while the faeces are collected simultaneously farther back. The plugging of urine hoses with refuse or cover material may be prevented via placement of plastic meshes.

Urine may be managed in two different ways. The first (and most conventional) way is to store it in plastic bottles (e.g., 4 to 20 litres) and carry it to agricultural fields, where it may be applied pure, diluted with water, or mixed with other elements, according to what is best for the particular species of plant, given local climatic conditions. The second way is to have it drain immediately to the agricultural soil, or among fruit trees, via perforated hoses, especially in wet, tropical climates, where abundant rainfall helps to disperse the urine, avoiding excess dosage for any individual plant. This is a very convenient option in many cases, as the urine goes to the plants without anyone having to deal with it and this occurs before it has time to ferment and produce bad odors. Many EcoSan practitioners state that this is not feasible due to a precipitate (Struvite) that plugs the holes, but the author has done this in the Amazon for 10 years and the holes do not get plugged. This may be due to the greater biodiversity found here, as tiny innocuous black ants are often seen running along the hose and presumably eat the precipitate before it accumulates. It may also be a matter of soil microbes. Wild animals sometimes chew holes into the hose to consume the urine; this may be avoided by covering the hose with sand, gravel, sawdust, or other similar material. One convenient way to perforate the hose is to insert pieces of plastic lollipop sticks (from candies, inner diameter roughly 2 mm) into holes punctured with sharp tools, every 50 cm, preferably spiraling around the hose.

Especially at high-use toilets, it is convenient to place an upside-down 3-litre disposable PET-plastic beverage bottle, with the beginning of the hose glued into its mouth and the pipe from the toilet fitting into a hole cut into its side. This allows urine to flow quickly from the toilet and then slowly, if necessary, into the perforated hose.

Faeces Management

The faeces are kept dry and are covered with a cup of dry material after each use, to get them out of sight, to control odors, to keep flies away, and to dehydrate them. The best dry material is wood ash, since it is very absorbent and alkaline. Other acceptable materials include sawdust, rice hulls, leaves, and soil, all of which must be as dry as possible and may be mixed or used alternately. Mineral lime (calcium carbonate) is sometimes used as a cover material, but is more expensive and causes more environmental impact through its extraction and transport.

Faeces may be stored in:

- buckets;
- standard, woven, polypropylene sacks (as used to transport grains, fertilizer, etc.); or
- (if the site has dry, absorbent soil) one-metre-deep holes in the ground where trees may later be planted (see the “ArborLoo” in Morgan 2007).

These receive a layer of dry material before use, to absorb liquids and reduce potential for odors. Faeces may also be deposited in two, alternating chambers, but that involves more investment.

Advantages of sacks include evaporation of water outward through the cloth and infiltration of oxygen, in addition to their extreme low cost and accessibility. Another advantage of sacks and other interchangeable containers is that when there is a problem with flies or smell (due to insufficient or improper cover material), they can be closed and replaced, thus immediately resolving the problem.

Figure 1: Simple, portable UDDT made from a discarded plastic barrel, a bucket, and two plastic bottles. Note the marks for placement of the feet.

Experience has shown no problems in storing faeces in sacks, after initial collection in buckets or via direct deposit into the sacks. One may imagine that some animal would break the sack to get to the contents, but this has not occurred. In the odd event that moisture appears on the outside of the sack, ashes may be applied to it. Ultra-violet radiation deteriorates their plastic fibers, so sacks should not be kept in direct sun, in addition to being protected from the rain.

These different strategies may also be combined. For example, a toilet could function with a bucket, which when full is emptied into a sack, which when full is emptied into a hole for planting a tree. Once built, the portable UDDT may be used with any of the three options.

Toilet paper may be processed together with the faeces, as it helps to absorb excess moisture. Leaves or other organic materials used for wiping may also be put together with the faeces. If water is used for cleansing, separate arrangements should be made for dealing with the contaminated water, which would be easiest in the Palm Wood UDDT for Squatting (c, below), and this water should go to a Constructed Wetland or be dispersed below the surface of the soil.

Four Practical Examples

The following examples comprise three of simple UDDTs, plus a urinal to reduce demand for the toilets. The elements used in each may be recombined as desired.

a) Barrel UDDT for Squatting

Materials:

- Half of a discarded 208-litre plastic barrel
- 20-litre plastic bucket
- Two 4-litre plastic bottles
- Tape, string and/or wire

The half barrel is cut at a height such that the 20-litre bucket (usually 39 cm high) can stand precisely inside it, optimally providing support to this end of the barrel, which will now becomes the floor of the toilet. An 18-cm-wide drop hole is cut across the entire end of the barrel (Figure 1). Although not normally necessary, it may be made more stable by driving a few stakes or nails around its base.

The bucket is placed on the ground, the cut barrel is placed over it, a Portable Urinal made from two plastic bottles (see d) is put in place, and the toilet is ready for use. The urinal is lifted out, emptied on agricultural soil, rinsed with water, and is ready to be used again. When the bucket is full, the cut barrel is lifted off for it to be changed or emptied.

If buckets are not available, one may use sacks held in place with four stakes driven into the ground, or by being tied to four holes made in the platform.

Advantages of this design include: it may be made in advance of events or emergencies; it is lightweight and robust for transport; it may be used immediately upon arrival; and surfaces are easy to clean and not susceptible to deterioration.

b) Wooden Box UDDT for Sitting

Materials:

- Several wooden planks
- Piece of wood 5 x 5 x 240 cm
- Linoleum, 1 m2
- 2” nails
- Upholstery tacks for linoleum
- 4-litre plastic bottle
- Plastic mesh
- Nylon fishing line, 30 cm
- 1-inch hose for electrical conduits, 1 m
- ½-inch hose for electrical conduits, 15 m
- 20-litre bucket
- Plastic toilet seat

The box is constructed 60 cm high x 60 cm long x 50 cm wide, with the 5 x 5 cm pieces of wood only in the four vertical corners. The top, made with two lengthwise planks, is nailed last, after cutting a pentagonal hole into it. The pentagon is drawn as large as possible within the inside and outside edges of the toilet seat that were traced onto the planks. The thin front edge of the pentagon is most conveniently cut from a separate piece of wood 5 cm wide, thus facilitating the sawing of the rest of the pentagon. This shape allows for a large hole which is unlikely to get soiled, and for folding the cut linoleum inside where it is tacked. Small pieces of linoleum, the width equal to the thickness of the planks, are placed at each of the five corners, under the main piece of linoleum, so that no wood shows at all. If linoleum is not available, or is too expensive, a thick sheet of plastic may be used, especially those with colorful designs sold for use on dining room tables.

The planks of three sides should optimally reach all the way to the ground; if not, the gap may be covered with plastic mesh to keep flies and other creatures out. The back side is left open, for taking the bucket out and for ventilation, and is also covered with a plastic mesh, which may be firmly nailed down on the one side and pushed over several nails with small heads on the other side. On the other hand, if a vent pipe is used, the box should be as air-tight as possible, so that all draft generated only pulls air into the seat hole.

A step is made about 36 cm down from the top, for the user's feet to be in a comfortable position. The height of this step may be adjusted to the average size of the users. Small children should be instructed to sit as far back as possible, so that their faeces do not fall in the urine funnel. As compared to a flush toilet, this design is safer and more comfortable for children and handicapped persons to use, since they may support and position themselves with their hands on the bench surface, which is absent from the flush toilet.

The wood may be treated with used motor oil, to act as a preservative, before the linoleum is put on. Everything is a resource when in the right place and the contaminants in used motor oil prevent insects, fungus and bacteria from attacking the wood, thus helping it last longer and reducing deforestation. This also allows for more effective use of the weaker wood from fast-growing species of trees. (Motor oil does not affect linoleum.)

The funnel is made from an empty four-litre plastic bottle (29 cm high, 15 cm diameter), cut diagonally through its cylindrical part (Figure 2). Plastic mesh is cut into an oval that fits into the "mouth" of the funnel, and is sewn onto it on the lower half of its "lip" with fishing line, every 1.5 cm, 5 mm below the edge, going in and out (not around the "lip"). The purpose of the mesh is exclude debris (e.g., toilet paper, sawdust), while allowing urine to pass without splashing. If the mesh is woven or knitted, its edge should be melted, passing it by a candle flame, before being sewn, to prevent it from coming apart. A portion of the urine flows down the mesh, tending to keep it relatively clean. Surprisingly, the droplets of urine held in the mesh do not produce noticeable bad odor, possibly because they have so much air around them. The mesh also deters the escape of any minor odors that may be present farther inside.

The funnel is held in place, just under the drop hole, by a string tied to one nail, passed through the handle of the bottle, and with a loop tied at the other end to be put around a second nail (Figure 3). The connection to the one-inch hose, which is permanently attached to a block of wood nailed inside the box to hold it in just below the spout of the funnel, is made with a simple sheet of plastic wrapped around and tied to the spout, then inserted several centimetres into the hose. In this way, the funnel may be easily removed for cleaning, repairs, or replacement.

This toilet could also be made with a cut-off, discarded plastic barrel, instead of the wooden box (as in a, above).

This model is a variation of one the author developed for a portable tourist camp in Brazil. Due to space limitations, it did not have the step and the buckets used were shorter. Also, a 16-cm-diameter chimney was

Figure 2: UDDT made with wooden planks and covered with linoleum, showing juxtaposition of urine-diverting funnel and faeces-collecting bucket. (Planks were later nailed vertically on all three sides of the step, to keep the whole box from tipping when stepping on it.)

Figure 3: View inside the toilet, showing solidly fixed 1" black hose and easily removable white funnel

put just behind the seat and went to above the roof of the tent where the tourists also sleep. There have been no problems with odors, as long as sufficient wood ash is available.

c) Palm Wood UDDT for Squatting

Materials:

- 1 palm stem
- 1 funnel, 18 or 25 cm diameter
- 15 m, ½" plastic hose for electrical conduits
- 5 m, wire
- 1 m, thin rope
- 6 poles, 4 m long
- Greenhouse plastic for roof, 4 x 3 m
- Privacy walls, as desired, possibly palm leaves

This model was designed to be simple, fast, and efficient, while minimizing the need for manufactured materials. It may be built by three people in one day.

The structure was built with a stem of Peach Palm (Bactris gasipaes), a tree cultivated for its nutritious fruit, which is difficult to harvest when the tree grows too tall, at which point the wood is very strong. It also provides one of the best "palm hearts" for eating. The first 3 metres from the bottom of the stem were cut and split into four pieces to make the posts. A platform was made 60 cm above the ground, using similar quarter-stem sections as rafters, tied with wire, on edge, in notches (cut into the posts with a saw and then knocked out with a hammer). The floor of the platform was made with eight similar quarter-stem sections of palm wood, although in this case from a stronger wild species, Chonta Pambil (Iriartea deltoidea, which also happens to be the most common species of tree in the Amazon). Half-stem sections of Peach Palm would have also worked very well. The floor measured roughly 130 x 130 cm, with a 15 cm gap in the middle to allow for use as a toilet. (This is normally 18 cm wide, but with the round poles it needed to be a bit narrower.) If preferred, sawed timber and planks could be used, covered with plastic or linoleum. Palm wood is fairly hard and smooth on its own.

At the center of this gap in the floor, the funnel is attached toward the front and the sack is attached toward the back. Attachment of the funnel is very simple: a thin rope is tied into a loop with a diameter to match that of the "throat" of the funnel (where the conical "mouth" joins the narrow spout) and then the rope is tied tightly around the two adjacent pieces of palm wood. With the loop on top, the tip of the funnel simply passes through the loop and is inserted into the perforated half-inch hose. Where this hose leaves the structure, it is tied firmly to a stake driven into the ground at the right place to maintain proper orientation of the mouth of the funnel. A small piece of plastic mesh is folded and inserted into the "throat" of the funnel to prevent entre of debris.

The edge of the sack is rolled down to adjust to the height of the platform and is wired or tied temporarily to four nails driven into the underside of the adjacent pieces of palm wood. If sacks are not available, baskets may be woven and lined with palm leaves.

Figure 4: Squatting model UDDT made of palm wood, a funnel and a sack. Privacy walls were added later. Larger funnels may also be preferred

If desired, plastic bottles may be cut to replace the factory-made funnel. Also, urine may be stored in bottles to be carried to agricultural fields.

d) Portable Urinal using 2 Plastic Bottles

Materials:

- 2 plastic 4-litre bottles
- Adhesive tape
- Plastic string and/or wire

Figure 5: Two positions for women to use this Portable Urinal. (Photos taken with the subject's knowledge and permission.)

This simple though useful implement is made with two plastic bottles, joined together at their mouths (Figure 5). The upper one is cut to serve as a funnel to catch the urine, while the lower one serves to store the urine. Very little odor is generated, as it must leave via the narrow mouth and air movement across that mouth is largely blocked by the upper bottle. As soon as is convenient, the urine is dispersed on agricultural soil as fertilizer. The urinal is then rinsed with water and is ready to be used again. In dry places, it is important to dilute the urine with water (which may be greywater), at a proportion of at least 3:1, water:urine, thus more water than urine.

The urinal is made in the following steps:

i. Carefully mark and cut one of the bottles diagonally through its cylindrical part, starting near the handle (see Figure 3).

ii. Connect the joined spouts of the two bottles with strong adhesive tape (e.g., duct tape). The top bottle may also be selected such that its mouth fits snugly into the mouth of the bottom bottle.

iii. Tie a loop of strong string between the handles of the two bottles, loose enough that it may be flattened against their mouths during the next step.

iv. Firmly affix the two bottles together with wire or string, tying tightly at the base of the threads shaped for screwing on the lid, strongly enough to withstand 4 kg.

v. Especially if wire was used, cover once again with tape.

vi. Wrap the entire connection in plastic string or fibers, for aesthetics and to prevent loosening of tape through exposure to water and urine.

A man may use it standing with the urinal held in the hand or set upon a platform that puts it at the proper height. A woman may conveniently use it in either a squatting or a semi-standing position (Figure 5). It is then set upright on the floor to await the moment to be emptied. There need not be any direct contact between the user's genitals and the urinal.

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Innovative urine diverting dry toilet (UDDT) designs from East Africa

This paper presents different UDDT designs from East Africa, which are responding to their users´ preferences and needs.

Author: Elke Müllegger

Abstract

Toilets are commonly not viewed as being attractive or interesting. They are normally designed only to serve a certain purpose - a function called excreta management, which is already unattractive by itself. In combination with the need to develop low-cost solutions, design is often neglected. In East-Africa urine diverting dry toilets (UDDTs) are constructed since almost 15 years. But still most of the UDDTs have a similar design with very view adaptations. The paper presents different designs of UDDTs which are based on experiences from more than 10 years of sanitation system planning in the region.

Introduction

Planning in sanitation was and still lies mainly in the hands of technicians. Solid and liquid waste management, treatment and disposal are solved purely on a technical basis, neglecting the fact that sanitation is more than just a technical problem (Müllegger and Lechner, 2005). However, during the last years sanitation marketing has become a keyword which captures the sanitation sector. The WSP Field Note "The case for marketing sanitation" even states that "development of the sanitation market is the only sustainable approach to meeting the need for sanitation in the developing world. […] Marketing has been more successful than anything else in changing the behaviour of people when they can see direct personal benefits." (WSP, 2004) Choosing a (social) marketing approach means that the attractiveness of the product is one important factor among others. Consequently toilet designs must respond to what people want, rather than what sanitary engineers believe they should have (WSP, 2004). A range of different products are needed to suit a variety of pockets and circumstances. Hence it is important to keep toilets affordable and that the market offers a range of products with various price tags.

Garduños (2005) gained experiences how important design and affordability is in Mexico and assumed that "it seems that the paradigm is changing, as owning a WC is no longer a status symbol. The reference point now is simply a dignified and efficient sanitation system, and the dry toilets seem to fully satisfy those expectations." Based on that, Garduño has developed a variety of innovative sanitation solutions, which are architecturally designed and developed with community involvement.

The following examples are all based (1) on a constant adaptation of toilet designs over the last 10 years and (2) on a participatory planning approach, meaning that the users were included in system development right from the beginning and they decided how the particular toilet shall look like.

1. UDDTs with underground chambers: Most UDDTs are constructed above the ground with steep stairs to enter the toilet. Where soil conditions allow, the substructure can also be constructed into the ground, providing a comfortable design especially for handicapped or elderly. Kitgum Town Council in Uganda decided to construct a barrier free toilet for their staff.
2. Indoor UDDTs: Flush toilets are commonly the only sanitation facilities which are constructed indoor. Two examples from Uganda show that UDDTs can also be integrated into a house, aiming to increase the users´ comfort.

Key Messages:

Choosing a (social) marketing approach shows that attractiveness of the product and the appropriate price is the key. Consequently:

- toilet design must respond to what people want,
- toilet design has to be attractive, and
- toilets have to be affordable.

3. UDDTs attached to the house: Integrating UDDTs into a closed compound maybe a comfortable solution for row houses as described in an example from Uganda.
4. Combination of toilet and bathroom: Users often prefer the combination of bathroom and toilet. An example from Nakuru (Kenya) illustrates how a sanitation facility with UDDT and bathroom for a private household can look like.
5. Waterless urinals for women and urinals for children: Female urinals are not a new invention but rarely constructed in practice. In Nakuru three waterless female urinals were put up for school girls and evaluated very positively by the users. Urinals for children were constructed for a nursery school in Nakuru (Kenya), which reduced misuse dramatically.

UDDTs with underground chambers

Location:	Kitgum Town Council (KTC), Kitgum, Uganda.
Planning institution:	ROSA project team Kitgum and EcoSan Club.
Timeframe:	In operation since 2009
Users:	Employees of KTC
Technological details:	The toilet block (Picture 1) consists of three individual UDDTs separated for men and women. The men toilet is additionally equipped with a waterless urinal to reduce misuse. The faecal collection chambers are constructed underground with sealed walls to prevent water entering. The faeces mixed with drying agent (ash) and cleansing material are collected in plastic containers, which allow a convenient removal of the material.
Further information:	Charles Omona, EcoSan Club Uganda (charles.omona@ecosan.at). Elisabeth Freiberger, EcoSan Club Austria (elisabeth.freiberger@ecosan.at).

Picture 1: UDDT with underground faecal collection chambers at KTC (Kitgum, Uganda).

Indoor UDDTs (1)

Location:	Office building, Arua, Uganda
Planning institution:	EcoSan Club
Timeframe:	In operation since 2006
Users:	Staff of office building
Technological details:	The UDDT (Picture 2) is constructed in an office building and used by women and men. It is additionally equipped with a waterless urinal. The user interface is a sitting toilet seat (Picture 3) which separates faeces and urine. A hand washing facility is additionally provided on the corridor in front of the toilet. The faecal matter, ash and cleansing material are collected in a plastic container and urine in a jerry can underneath the toilet. Emptying takes place from the backside of the building, by opening a small metal door which allows a convenient removal.
Further information:	Charles Omona, EcoSan Club Uganda (charles.omona@ecosan.at). Markus Lechner, EcoSan Club Austria (markus.lechner@ecosan.at).

Picture 2: Indoor UDDT for an office building (Arua, Uganda).

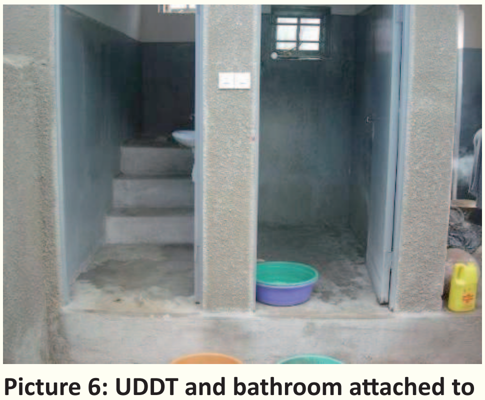
Picture 3: Sitting UDDT for an office building (Arua, Uganda).

Picture 4: Indoor UDDT for hospital staff (Kitgum, Uganda).

Indoor UDDTs (2)

Location:	St. Joseph Hospital, Kitgum, Uganda
Planning institution:	EcoSan Club
Timeframe:	In operation since 2008
Users:	Hospital staff
Technological details:	Four UDDTs have been constructed for hospital staff. The toilets are accessible from the corridor within the hospital building (Picture 4). They are squatting toilets and the facilities for men are additionally equipped with waterless urinals. Every toilet has a hand washing facility within the toilet cubicle, which is connected to a soak pit. Urine is collected in a jerry can and faecal matter (with ash and cleansing material) in plastic containers. The emptying takes place from outside the hospital building (Picture 5). Faeces are further treated at a central roofed composting area and the urine either used for composting or fertiliser in the hospital gardens.
Further information:	Charles Omona, EcoSan Club Uganda (charles.omona@ecosan.at). Elisabeth Freiberger, EcoSan Club Austria (elisabeth.freiberger@ecosan.at).

Picture 5: Emptying doors at the back of the building (Kitgum, Uganda).



Picture 6: UDDT and bathroom attached to a staff house (Naggalama, Uganda).

UDDTs attached to the house

Location:	St. Francis Naggalama Hospital, Naggalama, Uganda
Planning institution:	EcoSan Club
Timeframe:	In operation since 2004
Users:	One family with two children.
Technological details:	Row houses have been constructed for hospital staff in Naggalama in 2004. Each house has a small compound which is closed to the outside. To increase the comfort of the users a UDDT, a bathroom (Picture 6) and a kitchen have been constructed within each house. All three facilities are accessible from the compound, but are emptied from the backside of the house (Picture 7). Urine gets infiltrated via a soak pit into the ground. Faeces (with ash and cleansing material) are collected in wooden baskets and treated in a roofed composting area.
Further information:	Elke Müllegger, EcoSan Club Austria (elke.muellegger@ecosan.at).

Picture 7: UDDT from the backside of the house (Naggalama, Uganda).

Combination of toilet and bathroom

Location:	Private household, Nakuru, Kenya
Planning institution:	Egerton University / ROSA Project.
Timeframe:	In operation since 2002
Users:	One family
Technological details:	Mr. Kilonzo has constructed a UDDT within his private compound in Nakuru, mainly because of the rocky soil conditions which make digging nearly impossible. For his family's comfort he decided to attach a bathroom to the toilet block (Picture 8). The toilet (Picture 9) consists of a separate men and women toilet (the toilet for men equipped with a waterless urinal) and an additional bathroom. The water from the bathroom is infiltrated. Urine is collected in jerry cans and the faeces in plastic containers. For emptying he hires either a local service provider or he is using the material in his own garden, depending on his need for soil conditioner.
Further information:	Edward Muchiri, Egerton University (edmuchiri@yahoo.com).

Picture 8: Private UDDT with bathroom (Nakuru, Kenya).

Picture 9: UDDT for a private household (Nakuru, Kenya).

Urinals

Waterless urinals for girls (1)

Location:	Crater View Secondary School, Nakuru, Kenya.
Planning institution:	Egerton University / ROSA Project.
Timeframe:	In operation since 2009
Users:	About 120 school girls and 10 teachers.
Technological details:	The masonry toilet block (Picture 10) consists of 8 stances UDDTs with urinals for girls and boys, a urine storage tank, and roof water harvesting connected to hand washing facilities for a population of total 200 students. The girls section was provided with 5 cubicles (25 students per toilet), 4 female urinals (Picture 11) and a space for changing clothes. On the other side the boys were provided with 3 cubicles and 9 waterless urinals. The girls´ urinals are additionally provided with a waste bin for cleansing material and sanitary pads.
Further information:	Muchiri, E. W., Raude, J., Mutua, B. (2010). UDDTs and grey water treatment at Crater View Secondary School, Nakuru, Kenya - Draft. Case study of sustainable sanitation projects. SuSanA. http://www.susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=125

Picture 10: UDD toilet at Crater View Secondary School (Nakuru, Kenya).

Picture 11: Waterless urinals for girls at Crater View Secondary School (Nakuru, Kenya).

Waterless urinals for girls (1)

Location:	ROSA project office building, Arba Minch, Ethiopia.
Planning institution:	ROSA project team Arba Minch.
Timeframe:	In operation since 2008
Users:	Employees of the ROSA project and visitors.
Technological details:	The Ecolily (Picture 12 is a very simple technology and consists of three locally available parts: a funnel with a pulp and a 20 litre jerry can. The pulp prevents that urine is getting in contact with air and avoids the development of odour.
Further information:	Shewa, W.A., Teklemariam, A., Meinzinger, F., Langergraber, G. (2009): Resource-oriented toilets - a sustainable sanitation option adopted in Arba Minch, Ethiopia. 34th WEDC International Conference "Water, Sanitation and Hygiene: Sustainable Development and Multisectoral Approaches", Addis Ababa, Ethiopia, 2009. http://rosa.boku.ac.at/images/stories/Public%20Docs/34th_wedc_2009_ayele_shewa_et_al_2.pdf

Picture 12: Ecolily – a female urinal (Arba Minch, Ethiopia).

Waterless urinals for boys

Location:	House of fire ministry church and nursery school, Nakuru, Kenya.
Planning institution:	Egerton University / Rosa Project.
Timeframe:	In operation since 2008
Users:	The church congregation of about 50 members and 25 nursery school children between 3 – 7 years.
Technological details:	This masonry toilet block (Picture 13) consists of two single vault UDDTs, one double vault UDDT and male urinals for a population of 50 church members and 25 children. The men's section consists of one single vault UDDT and a urinal cubicle with five waterless urinals (Picture 14). Two of the urinal bowls are standard ceramic urinal bowls while the other three are specially designed for children out of 5 litre plastic containers and fitted lower to the floor level (300 mm compared to standard level of 600 mm) to allow ease of use by the boys.
Further information:	Muchiri, E. W., Mutua, B. (2010). UDDTs at a church and nursery school Nakuru, Kenya-Draft. Case study of sustainable sanitation projects. http://www.susana.org/lang-en/case-studies?view=ccbktypeitem&type=2&id=127

Picture 13: UDDT at House of fire ministry church and nursery school (Nakuru, Kenya).

Picture 14: Waterless urinals for men and boys (Nakuru, Kenya).

Conclusion

Far more attention needs to be given to the design of a sanitation system, in order to offer practical, user-friendly and aesthetically pleasing designs which can be adapted according to the economic and socio-cultural situation. Our experiences over the last years have shown that acceptance of (urine diverting dry) toilets increases if the facilities are also attractive and not only functional.

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Overall Project:

WECF

Experiences with urine diverting dry toilets (UDDTs) for households, schools and kindergarten in Eastern Europe, the Caucasus and Central Asia (EECCA)

This paper summarizes the experiences of WECF and partners from implementing UDDTs for individual households and in schools.

Authors: Claudia Wendland, Stefan Deegener, Fedde Jorritsma

Abstract

This paper presents experiences with the implementation of urine diverting dry toilets (UDDTs) in the EECCA countries. In total 960 individual, 50 school and kindergarten and 7 public UDDTs have been implemented. A huge variety of different designs and materials of the sanitation facilities was applied by the WECF network partners. Experience based indications are given related to the success factors for acceptance of the individual toilets and for school sanitation projects.

Introduction

Women in Europe for a Common Future (WECF) has its roots in the 1992 Earth Summit of Rio de Janeiro. WECF was officially registered in 1994 as a foundation in the Netherlands following an initiative of European women to work together on sustainable development. WECF is now an international network of over 100 women's, environmental and health organizations implementing projects in more than 40 countries and advocating globally for a healthy environment for all. WECF strives for balancing environment, health and economy taking into account the needs and perspectives of men and women.

WECF implements demonstration projects with local network partners that aim to develop and implement sustainable solutions to local problems in the areas of water and sanitation. Since 2003, WECF has implemented Urine Diverting Dry Toilets (UDDTs) (individual and public/schools) as sustainable sanitation solution in Central and Eastern Europe, the Caucasus and Central Asia (EECCA), specifically in Afghanistan, Armenia, Azerbaijan, Belarus, Bulgaria, Georgia, Kyrgyzstan, Kazakhstan, Moldova, Romania, Tajikistan, Ukraine and Uzbekistan. The UDD technology is especially suitable for areas without functioning water supply and wastewater and improves the hygienic and environmental conditions at once.

Individual UDDTs

Since 2003, WECF and its network partners have implemented 960 individual UDDTs in the EECCA region (Figure 1).

The construction of UDDTs started after initial training and awareness raising in the target area and with a hands-on

Key Messages:

- The urine diverting dry toilet (UDDT) is a sustainable sanitation option for households and schools in rural areas of the EECCA region where reliable water supply and wastewater management is missing. The successful introduction of such a new technology requires a change in behavior and must be accompanied with awareness raising ,training and motivated local partners.
- The main drivers for people to become a beneficiary for a UDD toilet were the dissatisfaction with the pit latrine, especially limited comfort and hygiene (cold, windy, smell and flies), the need to move the latrine frequently in areas with high groundwater tables and the interest to obtain cheap fertilizer (mainly among farming-orientated households).
- Decisive factors for the acceptance of UDDT were identified: smell prevention, own contribution in terms of finances and/or labor, involvement of women and men, groundwater level and distance to the house.
- In comparison to individual toilets, the introduction of the UDDT in schools is a particular challenge where a number of key factors in terms of software and hardware must be fulfilled.

workshop where the first demonstration toilet was built by WECF trainers. An important aspect is the adaption of the UDDT technology to local conditions (e.g. using locally available materials) and for demonstration. All partners developed criteria for the selection of beneficiaries, which differed somewhat per partner. Common criteria were the commitment to use the UDDT as meant, including proper cleaning and the sanitation products (urine and sanitized faeces) as fertilizer, the willingness to demonstrate their toilet to others and to lesser extend removal of the old pit latrine. Some partners included poverty as a criterion for beneficiary selection, but others choose to also build toilets for (relatively) better off families, including those of local leaders, to avoid UDDTs being seen as a solution just for the poor. Several partners gave preference to larger families, especially with several children, women and/or girls. Another common criterion was the absence of a proper existing toilet or the intention to build conventional toilets (i.e. whether a central sewage system and/or central water supply system (for flushing) was absent).

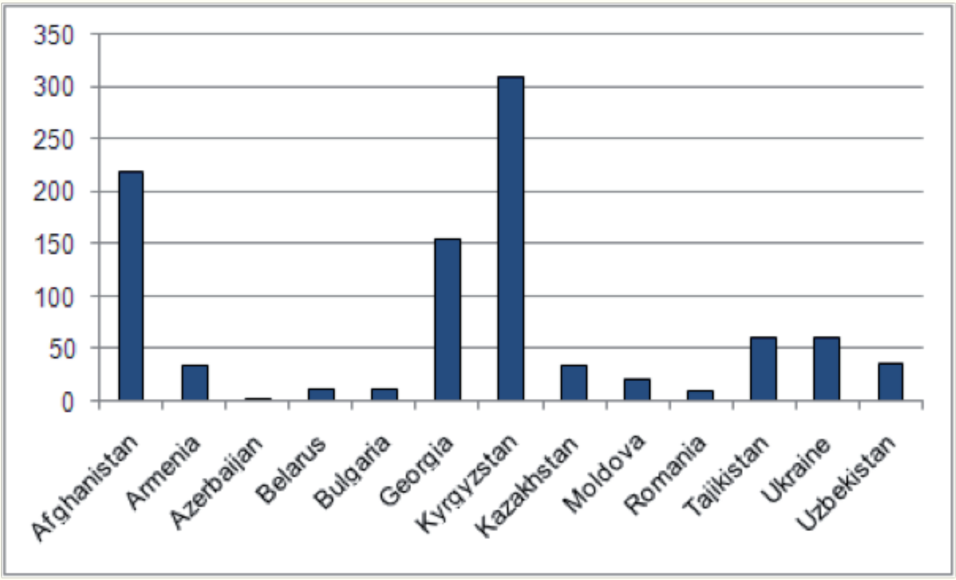

Figure 1: Number of individual toilets constructed by the WECF network in EECCA countries (2003-2010).

The main drivers for people to become a beneficiary for a UDDT were the following aspects:

- Dissatisfaction with the pit latrine, especially no comfort (cold, windy, smell and flies) and difficulties with cleaning
- In areas with high groundwater level, there is a lot of smell and the need to move the latrine frequently
- Interest to obtain cheap fertilizer such as urine (mainly among farmer-orientated households)

For the successful introduction of UDD technology and its sustainability, adequate training and awareness raising is crucial. That is why the implementation is always accompanied by hygiene training and workshops. In Central Asia WECF adopted the WHO tool “Participatory Hygiene and Sanitation Transformation” (PHAST) into one that is in line with resources-oriented sanitation: „Participatory Hygiene and Ecological Sanitation Transformation“ (PHAEST). This tool helps participants to analyse their hygiene behaviour, discuss safe and unsafe toilets and learn about pathogens in excreta. The use, cleaning and maintenance of UDDTs are discussed in a participatory way. This PHAEST tool was especially adopted in the Central Asian countries, but the above topics were included also in the training and awareness activities in the other countries. These training and awareness activities seem to have been well effective in the sense that they enabled the construction and (largely) proper use of UDDTs.

Only in Afghanistan the situation on the implementation of the UDDTs was different from the other countries and the local partner worked very independently based on its own experience with the local culture and background. That is why and due to the political situation this paper is basically about the experiences in the other countries where a closer monitoring was feasible.

Location, design and material of the toilets

Location

People in the rural areas of the EECCA country mostly have a toilet – commonly a pit latrine in their garden. Due to often unhygienic situations, smell and problems with flies, the location of the pit latrine is far from the house, sometimes close to the livestock. When introducing UDDTs people first are very skeptical about placing the toilet close to the house or even indoor because they cannot imagine that the technology is odor free and hygienic. To raise awareness about the advantages of the UDD technology, it is helpful to build first a demonstration toilet or to visit an existing functioning UDDT.

In general, the people in Eastern Europe and the Caucasus are more open to construct the toilets indoor while in Central Asia most toilets are constructed outdoor.

As the photos display, the realized toilet design and location were various. In the trainings, the principles of ecosan were explained in detail (2) and the partners were encouraged to make their own designs with locally available material. The local partners were often very creative.

Figure 2: Outdoor toilets

Figure 3: Toilets attached to the house

Figure 4: Indoor toilets

UDDT devices

The only specific device which is needed for the UDDT is the user-interface or urine diverting part of the toilet not available on the market in EECCA countries. In the Eastern European and Caucasus households, most people decided to implement a toilet for sitting which is considered as major advantage in terms of comfort compared to the pit latrine.

In order to start a local production in the countries, a mould made of fiber glas (ESAC, Cesar Anorve) was imported to produce toilet seats of concrete. With the mould, it is simple to produce good concrete seats which need to be painted afterwards in multiple layers, to obtain a long lasting and high quality finish. People like very much the option to have toilet seats in a selected colour, however the quality of paint influences the durability of the surface in the urine bowl. A very high quality seat can be produced with concrete, e.g. the Georgian NGO RCDA added ceramic powder which provides an excellent surface very close to ceramic. In Kyrgyzstan, the fiber-glass mould imported from Mexico

Figure 5: Different types of toilet model

was recently replicated for increasing the production. In Georgia, the factory production of ceramic UDDT interfaces was started in the frame of a WECF project. Another option is to use the ceramic dry toilet model which is available in most EECCA countries, so-called datcha model, and to insert a simple cut plastic bottle, a funnel or a plastic device for urine diversion, e.g. by the Swedish company Separett.

Some beneficiaries, especially in Central Asia, prefer to have a squatting toilet instead of a sitting model. Either they select the robust plastic slab produced large-scale in China which can easily be imported or they installed self-made versions with tiles or plastic funnels.

Toilet room

There is a wide variety of equipping the toilet room inside. Recommended was to install a hand wash basin inside which was not always followed as many people have their hand wash basin somewhere outside as they were used to have it outside. Also a urinal is recommended for the men, however often not used. There is some evidence that urinals are considered not to fit in Islamic cultures. The rest room can be very simple inside, the floor covered with local available floor cover, like linoleum or painted wood but many beneficiaries put tiles on the floor and decorated the room very nicely.

Urine collection

In individual toilets, the urine is usually collected in containers of 20 up to 50 liters volume next to the faecal chambers. The urine pipe is equipped just behind the toilet device with a smell stop (use of a condom). Typical problem of urine collection in these comparatively small canisters is that the containers are overflowing. Sometimes urine pipes are not implemented with a proper slope so that urine can stand in the pipe and starts to smell. This can also lead to freezing in winter and thus blocking of the pipe. Bigger containers are recommended for several reasons: reduced maintenance intervals, better frost-protection and storage during winter. The drawback of large volume containers compared to smaller sized canisters are higher costs, sometimes limited availability and the need of a pump for emptying.

Acceptance of the toilets

The decision to construct an UDDT also involved the willingness to invest time and money by the beneficiary. The projects provided only advice and guidance in the construction process and covered about 75% of the costs, in some cases less or even none at all.

Changing from one sanitation system to another involves a change in behaviour. This is a long process. There are a few examples of toilets that were initially not used because the family considered the toilet as “too beautiful” and instead used it as a showpiece for visitors. The old pit latrine continued to be the toilet used most. In one case, it took the owners about a year to gradually switch to using the UDDT until finally, when the old pit latrine was full, they decided not to move it to a new place and completely switched to using the UDDT.

The standard of cleanliness, however, is not always satisfactory. A main reason is a lacking habit of toilet cleaning as people hardly clean their pit latrines.

Figure 6: View into different toilet rooms

Concerning the location of the new toilet, sometimes the first beneficiaries in a village select the location for the ecosan toilet still quite far away from the house. When the people see during the project course that these toilets are indeed odor free and hygienic they build it more and more close to the house or attached to or even inside. Around 10% of all toilets in the WECF projects are installed inside the house. Some beneficiaries who had been skeptical in the beginning said that if they had known before that it is so comfortable they would have installed it indoor or attached.

WECF identified factors as being decisive for the acceptance of UDDTs. Major factors which are likely to play role for acceptance and non-acceptance of the new toilet:

1. Smell prevention: A crucial factor in user satisfaction is the absence of smell. This is maybe the most important advantage of the UDDT. In the cases where there was a smell problem, mainly coming from the urine either not properly cleaned, lack of smell stop or wrong slope in the pipe, it was the predominant reason for the non-acceptance of the toilet.
2. Involvement in construction: Households should significantly contribute both with labour and materials. If an external constructor was hired, there is not always the feeling of responsibility and ownership. The decision to construct a UDDT for the household should be taken by wife and husband together and both should take part in the trainings. In general it can be said that women focused more on hygiene aspects of the toilet while men paid more attention to technical aspects, and in some cases were especially focused on the reuse of nutrients. With the toilets fully in use and functioning properly, as a rule, men construct the toilets and/or repair them, while women clean them and make sure the family uses it properly. Anyway it was shown that the best acceptance was in cases where both man and woman were involved in decision-making and training.
3. Financial contribution: In all cases beneficiaries had a contribution to their UDDT ranging from 10-60% of the cost. In the cases where micro-credit was provided, beneficiaries reached a 100% contribution. An uncounted number of toilets were constructed in addition by interested people without any financial support from the project funds. It should be expected that the purely owner-funded toilets would be better accepted, due to the implied high levels of motivation. The chances for acceptance are indeed higher if the cost share of the owner is above 50%. But the distribution of costs between project funds and the owners has no automatic link to acceptance– some cases of initial non-acceptance were found among toilets funded completely by their owners. But in these cases the family switched to using the toilets after technical problems were solved.
4. Groundwater level: The groundwater level is considered to be high if it is less than 2 meters below the surface. At this height it can interfere with the pit latrine, causing a lot of smell. A high groundwater level also means that the pit latrine has to be moved often, because it is impossible to dig a deep pit. In some areas, where the groundwater level is only about 50 cm below the ground level in the irrigation season, this means moving the pit latrine every 3 months. Such conditions prompted a higher interest in constructing a UDDT. It is in line with these results that UDDT in areas with high groundwater levels faced no acceptance problems. The toilets which were or still are not being used are all in areas with low groundwater levels.
5. Distance: a toilet close to the home is considered as being part of the home and therefore maintained and used better. The comfort for the owners is much higher as well which is of particular importance for women, children and old people.

Although the re-use of the sanitation products is not a subject in this paper, a proper training on the safe handling and re-use of urine and treated faeces is obligatory for a high sustainability of the projects. Hands-on application training is necessary to demonstrate the application of the products. It was shown that theoretical workshops are not sufficient because the application of human excreta is completely new to most beneficiaries and stakeholders in the EECCA countries. Here the saying “seeing is believing” ,which is often used when smell free pilot UDD toilets are shown to stakeholders, is even more true. WECF also recommends the installation of demonstration gardens during these workshops to show the fertilizing effect of human excreta. They can be a real eye-opener and play a big role in convincing the people of the advantages of sustainable sanitation.

Figure 7: Agricultural workshop in Kyrgyzstan

School and kindergarten toilets

One of WECF´s key issues is the provision of sustainable school sanitation conditions because children are vulnerable and most affected by poor sanitation. In rural areas of the EECCA countries, the hygienic and sanitary conditions in schools are often terrible. Related diseases, particularly diarrhea and parasite infections hinder the children´s physical and intellectual development. In the WECF network, 50 toilets for schools and kindergarten and 7 public toilets have been built in the last years (Figure 8).

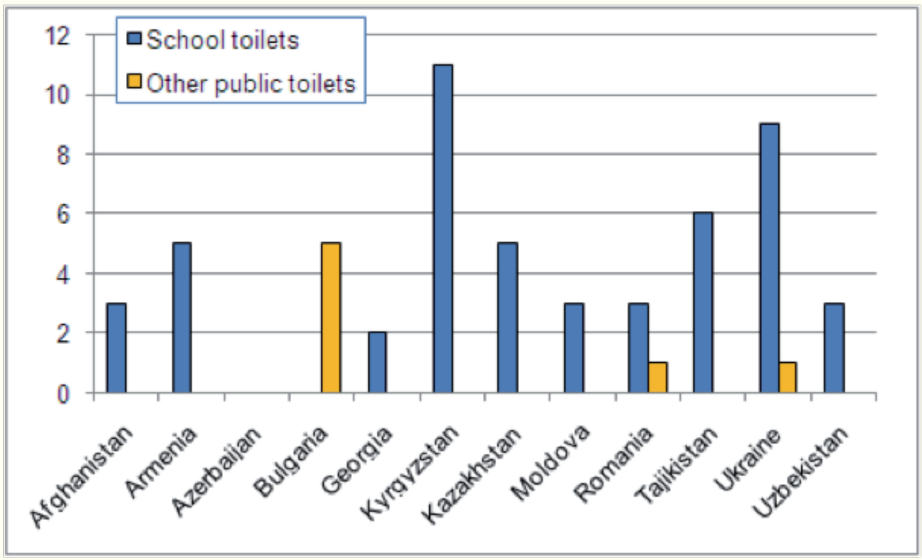

Figure 8: School, kindergarten and public toilets (2003-2010).

Location and design of school UDDTs

At the beginning of a school sanitation project is the selection of the school. WECF recommends to select a school which shows sincerely interest to build the school toilet inside as this is most convenient for the users:

- Convenient temperature, i.e. warmer in winter and colder in summer compared to a toilet in the yard. This is especially important for girls who are more prone to urinary infections (UTIs) exacerbated by cold temperatures.
- Keeping the toilet room cleaner and more hygienic is much easier if the children have not to cross the yard to access it.

A new school-building is the best opportunity to properly plan and design the infrastructure of the UDDT inside or attached. In most projects however the school building already exists and only the toilet facility is newly constructed. Then it is often possible to use intelligent planning or to retrofit a room that is not needed anymore such as a storage room. In other cases, it is possible to attach a new toilet building to the school and install a new door so that the children can directly enter into the new toilet. If there is no place available inside and no suitable place to attach the toilet, it should be implemented in the yard, as close to the exit of the school as possible to keep the distance short for the users. Hand wash facilities should optimally be installed in a separate room in front of the toilet rooms. Otherwise they should be as close to the toilets as possible. More detailed information about designs, no of rest rooms and other aspects can be found in (WECF, 2009b).


Figure 9: Boys´ urinals and rest room


Figure 10: Smell stop (condom) in a boys´ urinal

Sustainability of school UDDTs

It is a challenge to make a school UDD sanitation facility a sustainable success. Based on our experiences the key criteria that need to be considered are summarized in Table 1.

Compared to individual toilets, more effort is needed in terms of hardware. It is recommended to construct really robust and with good quality material to ensure long term operation without replacing spare parts too quickly. Also for school sanitation, the smell prevention is a key challenge - similar to individual toilets. In some cases where smell problems occurred the children were unsatisfied.

Concerning the software, to fix responsibilities from the beginning is crucial, often it is not clear that a school sanitation facility needs daily cleaning, requires the provision of material to cover the faecal matter and emptying the waste bins. Also the training for all groups– children, teachers, cleaning staff – which must take place at least every year for the new pupils again is crucial to ensure sustainability.

WECF is currently carrying out an “Assessment of Selected Health and Acceptance Aspects of UDDTs at Schools” based on a children´s questionnaires, focus group discussions and class book surveys to get a better overview and understanding of the real impact on the life and health of the children.

Table 1: Key criteria for sustainability and success of school sanitation

Hardware	Software
• Indoor if possible • Separate rooms for boys and girls with special facilities for girls during menstruation period (depends on culture) • Rest rooms that can be closed • Proper smell prevention • Hand wash basin and simple grey water treatment • Big urine tanks to guarantee a storage time of 6 months • High quality materials for long term sustainability • Make footprint near the squatting slab so children know where to stand.	• Get insight in school budget available for the toilet operation (for salary caretaker and equipment like toilet paper, soap etc) • Make a contract with the school in advance to fix responsibilities (especially staff for cleaning) • Talk to the related authorities (approval needed from different authorities - education, architectural, health, environment, emergency, utilities, fire, electricity) • Assure very strict control of proper usage in the first month of taking the toilet into use. The school might decide to to first educate elder classes. • Provision of hygiene education (e.g. PHAEST) • Regular training for the use, operation and maintenance of facilities for pupils, teachers and personnel • Training on re-use • Contract with farmer who is willing to use the urine and can arrange equipment for pumping the urine out and transport

Figure 11: Examples of school sanitation facilities

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Elegant yet economical urine-diverting dry toilets in Ecuador

This paper describes a recent project to build Urine-diverting Dry Toilets, with a new and efficient design, with a ferrocement bench made from readily available materials.

Authors: Charles Thibodeau and Christopher Canaday

Abstract

During the summer of 2010, six Urine-diverting Dry Toilets (UDDTs) were built for rural families in the Andes Mountains, in the county of Tisaleo, Tungurahua, Ecuador. These were built with a simple, innovative design that uses conventional, readily available materials, including ceramic tiles on the ferrocement benches and floors to improve aesthetics and ease of cleaning. Each family contributed US$ 80 toward the moderate total unit cost of US$ 390. Of the six toilets, five were built in 16 days (by two experienced masons), as opposed to the sixth toilet in eight days (by the user, a student volunteer and a UDDT consultant). It was learned that quality control must be constant; contribution from the users is crucial for project success; and education and follow-up are essential.

Introduction

The Urine-diverting Dry Toilets (UDDTs) are a very sustainable form of sanitation, as they avoids wasting and contaminating water, while returning nutrients safely to the soil. Urine, in particular, is very good fertilizer that generates high crop yields (Richert et al., 2010). Because of these benefits, many UDDTs have been built in diverse parts of the world in recent decades. In order to adapt to local contexts, many UDDT designs have been developed, which, in addition to adapting to different user preferences, also present trade-offs between cost and quality, while striving to stay within the budget, satisfy users' needs, and ensure successful long-term use. This paper presents a UDDT project that introduced a new technical design that seeks to efficiently balance these factors. The project's context, costs, timeline and results are also discussed.

Project implementation

Context

This project was the second phase of a broader project that aims to promote public health in the county of Tisaleo, province of Tungurahua, Ecuador. It was initiated by Ms. Kawshalya Pathiraja, a United States Peace Corps Volunteer, with the help of Peace Corps Ecuador and her counterpart organization, a non-governmental organization named Fundación Manos Unidas (FMU), based in Tisaleo. FMU supports local disabled children by providing them an education, some financial assistance and preparing them to live more independently as adults. FMU also contributes generally to children's health, maternal health, nutrition and family education.

After a few months surveying the communities' basic public health needs, a great demand for sanitation was identified and Ms. Pathiraja initiated a project to provide toilets to

Technical Data:

- The bench and floor are made of ferrocement, with ceramic tiles placed directly into the fresh concrete. The drop hole is 22 cm x 30 cm. Two small holes are kept open for attaching a standard plastic toilet seat.
- Urine is diverted via a funnel cut from a 4-liter plastic bottle, with a plastic mesh sewn in place to keep solids out. Urine is stored in 20 liter bottles, to later be transported to the fields.
- Feces fall into a rice sack and are covered manually with dry material. Full sacks are stored under the bench for at least 6 months to sanitize their contents.
- A PVC vent pipe (11 cm diameter) removes odors. The top of the pipe is cut at a steep angle (22 cm), to enlarge the exit hole area and so that most of the rain flows down the metallic fly screen to the outside of the pipe.
- Walls are made of concrete blocks and the roof is aluminum/zinc galvanized steel.

individual families. Survey results showed that the users desired toilets that 1) give privacy 2) avoid bad smells, 3) are easy to clean and maintain and 4) are aesthetic. She analyzed different options, taking into account the scarcity of sewer lines and the total absence of wastewater treatment, and arrived at the conclusion that the UDDT would be the best option under these conditions. She then learned, via Peace Corps, of the work of Canaday, a biologist and Ecological Sanitation promoter living in Ecuador, and asked him to help with the technical aspects. Together they presented this concept to potential users during community workshops, where people expressed considerable interest in the free, natural fertilizers that the system provides, in addition to sanitation and privacy.

In the first phase of the project, Ms. Pathiraja organized the building of toilets for seven families and one nursery school. The construction phase lasted over four months. They were all built in the county of Tisaleo. Sites range in elevation from roughly 3000 to 3400 m, with a warmer, drier climate at the lower sites and a colder, mistier climate higher up, although it is very cold at night at all sites. In addition to the actual construction, she held workshops about health, sanitation, and organic farming.

Thibodeau, a PhD student of sustainable sanitation in Canada, was interested in volunteering to build UDDTs in Ecuador and contacted Canaday (via the Ecosanres Yahoogroup), who suggested extending Pathiraja's project. Other residents of Tisaleo had mentioned interest, especially because they only had to pay 25% of the total cost, so a project was conceived to build six more UDDTs and to help teach the users about Ecological Sanitation.

Project description

New UDDT design

Canaday has been building UDDTs for over 10 years, mostly double-chambered models in the Amazon, which work well, but, in this warm, humid and biodiverse environment, users must be very orderly in covering the feces with dry material. In February 2009, two units were built in the Omaere Ethnobotanical Park in Puyo, Ecuador (http://www.fundacionomaere.org, also blog above) for use by visitors, volunteers, and staff. Use as a double-chambered UDDT was frustrating, as the feces form a mound and the new deposit would often roll off and not get covered properly. Also, many of the users did not follow the instructions, thus causing problems with odors and flies. He thought to place a woven polypropylene sack that would contain the feces and cover material, forming an orderly column, while still allowing for water to evaporate out and oxygen to filter in. This provides much more control, as the moment flies are seen to be emerging or there are bad odors, the sack may be changed, thus resolving the problem immediately. By using interchangeable sacks, the structure can also be much smaller and more cost-effective, even to the extreme that it is feasible to not build walls around these sacks (see Canaday, 2011). It also, thus, has an unlimited carrying capacity, as sacks may be stored elsewhere. Presumably, the only fecal pathogens that could actively go through the cloth of the sack would be hookworm larvae (Ancylostoma, Necator) and threadworms (Strongyloides stercoralis), but these only move through moist soil, not the dry cover material used in UDDTs, especially if wood ash is included. Rubber gloves may also be used while handling the bags.

Canaday has also built essentially the same model as in Tisaleo in community tourism projects in the Achuar village of Tiinkias (http://www.communityecotourism.com/tiinkias-ecotourism-center.html) and in the Yaku Kawsay Aquatic Animal Interpretation Center in Yasuní National Park (http://www.yakukawsay.org), where they have been functioning for 6 and 12 months, respectively, with no reported problems, in addition to the toilets in Omaere that have received fairly heavy traffic for the last 22 months with no problems beyond normal maintenance.

The Tisaleo UDDT is a single-vault model made of concrete blocks and a metallic roof (Figure 1). The toilet has two main functional sections: the upper part for the user and the bottom part for collection of urine and feces. Except for the foundation, the entire toilet is above ground. Key features are:

1. Ferrocement floor and bench. In order for these to be strong yet allow for free space underneath, and minimize the area susceptible to being soiled, a 3 cm thick ferrocement slab is made of 15 cm square electro-welded 4mm steel rebar with one layer of hexagonal wire mesh ("chicken wire") above the rebar and another below it (Figure 2). The mix is 3:1, sand:cement, with just enough water to moisten it properly. The bench is 38 cm high, or whatever height is appropriate for the users, thus being an advantage over pre-made pedestals. Other advantages of a bench over a pedestal include less internal soiling, better ventilation, no hard-to-sweep area behind the toilet, and more room for changing and storing sacks.
2. Ceramic tiles. These are put directly into the fresh concrete of the ferrocement floor and bench, including the inner edges of the rectangular drop hole. Tiles, which also extend 10cm up the adjacent walls, enhance aesthetics and are easy to clean, thus contributing greatly to acceptance by the users (Figure 3).
3. Plastic toilet seat. This is affixed on top of the drop hole via its plastic bolts that pass through two small holes that were maintained by placing sticks in the fresh concrete. If the bench is too thick, the corresponding plastic nuts will not fit onto the bolts, but wedges of wood can be jammed in from underneath to firmly hold the bolts in place. The seat contributes greatly to comfort, acceptance, and "normality".

Figure 1: UDDT Design. Interior dimensions were 120 cm long by 90 cm wide

4. Collection and storage of urine. Urine is collected in a funnel made from a carefully cut 4 liter white plastic bottle (which may have once contained chlorine). A plastic mesh is sewn with fishing line, 5mm below its sloped opening, to prevent feces and solids from going in. The mouth of the bottle fits into an elbow of a 5 cm PVC pipe which passes through the side wall and is inserted into a 5-cm hole in a plastic beverage bottle, with a hose glued into its mouth that goes to the bottom of a 20 liter plastic bottle for storage, thus avoiding ammonia emissions in the direction of the user (Figure 4).
5. Collection and storage of feces. Feces are collected in a rice sack that is held open by four elastic strings attached to the walls (Figure 4). Dry material (e.g., wood ash, sawdust, rice hulls) is added manually, using a cup, after each use. When it is full or starting to get heavy, the user ties it shut, marks it with the date, and puts it under the floor for six months in order for any pathogens present to die (given the tropical location; the rule of thumb for temperate countries is one year). Dried feces, which may be periodically examined under the microscope for ameba cysts and helminth eggs, can be used to improve soils or to cover new deposits of feces. Advantages of rice sacks include: concentrating feces and cover material so that feces are covered better; gas exchange through the cloth of the sack allowing water to evaporate out and oxygen to penetrate in; accessibility; and low cost. Nonetheless, if users prefer, buckets or other containers may replace the sacks.
6. Measurements. The inside dimensions are 0,8 m wide, 1,2 m long, and 1.9 m high (entrance door). This small space is sufficient for user comfort, and also allows for 5cm clearance on each side of the roof to prevent rain damage to the walls, given that the roofing was 1.1 m wide.
7. Doors. The front and back doors are made of painted wood and are 0.8 m wide, in order to fit directly in between the two side walls.
8. Ventilation. Front and rear windows, made with wooden frames and mosquito screen, let light and air into the room. A PVC vent pipe (0.11 m x 3 m) creates a flow of air away from the user, removing any odors. The top of the vent pipe is cut at a steep angle and covered with a metallic mesh. (In other locations, with warm, humid climates, a 0.16 m pipe is used.) The chamber should be as air-tight as possible, so that the draft pulls air consistently into the drop hole.

Figure 2: Ferrocement floor and bench before adding concrete. The brown plank forms have no need for holes. (Photo: C. Thibodeau)

Figure 3: Seat, funnel and sack. The yellow plastic mesh keeps solids out of the funnel. Note that the rice sack, in this case, is too high. (Photo: C. Thibodeau)

Figure 4: View of back door. Note the plastic bottle that collects urine and that the spaces around the door frame should be filled. (Photo: C. Canaday)

Overall, this new UDDT model has various advantages over other single-vault models. First, the urine and feces collection system is made largely from reused, post-consumer waste (chlorine bottle and rice sack) that have little or no cost, are easy to get, and can be replaced whenever needed. Moreover, rice sacks allow for gas exchange and are easily carried to farmlands when ready. Ceramic tiles are aesthetic and ease cleaning, compared with other, rougher materials. The ferrocement floor and bench allow for space underneath for storing sacks that are full. The large back door enables easy access underneath. Finally, the entire structure is made with easily obtained materials.

Costs

Table 1 shows the building costs, including materials, labor and transport of the masons. It does not include food for the masons (which was provided by the users), transport of material, quality-control visits, water and electricity fees, and final layer of paint. The presented costs are in line with the study made by Rosemarin et al. (2008).

The two doors cost US$ 90 (23 % of the total), while the material for the walls cost only US$ 70 (18 % of the total). These wooden doors could have been less expensive, but a more aesthetic and durable finish was desired. The 35 solid blocks (below floor and bench) and the 90 hollow blocks (above the floor and bench) needed for each toilet cost respectively US$ 0.28 and US$ 0.23 each. The excrement collection system is very inexpensive, since no costly molded inserts were used. Since the users contributed a significant part of the costs (24 %), it is worthwhile for a family to build on its own, with the help of neighbors or friends, as was the case for the sixth toilet. Finally, this model is aimed to have a long lifespan, therefore more durable and costly materials were selected. If a family wants the same functionalities at a lower cost, other materials could be used (see Canaday, 2011).

Timeline

Table 2 shows a generalized building timeline, indicating that each UDDT requires eight days. Each phase of construction represents a division of work that allows time for the concrete to attain sufficient strength before beginning the next phase. The number of man-hours used in each phase, by the experienced masons, was recorded. For example, if two masons work on Day 1, it will take them 2.5 hours to carry it out.

Preparation includes recruitment of families and procurement and delivery of materials and equipment. Day 1 starts with the determination of precise location, foundation building and placement of blocks up to the level of the floor and bench. Day 2 includes formwork for the floor and bench, placement of rebar and chicken wire, positioning strips of ceramics around the drop hole, mixing and placement of concrete, and installation of ceramic tiles. Day 3 involves building walls and installing the plastic hose conduit for electric wires. Day 4, the roof and screened windows are installed, plus the front step is made. Day 5 is dedicated to plastering the walls and installing the urine pipe. Day 6 is for painting on the primer, installation of the toilet seat, and placement of the grout between the ceramic tiles. Day 7, the electrician installs the light fixture and the carpenter places the custom-made doors. Day 8, the system for separately collecting urine and feces are installed, and installation of the toilet seat.

Five of these toilets were built by two masons with experience from the previous phase of the project and were supervised by Thibodeau. The sixth toilet was built by the family, a neighbor who is a mason, Thibodeau and Canaday.

Table 1: Budget for Building One Toilet

Materials and labor	US$	%
Walls (concrete blocks, mortar and plaster)	70	18
Ferrocement floor and bench	10	3
Ceramic tiles	15	4
System for collecting urine and feces	25	6
Vent pipe	10	3
Doors[1]	90	23
Roof	20	5
Electricity and light[1]	40	10
Miscellaneous equipment and materials	10	3
Primer (pre-painting)	10	3
Masons wage	80	21
Masons transportation	10	3
Total	**390**	**100**
If self-built :	300	77

[1] Made and installed by a subcontractor

Table 2: Normal Timeline

Day	Activity	Man-hours
Day 0	Preparation	variable
Day 1	Foundation and first rows of blocks	5
Day 2	Ferrocement floor and bench	10
Day 3	Walls and electricity	9
Day 4	Roof, windows and front step	7
Day 5	Plastering	12
Day 6	Painting (primer) and accessories	5
Day 7	Install doors and lighting	5
Day 8	Excrement collection system	4
	Total:	57

Figure 5: Finished UDDT in use. Mrs. Mélida T. is one of the most enthusiastic users. She and her family of four filled 2.5 sacks in six months, fertilize vegetables and fruit trees with the urine, and look forward to using the soil conditioner. (Photo: C. Canaday)

Follow-up

On December 19, 2010, Canaday visited and/or received first-hand reports of the use of 10 of the 14 toilets (including both phases of the project). Surprisingly, half were essentially not being used, despite the users' investment and training. This seems to be a case of old habits dying slowly, calling for more guidance, although in a couple of cases the adjacent house was not yet being lived in. The sacks were also positioned higher than is best. Ventilation was generally working well and only in a few cases were there problems with rain entering the pipe. Those who are using the toilets are very satisfied.

Lessons learned

During this two-month volunteer project, several lessons were learned:

Family contribution

Families were asked to contribute about 25 % of the total construction cost, which amounts to US$ 80 and is roughly equivalent to the cost of labor. In addition to this financial contribution, they helped with the handling and transport of material (e.g. sand and rocks) and offered lunches to the workers. For the sixth toilet, the family had to pay only US$ 20, but built the UDDT by themselves, with our help. Whether the contribution is financial or physical, it is considered fundamental, so that each family has the sense of ownership and investment that is essential to long-term use.

Quality control

Quality control during construction is crucial. One cannot simply depend on the hired masons to do everything correctly on their own. Therefore, supervision must be constant. The main things to watch are: measurements, proper mixture of concrete, position of the holes for attaching the toilet seat, and secure installations overall. All of these have an impact on user comfort, functionality, durability and aesthetics, and therefore on user acceptance and long-term use. Therefore critical elements should be done by the project leader or a trusted expert.

Figure 6: Final UDDT with beneficiaries. See a video about the project at http://www.youtube.com/watch?v=xzFONCN3YDY (Photo: C. Thibodeau)

Education and Monitoring

More than just a matter of construction, this project aimed at capacity building in Ecological Sanitation. Even with the best infrastructure, if families are not aware of infectious disease transmission via fecal contamination, sustainable public health cannot be achieved. During all stages of the work, we discussed sanitation, the proper use of these UDDTs, and the application of the fertilizers that will be generated with families, neighbors and visitors. There were also talks given at the local high school and at meetings of the parents from nursery schools. Even so, there needs to be a process of monitoring, answering of questions, and demonstration to eliminate any doubts the users may have. As this system is new to them, sometimes no one dares to be the first user, so organizers may make (or simulate) the first use. A new Peace Corps Volunteer, who wants to build UDDTs in another community, has offered to do a round of fine-tuning and education, which will include better positioning of the sacks and group visits to successful UDDTs and well-fertilized farms. In future projects, it would be recommendable to loan families portable UDDTs (see Canaday, 2011) as part of a process to train and screen them before investing in the construction of elegant, permanent units.

References

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Overall Project:

Technology review „Composting toilets“

This abstract gives a short overview about the technology review „Basic overview about composting toilets (with or without urine diversion)” written by Wolfgang Berger.

The target group of the technology review are people that want to get an overview on composting toilets , their principles and systems. The focus in the manuscript is laid on design, operation and maintenance (O&M), and the quality of the produced compost. The functional principles of composting toilets such as biological processes, bulking material and pathogen removal (desinfection) are explained and recommended literature is listed. Case studies from around the world show that composting toilets can be applied under different climatic and socio-economic circumstances.
Composting toilets are dry toilets without flushing water. Therefore, they can be applied independently from sewer systems and provide safe, hygienic sanitation and a wide range of possible application. The two basic elements of a toilet are a place to sit or squat and a collection or composting device. In addition to that, a ventilation system helps to avoid malodours and reduce excess moisture. Composting toilets can be either manufactured or owner-built. The emptying frequency depends on the size of the collection device, the feeding rate and the composting conditions. Toilets can be designed with or without urine diversion. Advantages of urine diverting composting toilets are the simplified management of leachate and the potential use of urine as liquid fertiliser. In the technology review 4 types of composting toilets are explained in detail: (1) single vault composting toilets, (2) multiple vault composting toilets, (3)) mobile bucket or bin toilets followed by external composting, and (4) composting toilets with mechanical devices. Regular maintenance of private or public toilets is crucial to ensure their safe functioning. Therefore, proper cleaning of the toilet and maintenance of technical components of the facilities is necessary. A strong commitment of the users and operators and the handling of faecal compost are necessary to keep the facilities running.

The composting process includes the degradation of organic matter by thermophilic aerobic bacteria (thermophilic organisms thrive best at temperatures between 40°C and 80 °C). Temperatures of more than 50°C can be reached if conditions are optimal. Then substantial pathogen reduction is possible. Due to its complexity, the composting process is difficult to manage and measurements have shown mesophilic (15°C and 40°C) conditions in he composting vault. Therefore, monitoring of the composting process as well as safe treatment, handling and application of faecal compost and possible leachate is very important. Complete pathogen reduction can rarely be obtained by composting toilets alone. In general long maturation times or secondary composting outside the toilet are often required.

For more information on composting toilets the reader is referred to the full manuscript:
Berger, W. (2010). Composting Toilets. Technology review 3, GTZ, Eschborn, Germany
Available free for download at: www.susana.org. (Main text/Appendix)

Notes

Notes

Next Issues:

Issue 7, April 2011: „**Planning Tools**“
Contribution due to 1. February 2011

Issue 7, July 2011: „**Solutions in mountain regions**“
Contribution due to 1. May 2011

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