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Report D7: Workshops on Construction of UDDTs in Dayet Ifrah

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List of abbreviations

GIZ	Gesellschaft für Internationale Zusammenarbeit
GTZ	Gesellschaft für Technische Zusammenarbeit
GW	Greywater
ONEE	Office Nationale de l’Electricite et l’Eau Potable
ONEP	Office Nationale de l’Eau Potable
UDDT	Urine Diverting Dehydration Toilet
WHO	World Health Organisation

1. Summary

This report presents the construction of double vault Urine Diverting Dehydration Toilets (UDDTs) in Morocco.

After an introduction on the project and the morrocean context general information on UDDTs is provided in order to give finally detailed step-by-step instruction on the construction of UDDTS. Planning, design, execution and maintenance of the toilets will be described in detail by also considering excreta reuse. The approach to consider excreta and water flows as resources instead of waste is also reflected by including a chapter on greywater treatment from showers, sinks and beigewater from anal cleaning.

This approach will be a red thread through the following chapters providing detailed activity-reports of 3 missions.

The three missions to Morocco have been conducted in:

- 1st mission: December 2009
- 2nd mission: June 2010
- 3rd. mission: July-Aug 2010

During the 3 missions four different models of UDDTs have been constructed:

- A: simple model: UDDT, urinal, sink, material: concrete bricks
- B: UDDT with shower, material: concrete bricks
- C: UDDT with shower : natural stones
- D: UDDT with shower: concrete bricks, constructed adjacent to existing house

Local masons and dwellers of the project-village Dayet Ifrah were trained. They are now able to design and build UDDTs. During the 2nd mission a major workshop for different stakeholders like NGOs, Office National de l'Eau (ONEP) and other administrations and organisations including giz-staff has been held. The participants of the seminars have been given practical knowledge as well as theoretical background on the construction of UDDTs.

2. Introduction

Morocco is one of Germany's core regions for international cooperation in the middle sea region. Since 1975 is the GIZ involved in projects and the AGIRE- project (Appui à la Gestion Intégrée des Ressources en Eau) is one of them.

Morocco globalised in recent years and especially its negotiated Free Trade Agreement with the European Union will bring further restructuring and severe changes to Morocco's economy. Growth and development have their impact on morocco's resources in a country without the most fortunate climatic preconditions. This is felt most severely in rural areas as morocco has also a widening gap between rural and urban areas in regards to development and modernisation. However, the economy is still highly driven by agriculture and nearly half of the population is employed in agriculture related fields. These rural areas are also most exposed to water scarcity, desertification and climatic extremes, which makes sustainable resource exploitation even more important.

Germany and Morocco agreed on three core areas in their development cooperation programmes:

- Sustainable economical development
- Usage and management of water resources
- Climate change including renewable energies

The AGIRE project is part of the second core area as sanitation plays a major role in water resource management. Sanitation is also one of the pillars for social development as the quality of sanitation has severe health impacts. Sanitation is also an area which touches one of the underlying core components: gender equality. Especially, UDDT systems increase health and safety in households and as this being in rural areas mostly in hands of women the impact on women and children's health is a direct effect of higher quality in sanitation.

This makes the introduction of sustainable sanitation practices to Moroccan rural areas from several perspectives a highly important task.
Apart from building UDDTs the project had additional aspects, which shows the interlinkages between all core areas of the development cooperation programmes like the incorporation of renewable energies. Therefore a subproject is the construction of a Biogas digester and a planted soil filter for the school of Dayet Ifrah.

The project consisted of several steps from an extensive research- and preparation period in summer 2009. As part of this interviews with some families as targeted beneficiaries were conducted, especially families without sanitation facilities and open defecation practices. Another early research step was an on site visit to Dayet Ifrah in order to prepare the planned first workshop on site.

3. UDDTs

3.1. General

UDDTs are toilets collecting urine and faeces separately. The principle of UDDTs is shown in Fig. 1.

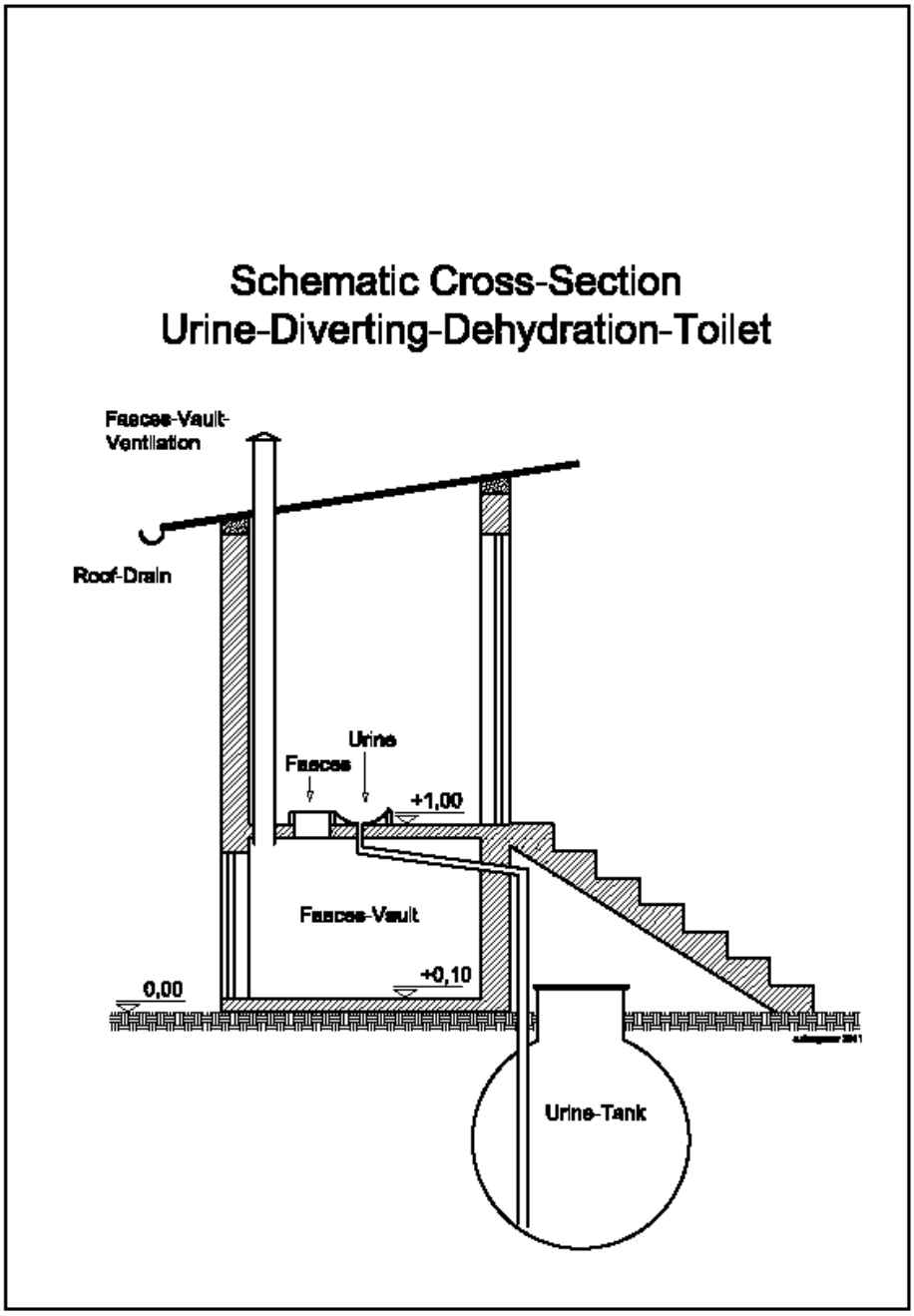

Fig. 1 : Principle of a UDDT

The separation is achieved by special UD-slabs or UD-seat-risers. Fig. 2 shows examples of different UD-slabs.

Fig. 2: examples of urine-diversion slabs with anal cleaning [1]

3.2. Location of toilet

In general there are three possibilities to locate toilets: inside the house, outside or adjacent to the house. When the toilet is constructed adjacent to the house, the entrance to the toilet can either be from outside or from inside the house.

[1] All Photos in this report are made by Lukas Ulrich, except photos of Mission 3(Chapter 9) or noted. All fotos of Mission 3 are by Stefan Deegener except noted.

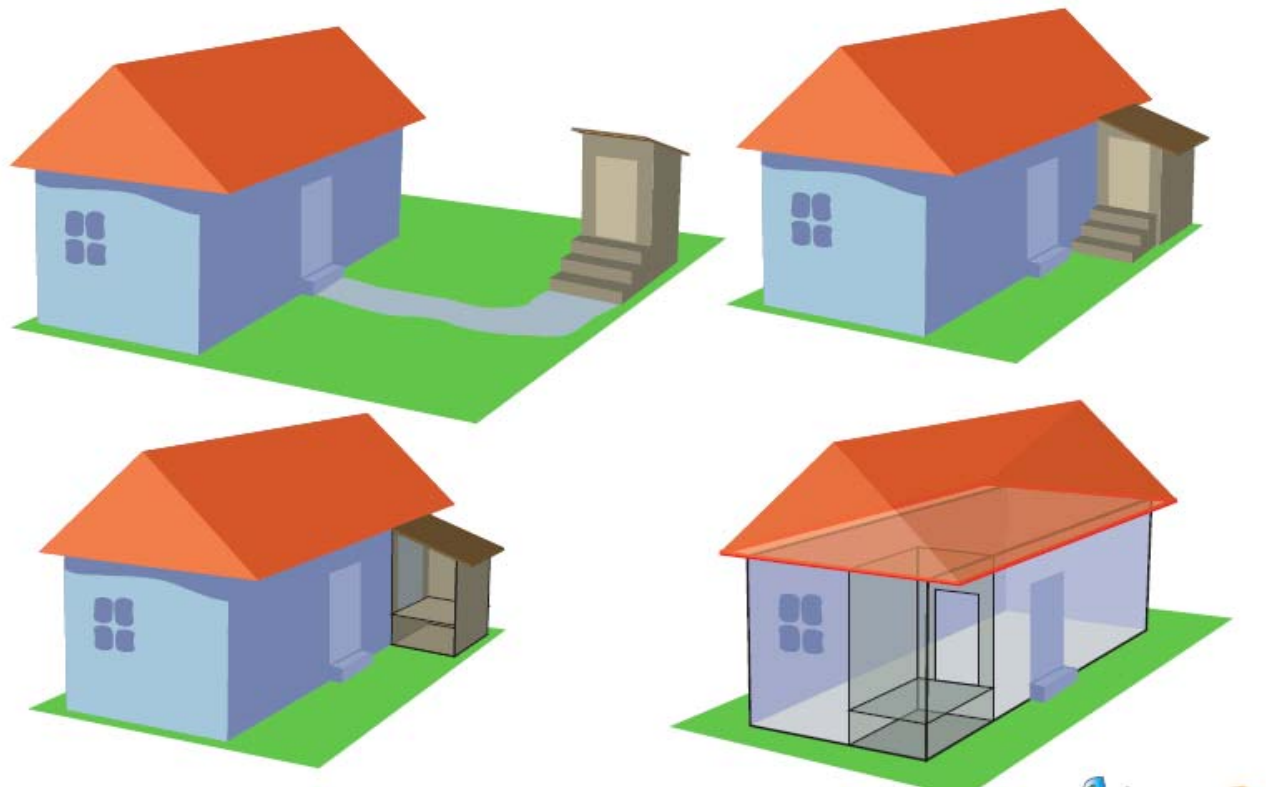

Fig. 3 : Options for the place of the UDDT [Wisdom 2010]

A location of the toilet close to the living space is considered as more comfortable once people get convinced on the lack of odour. However, it is a challenge to convince people as they are experienced with sanitation solutions they would like to have as far away from their everyday living spaces as possible. Therefore, experience has shown, that after beneficiaries realise that there is no smell, they say: “If we would have known this beforehand, we would have build the UDDT closer to the house or even inside!”.
Another advantage of in-house or adjacent solutions is that less material is needed as minimum one wall can be saved, which makes them less expensive than outside-models. So, the cheapest solution is to build inside, if space is available. Enough space is available if the toilet room is high enough for convenience and comfort by considering faeces-storage. In general, when building faeces storage chambers accessible doors and additional space on the backside of the toilet for emptying these faeces chambers have to be considered (approx. 2 sqm).

3.3. Design Challenges

The following factors have to be considered when designing a UDDT:

- Will there be a shower and/or a place for hand washing inside the toilet?
- What kind of Anal cleansing do the users prefer? Are they washer or wiper?

- What kind of water-supply is available? Is there a connection to a central water-pipe? Is it possible to install a water tank e.g. rainwater tank or is it necessary to bring water into the toilet by hand?
- Water storage inside the toilet or outside, e.g. on the roof?
- Depending on the volumes of greywater produced, different options for greywater-treatment have to be considered
- How many users will be there?
- Will the faeces be treated inside the toilet? Will the faeces be composted outside? Is there a place for a compost in the garden? Is external composting possible?
- Slope of area and surrounding geography
- Preferences of owners
- Use of urine and faeces: Will the owner/beneficiary use the excreta themselfes? Do they have enough garden/land and are they willing to use? If not, other users should be found

3.4. Construction of UDDTs

3.4.1. General

This instruction describes the construction of a double chamber urine diverting dry (UD) toilet without shower. Chapter 3.4.8 explains the construction of a UDDT with shower.
The toilet consists of 2 parts: The toilet room itself and 2 faeces chambers. The chambers are located underneath the toilet room. The toilet has a square ground plot of 2m * 2m = 4 sqm. An additional 1-2 sqm in front of the toilet are required for stairs and 0,5 - 2 sqm on one side of the toilet for the urine reservoir (depending on the volume of storage-containers). Another 1-2 sqm are needed on the backside of the toilet for opening faeces-chamber-doors and to handle collected materials. Also the place for the greywater-treatment and beigewater-infiltration has to be considered.

Construction Time

The construction time is approx. 2 weeks (incl. concrete drying time, 10-12 working days net) for the simple UDDT. For a UDDT with shower and greywater-treatment minimum 3 weeks should be planned.
Depending on the number of masons and helpers, construction works can be more time consuming. Interior work, e.g. laying tiles is also more time intense.

3.4.2. Foundation

In general UD-toilets should be build in such way that the floor of faeces chambers is above surrounding ground level to avoid water leaking into faeces chambers during heavy rainfall. Additionally, it is much easier to empty faeces chambers, if the floor is slightly above ground level.
The foundation has to be strong enough to carry the toilet load. The foundation form and shape depends on underground conditions. For example: solid rock grounds do not need an extra foundation under the faeces chamber floor. For most (loose) undergrounds a round foundation of 30 cm depths and 25 cm widths is adequate, see Fig. 4. In case of doubt an experienced local construction worker should be consulted on what kind of foundation suits the situation best. In general, a UDDT does not need iron-armor in the foundation or a groundplate. However, in earthquake-prone areas armor might be necessary to ensure sufficient stability.

Fig. 4 : Excavation for Round Foundation

First, the soil has to be excavated. Foundation size has to have the minimum size of the toilet, so a square of 2m * 2m. After this the excavated space should be filled up with concrete. To save cement, thus costs, the excavation can be filled with stones and then gaps are filled up with concrete. Attention has to be paid to filling up all gaps between the stones with concrete. The concrete has to dry (min. 1-2 days).
The mix for foundation concrete is: 1:4 or 250 kg/m^3.

3.4.3. Faeces-chambers

Floor of Faeces Chambers

The floor of the faeces chamber should be build from high-quality-concrete with a higher fraction of cement (mixture 1:3). The thickness of the floor should be a minimum of 7-10 cm. The floor should be levelled. A slope of 1-2 % towards the faeces chamber doors can be applied. This slope can drain possible water or urine that has entered the faeces chamber (this should not happen!).

A formwork from wooden slats has to be build. The top of the slats have to be levelled (the top of the formwork defines the final level of the floor. Then the formwork is filled up with concrete until the top of the formwork is reached, see Fig. 22. The concrete has to dry (min. 1-2 days).
It is recommended to build the foundation and the floor of the faeces-chambers in one step.

Faeces Chambers Outside Walls

The faeces chambers outside walls have to be build from solid material as they have to support the total weight of the superstructure (including toilet users). Possible materials include concrete, natural stones or bricks from different materials (burnt clay bricks, concrete bricks or lime sand bricks).The faeces chambers outside walls should have a height of minimum 60 cm, better 80cm. In case the toilet has many users and thus a high production of faeces the height should be 1m or higher. The urine outflow, greywater and beigewater has to be considered in order to avoid future wall breaks. The holes in the side wall for each pipe should be 50mm diameter each.
During brickwork it is essential to moisten the bricks. Due to high temperatures and the brick water absorbtion the mortar itself dries quickly and gets brittle, which affects stability.

Faeces Chambers Dividing Wall

The faeces chamber dividing wall is located between the 2 faeces chambers. The easiest way to build this wall is by using bricks, but concrete is an alternative. The faeces chambers dividing wall can be build in one step with the faeces chamber outside walls. The height of the dividing wall should be the same as the outside walls.

Faeces Chamber Doors

The doors of the faeces chambers can be built from different materials including wood or metal (iron, aluminium). Metal doors are preferable, because wooden doors can be attacked by rodents (e.g. mice or rats) who are attracted by the faeces (or the undigested food contained in the faeces). The size should be minimum 50 cm in height and width to ensure easy access to faeces chambers, which is important for maintenance (especially emptying). The size of the doors has to be big enough so that an adult person (caretaker of the toilets) can enter the faeces chambers if necessary (e.g. if the urine-pipes have to be changed). Therefore a door size of 60 cm * 60 cm or bigger is recommended. The doors should be as air-tight as possible, e.g. with a rubbersealing, see Fig. 5 .

Fig. 5: Sealing of Faeces-chamber-door with rubber

In areas with cold winters insulation with e.g. Styrofoam is recommended also, compare Fig. 6.

Fig. 6 : Insulation of faeces-chamber-door with styrofoam

Toilet room Floor-Plate

The floor of the toilet room (= ceiling of the faeces chambers) should be constructed from concrete. In any case the floor has to be covered by easy to clean materials, e.g. tiles. If the floor is made from wood, a covering is also necessary in order to avoid wetting the wood during cleaning the toilet room.

The first step is to build the lower framework. This framework will support the plate as long as the concrete is drying. The top of the formwork is level with the faeces-chamber walls, see Fig. 45.
The second step is to build a frame with the outside-dimensions of the faeces chamber walls, here 2 m * 2 m. The top of the framework defines the top of the plate and thus plate thickness . Two formworks for 2 holes of the UD-squatting pans (or seat-risers) have to be made and placed into the floor. To do so, the seat riser or slab is placed onto the floor and marked. The 2 holes should be centred above the middle of the corresponding faeces chambers. Also 50 mm holes for urinal piping and sink have to be considered before pouring of the plate, see Fig. 29.

For structural strength iron-armour has to be placed inside the plate. The diameter of this iron armor should be minimum 6 mm, but 8mm is also possible. The bar spacing should be maximum 20 cm. Pre-welded nets, if available, save time for making the net (connecting of bars with wire). The armor has to be placed in the lower third of the plate, but min. 1-2 cm of concrete needs to be below the armor to protect it from corrosion. The mixture for the plate is 1:3 or 350kg/m^3.

3.4.4. Superstructure

Walls

The walls can be build from solid material (bricks), wood etc. In this report a concrete brick wall construction is explained. The roof slope defines the height of each wall. In cold climates with snowfall a sufficient roof slope has to be build to avoid an overload in case of heavy snowfall. Here we adapted local construction-techniques and build the UDDT with a sturdy concrete roof (with minimal slope to drain rainwater). A window is optional.

Roof

The roof can be build from waterproof materials of all kind. Roof-covering with zinc-covered metal-sheets has in many cases shown to have a very good cost-performance ratio, since the sheets are relatively cheap but last long. Nonetheless here the construction of a solid concrete-roof is shown, since this kind of roof ist traditionally constructed in this area of Morocco, so local masons are used to this kind of roof. Also a flat concrete-roof fits better into the environment from an architectural perspective.

The principle is the same as for the toilet floor-plate, compare chapter 3.4.3. The framework has to be fixed in the walls and with pillars on the floor, see Fig. 52. An outflow for rainwater-drainage has to be build. The rainwater should be collected if possible. In case of rooftop water storage (like Fam. Jane) also an aperture for the pipe has to be planned, compare Fig. 56. The roof armor is made similar to the procedure for the floor. Min two layers of watertight plaster made of 1:50 sika and cement milk has to be applied to prevent water from leaking through the roof.

Toilet room Door

The door can be build easily from wood. Of course pre-fabricated doors can also be used. Another low-cost option is to build a frame from wood and cover it with e.g. bamboo or reed. If no window is constructed (and no electrical light is installed), holes have to be sawed inside the door to allow light to enter.

3.4.5. Stairs

The stairs can be constructed from wood, bricks, stones or concrete. The finished stairs made from stones and covered with concrete can be seen in Fig. 47. A fence should be build for safety reasons. It is recommended that all stairs have got the same height (to avoid stumbling). Sometimes the terrain slope can be used to reduce the number of stairs.

3.4.6. Sanitary Installations

UD-Seat riser or UD-Squatting Slab

The toilet users decide if they prefer a seating or a squatting model for urine diversion. Here squatting-models Shital-Cera from India and a Chinese plastic-models are used, see Fig. 2. Also a separate outflow for beigewater (anal cleansing water) has to be planned and constructed. If it is not possible to import UD-slabs, the urine-diversion can also be self-made with e.g. tiles/funnels, compare Fig. 7. A flexible hose or piping for urine and beige water must be fixed to the outlets of the slabs.

Fig. 7: Examples self-made Urine-Diversion [sd]

Waterless Urinal

Urinals are optional. If men do not want to sit down on the slab, the use of an urinal is necessary to keep urine from entering the faeces chambers and avoid bad smell causing sprinkles of urine on the floor. Special waterless urinals are available. Also water flush urinals from ceramics can be modified and used as waterless urinals. Instead of a siphon / p-trap a smell-trap in form of a condom is used. The wall behind the urinal should be covered with a material, which can be cleaned easily e.g. tiles. Then the urinal is attached to the wall. The height of the urinal should be adapted to the smallest male member of the household, see Fig. 96 .

Urine-piping

For the urine piping hoses and pipes from different materials can be used. For the UD-slabs flexible hoses are recommended for easy installation and changing, if good-quality hoses (reinforced) are available. If not 50mm pipes from Poly-Propylene (PP) are a good choice. Also for the Urinal these pipes should be used. If PP-Pipes are not available, PVC-pipes can be used. It is important that all pipes and hoses have a slope of minimum 2 % to avoid a negative gradient and thus urine staying in the pipes (and causing bad smell). The slope should be a big as possible. When laying the pipes the space for collection/storage of the faeces has to be maximised, this means the pipes should be out of the way/ as close to the walls as possible and as little disturbing as possible, see Fig. 104. Outside (underground) 100 or 110mm pipes are recommended.

Urine Collection and Urine Storage

The volume for the urine collection is chosen mainly by aspects of costs and of comfort. The smaller the container, the more often it has to be emptied (comfort-aspect). The bigger the container, the more expensive it is. The container should be buried in such way that it will not freeze in winter but can still be emptied easily.
For bigger containers that cannot be taken out of the ground, a pump should be used.

Fig. 8: Containers used for urine-storage

Fig. 9 shows a manual pump suitable for pumping urine. After usage the pump has to be thoroughly flushed with water to prevent corrosion.

Fig. 9 : Manual Pump for emptying urine from tank [sd]

3.4.7. Ventilation

The faeces chambers ventilation pipes guide the air from the faeces chambers to above the roof. The pipe should be so long that it ends at least 30 cm above the roof. If the vent-pipe goes through the toiletroom and through the roof, it has to be sealed in the roof with silicone or another sealing material to keep water from entering. A rain-cap or a T-pipe has to be applied to the top of the pipe for the same reason. The ventilation rain-cap can be seen in Fig. 10 . For a household-toilet a ventilation-pipe-diameter of min.150mm is recommended.

Fig. 10 : rain-cap of vent-pipe with flynet

Another possibility is to construct the vent-pipe outside. But no 90°-bend should be used, instead 2 times 45°-bends, compare Fig. 11. The top of the pipe should be level with the top of the faeces-chamber, to allow all air to escape via the pipe.

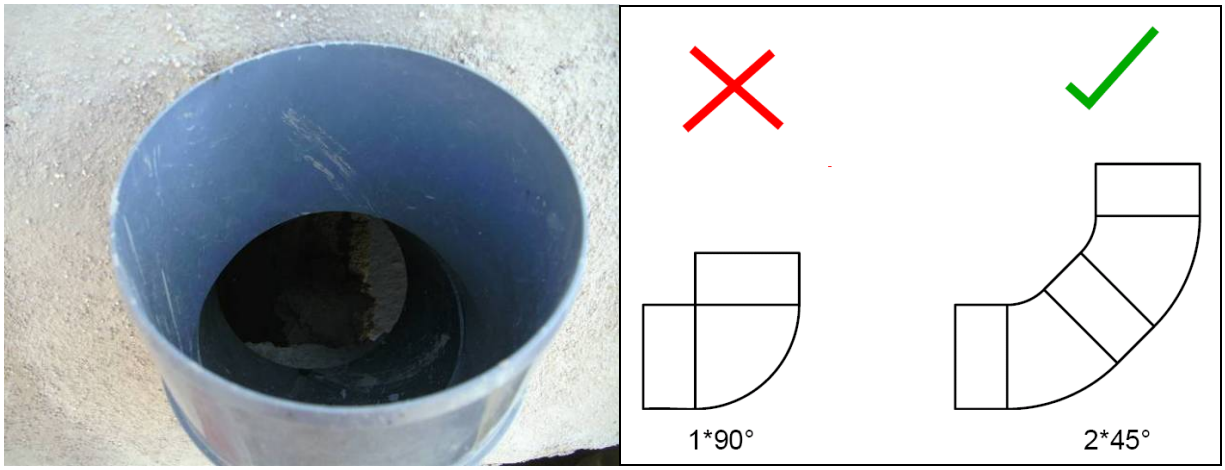

Fig. 11 : 2 times 45°-bend for vent-pipe

3.4.8. UDDT with shower

The foundation und thus the whole construction needs to be larger in order to make space for the shower. The foundation needs to be 2,6m*2,6m instead of 2,0m*2,0m for a UDDT without shower. Since the faeces-chambers do not need more space than in a simple UDDT, there is space for a

third chamber. This chamber can be used for storage of e.g. cover-materials or cleaning-equipment, but the biggest advantage is that there is space for the piping in a third chamber, see Fig. 104.

3.5. Maintenance of UDDTs

3.5.1. General

UDDTs need, like all sanitation systems, a certain amount of maintenance. In the following sub-chapters the most important and essential maintenance-procedures are explained. Anyhow it is recommended that a flyer or poster are installed inside the toilet, so visitors can easily understand the correct use of the UDDT, see Fig. 106 : Poster for correct use in all UDDTs.

3.5.2. Cleaning

The toilet floor can be cleaned as usual with water and some detergent. But it is important that no, or only very small amounts of water enter the faeces chambers during cleaning. A moist but not wet rag or sponge can be used for cleaning the slab. A bit of warm water or vinegar can be added periodically to the urine separator and to the urinal to avoid smell and sedimention of struvit.

3.5.3. Covering the faeces

After each defecation the faeces have to be covered. At least one cup of a cover material must be added to cover fresh faeces. Used toilet paper can be disposed in the chamber.
Before using a chamber, a 5 cm fine layer of prepared soil or compost must be placed on the floor. If not enough dry soil is available, sawdust or other dry organic materials can be used instead. Ash is to be preferred above lime. Ashes and lime take away the smell and decrease pathogens. It is important that the covering material has a fine structure and absorbs humidity.
Different cover materials are shown in Table 1.

Table 1: Cover materials for faeces

Cover material	Remark
Sawdust	In mixture ok, but little structure and might not let enough air in
Wood chips	Ok, do not soak up a lot of moisture
Charcoal	excellent, but expensive
(Wood-) Ashes, lime	good, increase ph
(dry) Soil	Ok, can act as inoculum
(dry) Animal-excreta	Ok, can act as inoculum
Sand	Only use if nothing from the above is available

3.5.4. Levelling

It is important to level the mound formed by falling excreta regularly. Depending on the toilet's frequency of use, the faeces must be levelled weekly with a stick or other tool, and some more cover-material should be added.

3.5.5. Changing the chamber

The two faeces-chambers are used alternately. Only one faeces chamber is in use at one time. The other one (which is not in-use) must be closed.
When the in-use chamber is about to be full, the faeces must be covered completely with a layer of cover material. The slab of the full chamber is covered with a lid and closed.

3.5.6. Emptying

When both chambers are full, the one which has been out-of-use, needs to be emptied. After a storage time of at least one year the product can be used as soil conditioner. Optimally the product looks like dry soil and does not smell. However in UDDTs the product is not converted completely (composted) but rather dried, so some might prefer a secondary or post-composting step before application as soil-conditioner in the garden. It is better to let a bit of the material on the bottom of the chambers as inoculum before using it again.

3.5.7. Urinating

On the squatting toilets, men must sit-down for urination. They should take care not to wet the faeces chambers. In cultures where men don't like to sit or squat down for urination, a urinal is therefore recommended. The urine is collected in a reservoir and can be used as a fertiliser in agriculture or in the garden, compare chapter 3.6 .

3.5.8. Humidity: bad smells or flies

If bad smells or flies are perceived, a check must be done to assure that there is no uncovered excreta, nor leaks in the urine hose. The toilet owner should check regularly if the chamber inside is not too wet. Humidity can also enter through a bad sealed slice or through the walls, if these are not tight, or too much water enters during cleaning the toilets. If humidity is too high, it is recommended to add abundant prepared soil or other organic moisture absorbing material.

3.5.9. Urine Pipes

It is recommended that the urine-pipes are flushed regularly (weekly, minimum monthly) with an acid like vinegar or citric acid.

3.6. Reuse of Urine and Faeces

3.6.1. General

UDDTs, as one possibility of sustainable sanitation or ecosan, aim at the safe collection and later reuse of urine and treated faeces in order to close the nutrient cycle. Several points need attention and should be followed to ensure a hygienically safe reuse in each step of the cycle. Apart from the aspect of hygenisation there is like with all fertilisers a danger of over-fertilisation, so max. doses should be followed.

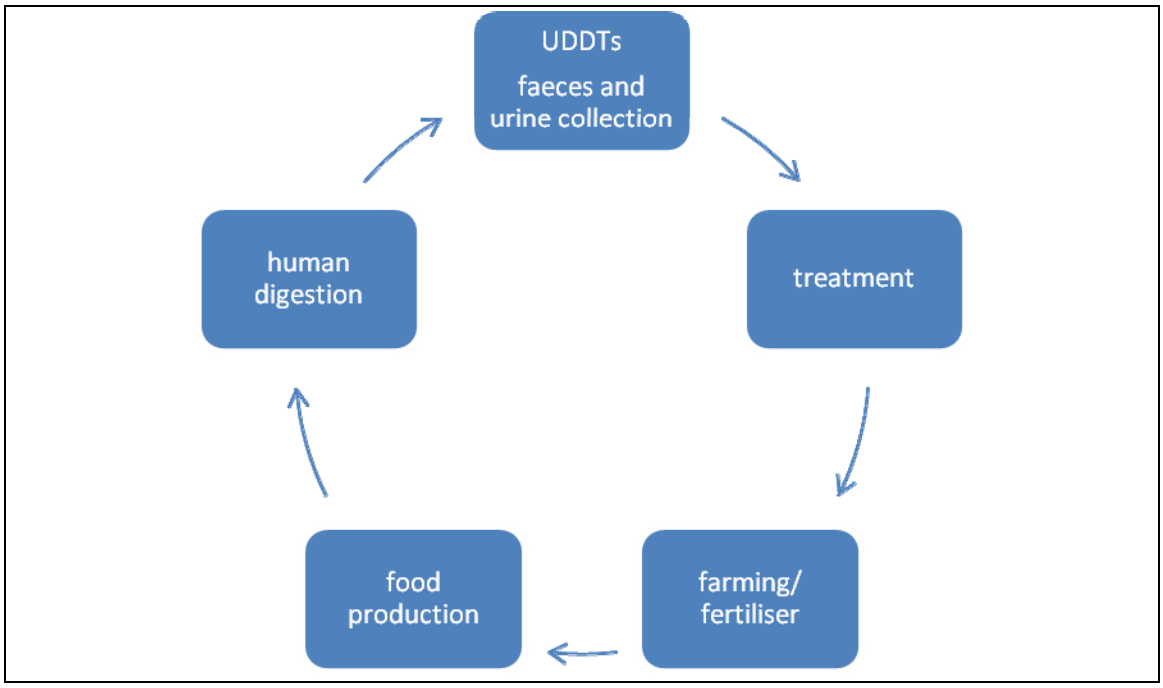

Fig. 12 : Human nutrient cycle

3.6.2. Hygienisation

According to the WHO guidelines on the safe reuse of human excreta in agriculture [WHO 2006] urine from household-level can be reused without further treatment.
Faeces on the other hand need to be hygienised properly, since they can contain many pathogens. The first treatment-step is achieved in double-vault UDDTs by storage in the vault. This is mainly achieved by dehydration of the faecal matter. But not all pathogens will be killed by storage/dehydration. Thus it is recommended to compost the faeces with other organic materials after the chamber is emptied for at least 1 additional year, before applying the compost in the field.

3.6.3. Fertilizing with Urine

Urine contains next to the macro-nutrients like nitrogen, potassium and phosphorus, also micro-nutrients like calcium, iron, sulphur etc., which are essential for plants. Depending on the diet, human urine collected during one year (approx. 500 liter) contains 4 -5 kg nitrogen per person, but faeces (approx. 50 kg) only approx. 0,5 kg nitrogen.
The urine from 30 persons collected during one year can fertilise one-hectare farmland, which is equal with an application of 120 –150 kg Nitrogen per hectare. Or in other words, the daily urine from one person contains enough nutrients for fertilising approximately 1 m2 field. In case of high nitrogen demand more urine can be given in several applications. Urine is comparable with artificial fertiliser and therefore there is a danger to apply too much or too concentrated urine to plants.
There are different ways to use urine as a fertilizer:

Application of urine without dilution

Before sowing or planting, urine can be applied undiluted onto the soil. In addition urine can be given undiluted to trees. Urine can also be used to moisten too dry compost heaps.

Application of urine with dilution

Once crops have started to grow, the urine should be diluted with water in a ratio of 1 to 4 till10 for fertilising the plants. A safe dilution ratio is 1 to 8 (one part urine-7 parts water) for all plants. Another possibility is to apply the urine during or directly before rainfall without dilution, a sufficient amount the rain dilutes the urine. In this case only the urine needs to be transported to the field and not the water for diluting it. After application it is recommendable to cover the place with soil or leaves, to avoid evaporation. To avoid wasting this fertilizer, it is recommended to apply urine only during the vegetation period, so during spring and summer time or, for winter crops, in early autumn. Urine should not be used during winter.

3.6.4. Fertilizing with composted faeces

Fresh faeces contain high amounts of pathogens (illness causing bacteria or viruses). Therefore, faeces must always be treated before they can be applied on a field or a garden.
Well treated (composted) faeces and other composted organic materials are safe to use and improve soil structure and soil health and are a good fertiliser (phosphorus, potassium, magnesium).
Human excreta from 1 person contains in average only 0,5 kg nitrogen, 0,2 kg phosphor and 0,17 kg potassium a year. Therefore, due to the rather low nutrient and the high humus concentration, sanitised faeces or compost is best used as a soil conditioner and can be applied in rather high amounts:

- 1 to 2 litre compost per square meter soil (/m2)
- 2 to 3 litre /m2 for plants with rather high nutrient consumption like potatoes or onions

- 3 to 4 litre /m2 for plants with high nutrient consumption like maize, tomatoes or pumpkins

3.6.5. Demo-Gardens

It is recommendable to build demo-gardens to demonstrate the fertilizing effect of urine and treated faeces.

Fig. 13 : Demogarden of Fam. Jane (front with urine, background without urine)

These gardens make it possible for beneficiaries to actually experience the advantages of UDDTs by being able to monitor increased plant growth by themselves. This practical and also touchable experience makes them more approachable, especially in rural areas and can be one successful communication tool to create demand for improved sanitation solutions. Another key aspect is, that the beneficiaries acceptance to run systems on the long run is essential, therefore, free, high quality fertiliser, especially in a rural context can be a useful and convincing argument.

3.7. Sustainability of UDDT-Pilot-Projects

Sustainability has in the context of UDDT-Pilot-Projects two major aspects:
Firstly, sustainability in regard to proper implementation of the project that resource flows are actually sustainable and resources are getting preserved apart from just a sanitation improvement. The second aspect is linked, but also dependant, and considers the sustainability in form of its long term perspective. In the following several aspects will be discussed influencing, that after a pilot project is started beneficiaries run their UDDTs and keep their nutrients cycle running.

In recent decades a paradigm shift took place in the context of development projects from top down toward participatory approaches. This can also be seen as a reaction on ample failed projects, where ideas were generated in offices far away from beneficiaries realities. Then projects were implemented, but without much involvement of local people and let them not accept these changes for “their good”. Non accepted pilot projects are severely unsustainable as materials start

to be waste after the initiators left. Due to this history in development participatory approaches gained more and more importance and were also theoretical background for this project.
Participation was reached on several stages. The following table shows the idea of participatory project planning developed for the netssaf project, which will help to discuss which steps could be established very well in Morocco and where major challenges had to be dealt with.

Fig. 14 : Planning for Sustainability of Sanitation Projects [NETSSAF]

To include local knowledge on an early planning stage is always important as sometimes climatic conditions or specific local circumstances can have a major impact on the success of a pilot project. This contribution of knowledge by locals can be also the first step for bonding people to projects. This part could be still improved as some delays or challenging situations could have been avoided. This will be further discussed in the section “lessons learned”, but need at this point already mentioning. Lacking knowledge on yearly working and migration patters of the area had an influence on accessibility of skilled workforce and the ability of locals to actually being able to participate.

Knowledge is also a key component for the long term sustainability of this pilot projects as before mentioned the successful fertiliser application in demo gardens is already one important way to create the demand for these improved toilet systems. However, as the avoidance of health hazards is the dominant argument for improved sanitation systems the creation for this demand

needs the transfer of knowledge on pathogens and invisible health hazards. An always challenging task is to create demand to avoid something which is not touchable and needs abstraction. The transfer of this knowledge worked quite successfully in the 3 missions.
Apart from creating the demand beneficiaries also participated in more direct ways. In order to create a close attachment to the project with a sense of ownership a contribution by dwellers was planned in form of labour or financial tokens to pay for labour. Therefore, in this project several steps of participatory project management were implemented with necessary improvement on early project planning integration and especially communication.

4. Greywater- and Beigewater- Treatment

4.1. General

One of the main ideas of Ecological Sanitation is the separation of the different wastewaters. With the UDDTs urine and faeces are collected and beigewater is infiltrated after filtration. So greywater is the only domestic wastewater that needs to be treated. Since greywater contains only small quantities of nutrients, pathogens and other components. The separated collection makes the treatment for reuse of the greywater easier. The treated greywater can be used for e.g. cleaning-purposes or irrigation of plants. In this chapter the construction of a treatment-system for the greywater-component of UDDTs with shower is described.
In order to foster for improved health conditions workshops on planning for water are also always a good way to communicate the importance of handwashing. These wanted changes of habits need to be integrated in calculations on necessary water flows. Apart from hand washing the form of anal cleansing is reflected in needed water quantities. For this project it was important to consider these preferences as anal cleaning with water (washers) is more common in Morocco than in Europe, where most people use toilet paper (wipers).
For wastewater-treatment with constructed wetlands a pre-treatment like sedimentation or filtration of solid wastewater-components is necessary. Since here only greywater is treated, no pre-treatment is constructed, because only very small quantities of solids, e.g. hairs or sand are expected. It is very unlikely that blocking will occur, because the distribution-area of the constructed wetland consists of stones of 6-10cm.
The here explained type of wetland is comparable to the big wetland constructed in the centre of Dayet Ifrah for the school and mosque. See here also the report of Marc Wauthelet.

4.2. Production of grey- and beigewater

The production of greywater is affected by the availability and consumer habits, which are e.g. affected by the wealthiness of the beneficiary. Hence it makes no sense to use generalized estimations for GW-Production. According to this each household has to be considered individually in order to prevent an over- or under-sizing of GW-treatment plant.

Points concerning the greywater-production can be:

- Availability e.g. distance to water well, way of transportation (pump, donkey)
- watertanks at the households
- habits of consumption (usage of showers or simple washing)
- second use of water, e.g. for garden or cleaning
- wealthiness of consumers

Usually there is no water well on family's property and water has to be transported from a distant water well. For this transport commonly a donkey is used, which at a rough estimate can carry up to 100kg or 100 liter of water.
In contrast to the GW-production the beigewater-production varies little. It can be roughly calculated with 1 litre per Person and day.

Table 2: Approximate Grey- and Beige-water production per Family

Family	Persons	Greywater	Beigewater	Remarks
Ferhoui	14	100 l	14	Generally low water consumption
Jane	5	120 l	5	Water tank on roof, relatively wealthy
Ahnuch	7	50 l	7	No shower, but kitchen connected
Khaled	3	50 l	3	Relatively wealthy

4.3. Greywater-treatment for reuse

There are several types of constructed wetlands e.g. ponds, planted vertical and horizontal sandfilters. Due to the climate situation and to avoid high cost for pipings we decided to use a horizontal-subsurface-flow constructed wetland, based on the "EVUPAL"- Greywater filter constructed by the company "EVUPAL". This can be seen as hybrid of a pondsystem and a horizontal subsurface flow wetland. Fig. 15 shows the scheme of such a filter system.

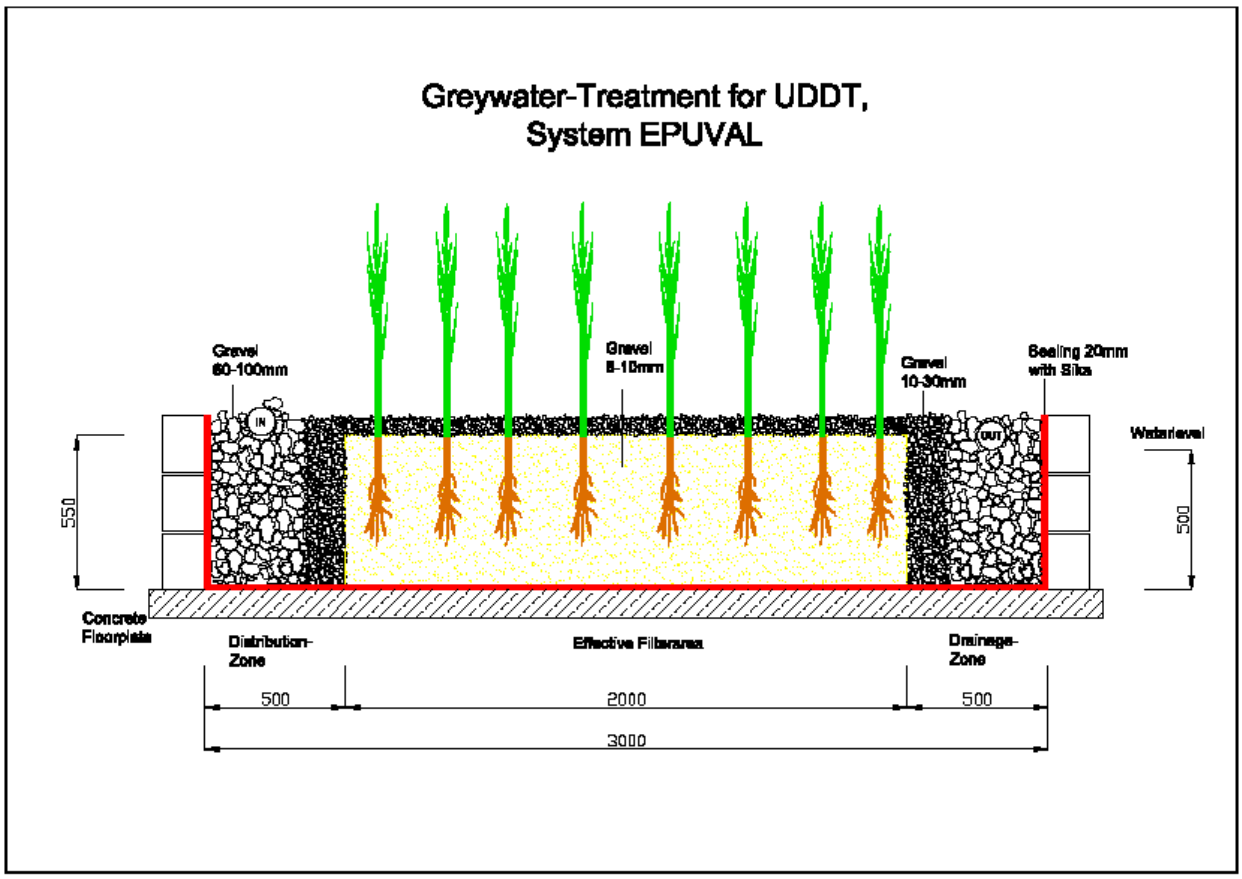

Fig. 15 : Constructed wetland EPUVAL

4.3.1. Principle

As shown in Fig. 15 the wastewater is distributed in the first section and then passes through the effective filter area where micro-organism remove organics and nitrogen. In the drainage section water flows out. The water level is determined by the position of the out flow pipe (0,55 cm) while the inflow pipe is positioned 5 cm above the outflow pipe (0,60cm) to prevent back flow.

The roots supply the watered filter with oxygen so that in the root layer there is an aerobic environment. Oxygen doesn't reach the area without roots so there is an anaerobic environment. This leads to an aerobic and anaerobic hybrid system which works well for greywater treatment.

Due to root growth the roots will expand through the filter and may reach the distribution and drainage area and improve aerobic processes.

4.3.2. Location of the constructed wetland

The location of the constructed wetland should be as close to the toilet as possible, to keep the pipes as short as possible. This also leads to a more compact overall-design of the whole sanitation-system. As with the toilet itself, when attaching the wetland to the toilet or to an existing wall, construction materials and time can be safed (all wetlands except Jane). In this case, the connection to the existing wall has to be solid and should be reinforced with iron bars.

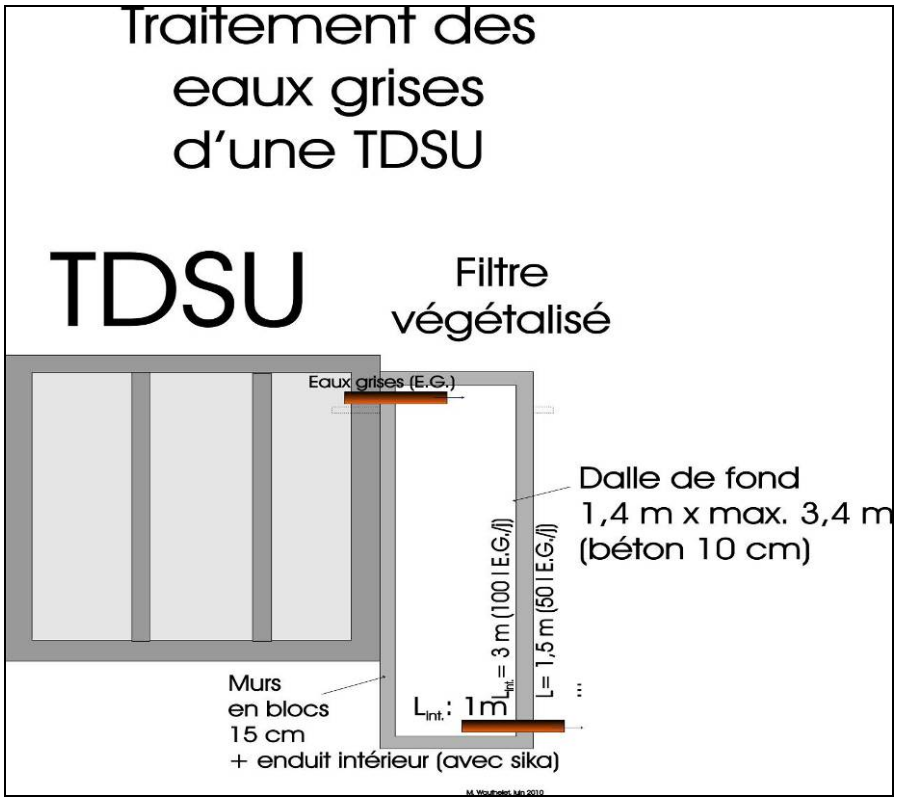

Fig. 16 : Plan of Wetland for treatment of Greywater [Wauthelet2010]

4.3.3. Design of Constructed wetland

Dimensioning a CW it is usual to refer the surface area of the effective filter area to the number of persons supplied by such a GW-treatment plant (e.g. min. 2 m²/cap). Since expected water consumption differs significantly it is not possible to dimension a CW using this parameter. Hence it should refer to the daily GW-production. Referring to this parameter a dimension factor of 2 [m²/100l GW] is used to determine effective filter surface area. While the proportion of filter length to width (effective area) should be min. 1,5:1. The length of the distribution and drainage area (each 0,5m) and the height of water level (0,55m) is constant.

For construction there are several adjustable and fixed parameters. Fig. 15 gives an example how to build CW for a GW-production of 100l per day. The adjustable parameter referred to varying GW- Production is the effective filter area. Under the next point “Dimension” it is explained how to use this parameter. The non adjustable parameters are the height of the water level, the position of in- and outflow-pipe (see above), as the length of the distribution and drainage section. The distribution- and drainage sections are filled with broken rock (5-10cm) and have a length of 0,5 meters. To prevent mixing of the coarse broken stone zone and the filter media (gravel) a 15 cm transition layer with coarse gravel (grainsize 10-30mm) can be set between. This divides the distribution- and drainage-layer into two subsections. Therefore the length of the broken stone (grainsize 5-10cm) is 0,35m so that the total length of 0,5m for the distribution-and drainage-area stays untouched. The filtermedia is gravel (grainsize 6-10mm) the length of this section is 2m (for 100 l-GW/d). The height of the sections is 0.6m.The filter is covered by gravel (grainsize 10-30mm). The coarse stone in drainage and distribution section should not be covered.

4.3.4. Construction

Foundation and Floorplate

Before the foundation can be build excavation work has to be carried out to level the ground for the Wetland and to assure a stable underground for the concrete foundation. For the concrete foundation a mixture of 1:4 or 250 kg/m^3 cement is used. Since ground character differs from location different techniques for levelling and stabilising have to be used. It is essential to create a stable ground before filling the concrete. Otherwise the wall might crack which leads to leaking and water-losses. For levelling the ground a water-level is used.
If the ground is sandy and loose excavation is easy but results in a too unstable ground for the concrete foundation. In this case a min. 10cm thick layer of stones should be laid below the floorplate. Onto this layer iron-armor is placed, compare Fig. 62 and Fig. 66. The steel mesh should have the same size as the excavation hole. To minimise effort on rocky grounds the loose ground should be removed and the generated holes can be filled with stones for levelling before filling the excavation hole with concrete. The floor plate should have a thickness of min. 10cm.

Walls

For building the walls of the wetland concrete, bricks (20 x 15 x 40) or natural stones can be used. For the mortar a mixture of 1 part concrete and 3 parts sand is used. Before laying bricks the profile of the outer wall-rectangle is lined with a construction line.
Using bricks the wall can be brought up easily and quick. When building up the wall with natural stones it is necessary to create a plain surface on the inner side of filter. Therefore a wooden frame can be used. It should be stabilised with iron bars or stones. While building the wall it is essential to leave 2 gaps for the in- and outflow-pipe (110mm-pipes).
The pipes will be adjusted and fixed after brickwork using mortar suitable filling. The in- and outflow-pipe have a slope of min. 2%. During brickwork it is essential to moisten the bricks. Due to

high temperatures and the water absorbtion of bricks the mortar itself dries quickly and gets brittle, which affects stability.
Considering the financial aspect using natural stones might be cheaper than using bricks but as it showed up during construction higher use of mortar outlines the advantage of using “costfree” natural stones. So bricks should be preferred as material.

Plaster of the walls

The wall is coated with two layers of plaster. The first layer a mixture with sieved sand the volumetric mixture is1 part concrete: 1 part chalk: 6 parts sand. For the second layer the mixture is 1 part SikaLite: 50 parts concrete: 150 parts sieved sand.

Hydrostatic test

For the function of the wetland it is essential that the construction is water tight. Before adding filter media it is necessary to check its tightness. This can be done by filling the construction with water and letting it stay for several hours. If the water level sinks the construction is not tight and an additional coating with Sika-mixture has to be done. If the test is successful filter media can be added. If also the second test does not work last opportunity is to coat the wall with bitumen.

Filtermedia

The filter consists of three different filter media arranged in 3 (5 with transition section) different section. To keep a clean boundary between sections a wooden frame is set and then the filter media is filled into the space the wooden frame is stabilised with iron bars compare Fig. 101 (right). Doing this the work should start at in- and outflow-side, respectively with the distribution and drainage section, of the filter so that the last (middle) section can be filled with gravel. Supporting the stabilisation with filter media on both sites will help to keep a clean boundary. After filter media is added the wooden frames can be removed and the last horizontal 10cm cover layer of stones can be set.

Planting

Last step is planting the filter with reed (Phragmites). The denseness of plants is 4-6 plants/m². They can be planted in all seasons except in winter. Plants have to be planted with roots in the filtermedia and not in the cover layer.

4.4. Beigewater-treatment for Infiltration

4.4.1. Simple sand-filter

If only handwashing-greywater and or beigewater from anal cleansing is produced in the UDDT, the volumes are too small to reuse. In this case a filter and afterwards infiltration is recommended. Since in the here constructed toilets the greywater from the sinks is treated in the constructed wetlands, only beigewater is treated in the simple filter. The beigewater contains many pathogens from anal cleansing. This makes the reuse of this water critical. Since the volumes of beigewater are small, infiltration after filtration in a simple sand-filter is the best option.

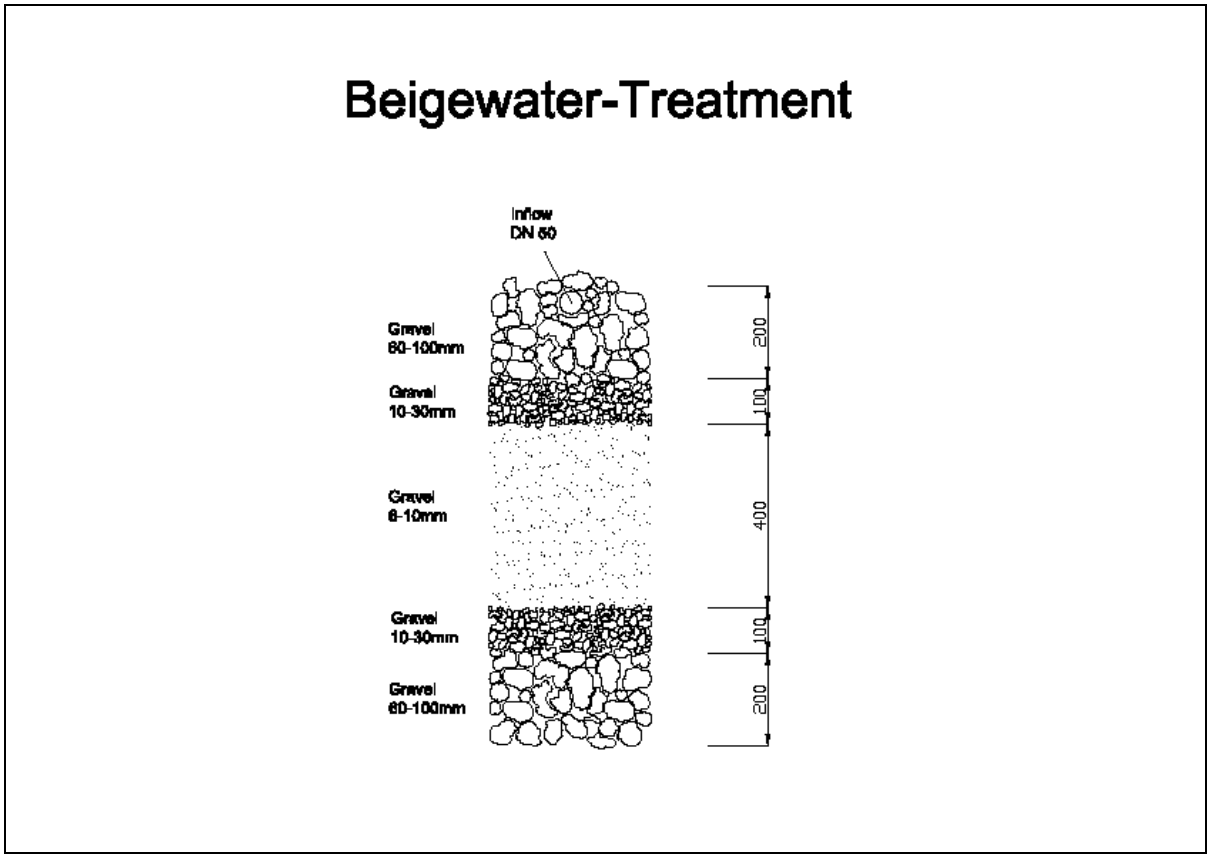

Fig. 17 : Principle of Beigewater-Filter

Fig. 17 shows a cross-section of the sand-filter. The beigewater enters the filter in the upper distribution layer via a 50mm pipe. It is evenly distributed until it reaches the effective filter-area, where microorganisms treat the wastewater aerobically.
After the wastewater passed the effective filter is a drainage-layer to distribute the filtered beigewater evenly and ensures good infiltration. In Fig. 89 the different kind of stones and gravels can be seen. If the underground is rocky or contains high portion of fine particles like clay, the infiltration-area needs to be enlarged, compare Fig. 88.

5. Objective of the workshops

The workshops should not just improve the beneficiaries sanitation situation, a major objective is to build capacity and knowledge. After the workshop dwellers and masons should be able to build further toilets by themselves and know how to use and maintain toilets. A second project area is to communicate knowledge on correct and safe reuse of toilet-products (urine and dried/composted faeces). Therefore, during the construction were local dwellers and masons trained on how to build this kind of toilets. In the workshops 4 UDDTs have been build. Table 3: Characteristics of the 4 constructed UDDTs shows the characteristics of the toilets.

Table 3: Characteristics of the 4 constructed UDDTs

UDDTs Dayet Ifrah	Unit				
Beneficiary	[-]	Ferhaoui	Jane	Ahnouch	Khaled
Nr. of users total	[-]	14	5	7	3
Location of the toilet		Free	Adjacent	Free	Adjacent to wall
Foundation-area	[m2]	5,3	2,4*2,6 =6,2		
Floor area effective	[m2]	2,2*2,2= 4,8	2,2*2,2=4,8	1,6*1,6=2,6	2,15*2,15= 4,6
UD-model		China	India	India	India
Sink	[y/n]	Y	Y	Y	Y
Shower	[y/n]	Y	Y	N	Y
Material	[-]	concrete-bricks	concrete-bricks	concrete-bricks	natural stones
Faeces-storage-volume	[l]	2*1,45	2*1,15	2*1,05	2*1,15
Urine-storage-volume	[l]	1000	200	200	200
Location of wetland		Adjacent to toilet	Free	Adjacent to stable	Adjacent to toilet
Wetland foundation area	[m2]	1,4*2,2=3,1	1,6*3,6=5,8	1,2*2,05=2,5	1,2*2,4=2,9
Wetland total area	[m2]	1,25*1,9=2,4	1,0*3,0=3,0	1,05*1,75=1,8	1,05*2,25=2,4
Wetland effective area *	[m2]	1,25*1,1=1,4	1,0*2,0=2,0	1,05*1,0=1,1	1,05*1,45=1,5
Kitchen connected	[y/n]	N	N	Y	N
* Volume without inflow-/outflow-area					

6. Workshop Preparation

Preparations were necessary before arrival in Morocco. A preliminary material list and tool-list was elaborated. The materials and tools needed for the first day (building the foundation) should be organised beforehand. The other materials could be bought during the workshop. A schedule for the workshop was also elaborated in advance.
On Dec. 11th 2009 a meeting in Agadir of the project-team and head of project Mrs. Werner was held. Financial issues were discussed. After a discussion about the type of toilet (single- or. double-vault) we made the decision to construct in the first step only double-vault-UDDT because less maintenance is required for double-vault UDDTs compared to single-vault-UDDTs. Also the risk of handling fresh faeces and the risk of hygienically reusing of not proper treated/stored/composted faeces is higher.
The decision, if the pilot-toilets should have a shower or not will be left to the beneficiaries. (later, after the experience from part 1 of the workshop and because of the high costs of the first UDDT with shower, we propose to build 1 variant without shower/wash-place (although family prefers to have a shower, understandably!).

6.1. Selection of beneficiaries

The following factors for the selection of the beneficiaries have been taken into account:

- The family has no sanitation facility
- The dwelling is located near the center of Dayet Ifrah for workshop practicability (easy to switch between the construction-sites and potentially an increased number of participants and interested dwellers)
- The beneficiary-families should have a garden or field where the products can be used
- The beneficiaries are interested in sustainable sanitation and reuse of the toilet-products

4 Beneficiaries have been identified and been selected for implementation, compare Table 3:. All 4 Families fitted the above mentioned criteria for the selection. Only one problem occurred with Fam. Ahnuch, whose field, which they showed the projectteam for reuse of the products did not belong to them! But the sheik of Dayet Ifrah later gave a plot to the family.

6.2. Local Conditions

The project-village is located at an altitude of 1700m above sealevel. Here cold winters can occur and need to be considered for the urine-storage, smell-traps, possibly insulation.

Problem during summer, they have work elsewhere

Weather

Workshop timing was not good. In the middle to end of Dec. there was lots of rain, the temperatures were +/- zero degree Celsius. There were also strong winds, which made the wind-chill factor even lower. The helpers had no good / appropriate working clothes, sometimes wearing flip-flops barefeet.
The low temps are a problem for the curing of the concrete. Therefore cement 45 was selected (and was the only kind available at this time of the year).

Fig. 18 : Frozen water in the afternoon! of 15.12.09 (photo: S. Deegener)

6.2.1. Construction Materials

Availability of Construction Materials

There is no shop for construction-materials in Dayet Ifrah. Most materials can be found in Immouzer or Ifrane .The costs for transport of the materials have to be taken into account. For the second and third mission most materials have been ordered in Fes, since huge quantities have been needed for the biogas-plant and constructed wetland for the school and mosque.
The material list and prices for the UDDT incl. constructed wetland can be found in Table 4: .

7. Detailed Report of Activities Mission 1

7.1. General

7.2. Planned Schedule/Timeline

Day 0: Visit of the construction-site, discuss place for the construction together with the beneficiaries, come to a decision on location, check prepared materials
Day 1: Building of formwork for foundation; build foundation, Introduction-Lecture
Day 2: Building the walls of the faeces-chambers, possibly prepare formwork for floor of toilet room
Day 3: Pour groundplate of floor for toilet room
Day 4: Building of the superstructure-walls (walls of toilet room)
Day 5: Building of toilet roof
Day 6: Sanitary installations, Installation of door, window and faeces-chamber-doors
Day 7: Inauguration of finished toilet, Lecture on maintenance and reuse

Remark: because of the weather conditions, material-problems, etc. the workshop could not be finished in the time planned. Therefore a second (and third) mission was planned.

7.3. Saturday, 12.12.2009

Saturday arrival in Ifrane.

7.4. Sunday, 13.12.2009

In the morning the project-team met Mr. Salahedin from Al Akawayn University, Ifrane.
We discuss different construction-types and different materials. Mr. Salahedin is looking for people from the University who can/want to participate in the workshop. Beforehand the gardener of the University was identified by Lukas Ulrich as an interested and possible participant.
At noon the project team travels to Dayet Ifrah, visit 2 (previously selected) beneficiary-families, discuss different places for the planned toilets, both want shower (wash-place) inside the toilet,
Places were selected by beneficiaries as part of the participatory approach, compare chapter 3.7 “Sustainability of UDDT-Pilot-Projects”.
Inside the existing house no place for the toilet, but as close as possible to the house.

Fig. 19 : Site visit beneficiaries, Ferhaoui left and Jane right

Meeting with Sheikh, in which we discuss the financial issues of the toilets (project pays all or contribution by beneficiaries). After some discussions, sheikh remembers, that it was agreed beforehand that the beneficiaries should pay masons, project pays materials. (See also (Compare with) new politics in 2nd and 3rd mission!)
No materials were organised yet, although it was agreed on this before.
Evening: Calculation of the needed space and preliminary design of toilet. Special attention has to be paid to the direction of the urine-diverting-pans, in moslimic countries they must not be in the same direction of praying (Mecca). For Dayet Ifrah this means that the slabs should be in the direction N-S.
Single-vs. double-vault: it was decided already before to choose double-vault UDDTs for the first pilot-toilets.

7.5. Monday, 14.12.2009

No materials are delivered yet.
Family Jane has no mason, nor workers: The project-team decides not to build the toilet for this family at this point of time (December).

Part of the project-team leave to order sand and buy first materials.

Fig. 20 : Place and setting the formwork for foundation at Ferhoui

We start excavation for the foundation.
In the afternoon wood for the formwork of the foundation was delivered and construction of the formwork for the foundation could start. Problem: the supplied wood-boards were only borrowed and were not allowed to be cut, because replacement would be expensive.
Problem: rocky ground, where digging is extremely difficult, in most places even impossible. Surface-near rocks (weather-beaten, up to aprox. 10cm below surface) can be broken, but deeper rocks are impossible to break with the (simple) tools available. This fact needs to be taken into account also for the location of the urine-tank and greywater-treatment.

7.6. Tuesday, 15.12.2009

We start pouring the foundation in the morning and finish in the evening.

Fig. 21 : Finished formwork for foundation, interested neighbours watch pouring concrete

7.7. Wednesday, 16.12.2009

Fig. 22: Finished foundation

In the morning we start building the faeces chamber walls. After 1 hour watching, we decide to stop, because the mason doesn't have the skills to build the walls in an acceptable way, he is not an educated mason, maybe helper.
We ask the family to call for a proper mason. After the professional mason arrives, we start building of the faeces chamber walls.

Fig. 23 : Mason building faeces chamber walls

These concrete-bricks have a bad quality. They have to be filled with concrete and gravel (small stones) to allow sufficient stability.
An alternative (and as the locals build) would be a concrete frame (piles with iron), so that only small loads have to be carried by the stones.
But due to time-considerations, we continue with filling the bricks with concrete and stones/gravel.
For the next toilets, we want to use different kind of bricks, either burnt clay-brick or 20 cm wide concrete-bricks with reinforcement (we choose the latter for the other toilets) that do not need to be filled with concrete and still offer sufficient stability.

In the evening the faeces-chamber-walls are almost finished, 4 out of 5 layers are done.

Fig. 24 : Faeces chamber walls

7.8. Thursday, 17.12.2009

Thursday: no mason
We decide to continue with the construction of stairs, because no mason is needed for this construction-stage.
The stairs are built in such way, that the slope of the terrain is used in order to reduce the number of needed steps. Also the entrance of the toilet is located as close as possible to the exits of the existing house.

Fig. 25 : Building stairs

In the afternoon I give a presentation on Ecological Sanitation and UDDTs in women's house, Nour el Houda provides the translation English-Arabic.
Approx. 30 dwellers attend the presentation. Most participants seem very interested. Part of the presentation is taken over by Mohammed Jane. He and other participants know already

something about Ecosan and UDDT from earlier presentations held by Lukas Ulrich and others in the preparation-phase of the project (before this mission).

Fig. 26 : Presentation in women's house, also Mohammed Jane explains details

7.9. Friday, 18.12.2009

On Friday the mason finally arrives and finishes the faeces chamber walls.

Fig. 27 : Faeces chamber walls and stairs

7.10. Saturday, 19.12.2009

There is heavy rain on Saturday, so it is impossible to do construction works. Consequently, Lukas Ulrich and me are leaving to Fes to search for needed materials. We purchase a pump to extract urine from the tank. We found 2 options: One pump for 140MDH is originally intended for pumping oil. An alternative would be pump for 160MDH.
We are also looking for urine-storage-containers and find 2 suitable variants:

1. IBC 1000 liter for 1000MDH
2. PE-Oilbarrel 200 liter: 300MDH

We inspect also different door-makers and carpenters in Immouzer and Ifrane.
We return to Dayet Ifrah in the afternoon and prepare iron and lower formwork for the groundplate.

Fig. 28 : Preparing lower formwork and cutting iron for armour of the ground plate

7.11. Sunday, 20.12.2009

In the morning we finish the formwork for the ground plate and finalising the armour.

Fig. 29 : Prepared formwork for ground plate and finished ground plate

In the afternoon we are pouring the ground plate. Note the formwork for the UDDT-slabs and pipes in Fig. 29.
In the evening we leave to Fes. When leaving 1-2 sacs of cement are left over. The locals use this to finish the stairs. We decide that the locals should not continue to build the walls of the superstructure, because of the risk that they might build them in a wrong way without proper supervision.

7.12. Remarks to Mission 1

7.12.1. Finish first toilet Family Ferhoui

To finish the superstrucure of the Ferhaoui-UDDT following materials are still needed:

Faeces-chamber-doors: 3 pieces
Door
Roof-plates (At this stage of the project it was planned to build the roof from metal-sheets, because this is much faster than building it from concrete. Because time was not a critical factor for the 2nd and 3rd mission and a concrete-roof fits better to the local building-style, we finally build it from concrete.)
Urinal (possibly bottle/canister)
Tiles for floor
Paint
Wood for support of roof
cement
Impossible to dig, so stable best possibility for frost-protection

Fig. 30 : Photo of stable for urine-tank

8. Detailed Report of Activities 2nd Mission

8.1. General

It was decided that this time a big, hands-on workshop should be carried out, to train as many people as possible. The workshops consisted of a combination of theoretical and practical lessons. There have been 2 groups, each of them had 5 days in week 1 and week 2.
Other changes compared to mission 1 was that 4 toilets instead of 1 demonstration-UDDT should be build. Also each of the 4 toilets should get a sophisticated constructed wetland for greywater treatment instead of a simple-sand filter with infiltration.
Additionally to those seminars, special lectures were held for beneficiaries and masons.

8.2. Sunday 13.06.2010

We visit Dayet Ifrah for workshop preparations.

Fig. 31 : State of UDDT Fam. Ferhoui on 13.06.2010

We visit the construction site of Fam. Ferhoui. The stairs of the Ferhoui-UDDT have been finished, although not very accurate, see Fig. 31 .
We also visit Fam. Jane. The family has already decided on the place for the UDDT (as participatory contribution) and started excavation works.

Fig. 32 : Place for Toilet of Fam. Jane, Excavation work already started

8.3. Monday 14.06.2010

Two parallel seminars were held: The first one for the invited guests, the second one for beneficiaries and masons. Nour el Houda provides translation.
We start with foundation-works at Jane after completion of the workshop for masons.

Fig. 33 : Parallel seminar for beneficiaries/masons (left) and water-professionals (right)

Construction materials are delivered and distributed to the different construction-sites.

Fig. 34 : Natural stones for Construction of UDDT for Fam. Khaled, sand-delivery

8.4. Tuesday 15.06.2010

In the morning we continued with the seminars.

Fig. 35 : Foundation works Fam. Jane

8.5. Wednesday 16.06.2010

On Wednesday morning, all masons have been ordered to the construction-site of Fam. Jane to demonstrate how to build a proper foundation.

Fig. 36 : Excavation Fam. Jane (left), adding water to finished groundplate (right)

In the afternoon we start excavation-work at Fam. Ahnuch. The ground is a very rocky, which has the advantage that it is solid and less concrete has to be used for the foundation. On the other hand the ground makes problems when digging for wetland, beigewater-infiltration and urine-tank.

Fig. 37 : Excavation for UDDT at Ahnuch, note rocky ground !

Start excavation at Fam. Khaled

Fig. 38 : Preparation of formwork for foundation at Khaled

8.6. Thursday 17.07.2010

Pour foundation at Khaled, Ahnouch

Fig. 39 : Pouring foundation at Fam. Khaled (left) and Ahnouch (right)

Fig. 40 : Faeces-chamber-walls at Jane, note space for pipes (left); formwork for plate (right)

Fig. 41 : Building superstructure-walls at Ferhoui

8.7. Friday 18.06.2010

Fig. 42 : Almost finished walls at Ferhoui

At Ahnuch and Khaled we begin with the construction of the faeces chamber walls.
At Jane we prepare the formwork and the iron for pouring the plate:

Fig. 43: Building the formwork and iron for the plate

8.8. Saturday 19.06.2010

No seminar-participants, only project-team, locals and masons.

Fig. 44 : Building beam above door at Ferhoui

We continue with the faeces-chamber-walls at Khaled. It is much more time-consuming building the walls from natural stones compared to bricks (all other toilets). Also much more mortar is needed to connect the stones with this type of construction.


Fig. 45 : Support for and lower formwork for plate at Ahnouch


Fig. 46 : Pouring groundplate at Jane

In order to purchase/order doors and windows, part of project-team went to market in Fes.

8.9. Sunday 20.06.2010

The construction-work is only carried out by masons and families.


Fig. 47: Building stairs (left) and preparation for plate at Khaled (right)

At Jane no work is carried out because the concrete of the plate has to cure minimum one day before we can start with the erection of superstructure walls.

At Ferhaoui the first layer of plaster is applied to the finalised walls.

Fig. 48: Plastering of the walls at Ferhaoui

8.10. Monday 21.06.2010

A new group of invited water-professionals arrives. The seminar is this time only held for them and no sessions are provided for beneficiaries and masons (they have been trained the week before).

Fig. 49: Pouring (left) and finalised plate at Khaled

Fig. 50 : Cutting iron for plate and pouring plate at Ahnuch

The traditional and local way to cut the iron bars is with axe and hammer, compare Fig. 50

Fig. 51 : First layer of plaster (left) and start sanitary installations at Ferhoui

Fig. 52 : Formwork for roofplate at Ferhoui

Fig. 53 : Theoretical and on-site lessons for the next water-professional-group

8.11. Tuesday 22.06.2010

After the theoretical part of the seminar in the morning, the participants work on the construction-sites.
At Ferhaoui we start the excavation for the wetland. There is an extremely hard underground.
No work is carried out at Ahnuch because the concrete of the plate has to dry.
At Jane the superstructure walls are build.


Fig. 54 : In the afternoon seminar-participants building walls at Khaled (left) and Jane (right)

8.12. Wednesday 23.06.2010


Fig. 55 : Building superstructure walls at Ahnuch (left) and Khaled (right)

At Jane the formwork and iron for the roof of toilet are prepared. At Ferhaoui we continue with the installation of the pipes and dig for the wetland.

8.13. Thursday 24.06.2010

Fig. 56: Formwork and iron for roofplate (left) and finished roofplate at Jane

Fig. 57 : Excavation for wetland (left) and urinetank in stable (right) at Ferhaoui,

At Ferhaoui we continue with excavation. The excavation for the wetland at Ferhaoui is very time-consuming because of the rocky ground.

Fig. 58 : Demonstration how to make adapters from PVC-pipes with heat

At Ahnuch no progress is made, because the mason works at Marc Wauthelet's constructed wetland at the mosque.
In the afternoon no work is done because the we have a big barbecue-party.

8.14. Friday 25.06.2010

Certificates for participants.

Fig. 59 : Excavation for wetland at Jane

Fig. 60 : Building walls (left) and at Khaled

At Ferhaoui all Pipes have been connected to demonstrate how the toilet works, compare Fig. 61. At Ahnuch the UD-slabs and tiles have been arranged to show the seminar-participants how the toilet will look like after finalisation.


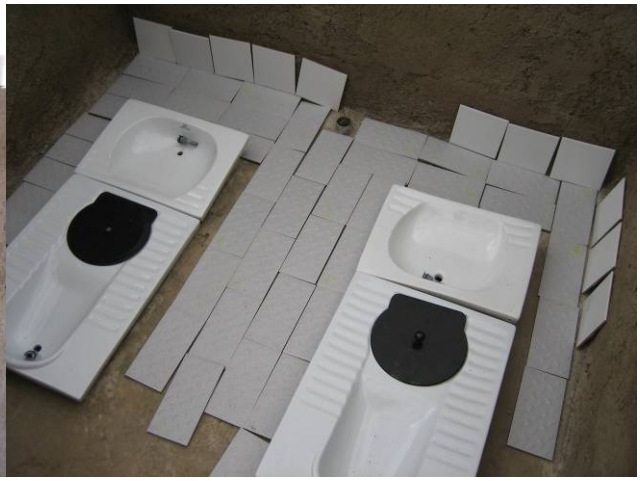

Fig. 61 : Provisorical sanitary installations at Ferhaoui (left) and Ahnuch (right)

8.15. Saturday 26.06.2010


Fig. 62 : Iron for floor of wetland (left) and excavation for urine tank (right) at Jane


Fig. 63 : Finalise walls (left) and preparing iron for roof-plate (right) at Ahnuch,

Fig. 64 : Ferhaoui-UDDT almost finished

Fig. 65: Pouring roof plate at Khaled

8.16. Sunday 27.06.2010

Fig. 66 : Preparation (left) and finished floorplate of wetland at Khaled

Fig. 67 : Building walls of wetland (left) and installation of doors (right) at Jane

Fig. 68: Installation of urine-pipe (left) and plaster of ceiling (right) at Ferhaoui

Fig. 69: Formwork for beam above door at Ahnuch

At Ahnuch next to the beam above the door is poured the walls are plastered and the formwork for the roof plate is prepared.

8.17. Monday 28.06.2010

We held a meeting with all masons to discuss the work that can be carried out before my next arrival in Dayet Ifrah.

Fig. 70 : Planning meeting with all masons (left) and detailed instructions for each mason (right)

Fig. 71 : Installing ventilation-pipe (left) and plaster of the wetland (right) at Jane

Fig. 72 : Building walls of wetland and urine-pipeline at Ferhoui

Fig. 73: Formwork for (left) and pouring of roofplate (right) at Ahnuch

Fig. 74 : Walls of wetland at Khaled

At Khaled the walls of the wetland are build.

8.18. Tuesday, 29.06.2010

Travel Dayet Ifrah to Fes.

8.19. Tasks for Masons to do

For the time between leaving and next arrival following work should be carried out by the local masons: Tiles for the walls should be applied and sanitary installations should be carried out under supervision of the mason Moha Ali, since he was trained best for this task. All pipes should be laid, but not glued to eventually fix/repair them.

8.20. Remarks to Mission 2

Lukas Ulrich was essential to supervise 2 of the 4 construction-sites, because the local masons seemed to stop working as soon as he or I left. The distance between the sites caused difficulties, because we had to switch very often. A bicycle would have been good.

We had a lack of skilled masons. This led to a “Fight for workers”. Some of the masons that should have worked at the UDDTs were ordered to work at the constructed wetland for the school/mosque and the digester. This led to a delay for the construction of the UDDTs.

9. Detailed Report of Activities 3rd Mission

9.1. General

The project-team decided that it was necessary to come back and finalise the started project and constructions.
Mainly Finalisation of constructions
Sanitary installations
Wetlands
Tile-layer cannot be found, so we had to select an amateur: this has led to not accurate laying of tiles, slope wrong, e.g. at Ferhoui, shower-water flows into anal-cleaning-bowl.

9.2. Saturday, 17.07.2010

Arrival Rabat

9.3. Sunday, 18.07.2010

Travel Rabat-Ifrane
Visit Dayet Ifrah, we check the work done during the last weeks.

Fig. 75 : Wetland (left) and roof (right) of Jane, note pipe for water-connection !

Later Fam. Jane want to install a big water-reservoir on the roof. Therefore a pipe has been put into the roof to make the installation easier later.

Fig. 76 : Wetland at Ferhoui

Fig. 77: State of the UDDT at Ahnuch

9.4. Monday, 19.07.2010

Fig. 78 : Preparation for wetland (front) and urine-tank (back) of Ahnuch

Fig. 79 : Urinetank (left) and beige-water-infiltration (right) at Jane

Fig. 80 : Repairing of broken roof at Jane

Fig. 81: Plaster of wetland, beigewater-infiltration (left) and sealing of roof (right) at Ferhaoui

9.5. Tuesday, 20.07.2010

Fig. 82 : Preparation for floorplate of wetland and urine-tank at Ahnuch

Fig. 83 : Repair of broken sealing of wetland (left) and digging for urine-pipe (right) at Ferhaoui

Fig. 84 : Plaster of wetland at Khaled (left) and Jane (right)

Fig. 85 : Transport of urine-tank from center to Ferhoui by donkey

9.6. Wednesday, 21.07.2010

Fig. 86 : Building walls of wetland at Ahnuch

Fig. 87 : Repairing of broken floor of wetland at Ferhaoui, compare Fig. 83Fig. 83

Because of the clay-soil, we increase the infiltration area at Jane, so that blockage of the infiltration will less likely occur.

Fig. 88 : Increasing infiltration-area at Jane

9.7. Thursday, 22.07.2010

Fig. 89 : Drainage-Layer (left) and transition-layer (right) for beige-water-infiltration at Jane

Fig. 90 : Walls for Urine-tank (front) and wetland for Greywater (background) at Khaled

Fig. 91 : Preparing floor for tiles at Jane

Fig. 92 : Preparing tiles and almost finished floor at Ferhaoui

At Ahnuch we apply 2 layers of plaster to the walls and floor of the constructed wetland.

9.8. Friday, 23.07.2010

Fig. 93 : Influent-pipe exactly 5cm higher than effluent-pipe at Jane

9.9. Saturday, 24.07.2010

Fig. 94 : Floor finished at Ahnuch

Fig. 95 : Metal-cover for urine-tank (left) and filling wetland with gravel (right) at Khaled


Fig. 96 : Adjusting height of urinal at Jane (left) and Ferhoui (right)

Fig. 97: Urine-Tank (left) and beigewater infiltration (right) at Jane

9.10. Sunday, 25.07.2010

All sanitary installations are done at Jane at Ferhaoui, but not fixed finally. So a provisorical use of the UDDT is possible.

Fig. 98 : Test of ventilation-efficiency with smoke

Fig. 99 : Planting reed at Jane (left) and urine tank/ constructed wetland at Ahnuch (right)

Fig. 100 : Infiltration-drainage-layer at Khaled

Fig. 101: Beige-water-filter (left) and inflow-area of wetland (right) at Ferhoui

9.10.1. Lecture on maintenance and reuse

After finishing the toilets, a lecture with practical maintenance-tips was conducted for the beneficiaries. Focus was on cleaning. Also the application of urine was discussed. Reuse according WHO-guidelines for safe reuse, adapted to cold climates.

Fig. 102 : Presentation for Beneficiaries on Usage and maintenance of UDDTs

9.11. Monday 02.08.2010

We finalise sanitary installations at Ferhaoui and Jane.

Fig. 103 : Greywater-pipe from kitchen to wetland at Ahnuch

9.12. Tuesday 03.08.2010

Finalise sanitary installations.
Change pipes at Jane

Fig. 104 : Pipes at Khaled below shower (left) and in faeces-chamber at Ahnouch right

In Fig. 104 the difference between a simple double-vault UDDT and a UDDT with shower can be seen. On the left in the chamber below the shower the pipes can be laid with maximum inclination, whereas on the right (simple UDDT) the pipes have to be laid as close to the wall and the top of the chamber as possible, so the pipes do not interfere with the faeces.

Fig. 105 : Water-tank, sink and place for shower at Khaled

Fig. 106 : Poster for correct use in all UDDTs

10. Next steps

10.1. Low-cost UDDT

One of the biggest problems is that the projects UDDTs systems are not affordable for rural dwellers. Especially, rural areas are often quiet poverty struck and have simultaneously a high demand for sanitation improvement as negative health impacts keep the poverty spiral even more in motion. At the same time are systems more accepted, sustainable in their usage and long term impact, when beneficiaries feel a high grade of ownership. In order to make it possible that these projects have a snowball effect instead of just singular impact dependant on subsidies the systems need to be more affordable than the tested ones.

The here constructed first 4 pilot- UDDTs in Dayet Ifrah are quite expensive, compare Table 4: . This is not replicable for the local dwellers without subsidies. The (long-term) aim should be to

demonstrate a variant that can be replicated without external help and with the capacities that have been built during the workshops/trainings.

Compared to the first toilets, following cost-saving measures can be applied and can serve as an example for realising low cost variants:

- Indoor-UDDT: A lot of materials can be saved if the UDDT is constructed inside the house.
- smaller footprint, no shower-place, no sink inside the toilet (outside sink)
- no tiles but instead painted floor and walls
- metal/wood-roof instead of concrete-roof
- greywater infiltration instead of treatment

10.2. Monitoring / Evaluation

Regular monitoring and evaluation are, especially for pilot-projects like this, essential for a successful and sustainable project.

10.3. Water- and Sanitation Commitee

For a successful project it is recommendable to establish a local (on village-level) structure for coordination with the giz and scientific local partners. This could result as a next step in a local water/sanitation committee. Local water committees are one idea for institutionalising local participation and generating future independence from external consulting. Funding should be directed into this kind of infrastructure as it generates long term sustainable solutions and snowball effects in for of knowledge transfer instead of one time material transfer.

11. References

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12. ANNEX

12.1. Material lists incl. costs

Table 4: Materials UDDTs with constr. Wetland for greywater-treatment

Matériau	Unité	DI 2010 [DH/Unité]	Réel [DH/Unité]	Quantité	Coûts [DH]	Quantité	Coûts [DH]	Quantité	Coûts [DH]	Quantité	Coûts [DH]
Ciment CPJ45	t	1270		1,7	2159	1,45	1841,5	1,2	1524	2,05	2603,5
Ciment CPJ35	t			0	0	0	0	0	0	0	0
Sable	m3	170		4	680	3	510	2,7	459	4,7	799
Sable "Oued"	m3	292		1	292	1	292	1	292	1	292
Sable "Meknès"	m3	300		0	0	0	0	0	0	0	0
Gravier concassé	m3	150		2,5	375	2	300	1,5	225	2	300
Gravette 6-10 mm (pour filtre planté)	m3	200		0,7	140	1	200	0,7	140	0,7	140
Moellons (pierres naturelles)	m3	120		0	0	0	0	0	0	5	600
Moellons locales (pierres naturelles)	m3	0		0	0	1	0		0		0
Barres de fer 8 mm	m	3,75		150	562,5	200	750	150	562,5	200	750
Fil de fer pour ferraillage	kg	30		1	30	1	30	1	30	1	30
Sikalite	kg	8		3	24	3	24	2	16	2	16
Bitume Flintkote	kg	10		1	10	0	0	1	10	0	0
Clous 100 mm	kg	30		0,75	22,5	0,75	22,5	0,75	22,5	0,75	22,5
Clous 60 mm	kg	30		1	30	0,5	15	1	30	1	30
Briques rouges, 15*20*40 cm	p	4		0	0	70	280	60	240	60	240
Briques 10*20*40 cm	p	3		60	180	50	150	20	60	60	180
Briques 20*15*40 cm	p	5		370	1850	160	800	220	1100	0	0
Carrelage 15*15 cm	m2	110		8	880	8	880	4	440	8	880
Ciment pour carrelage	kg	2		75	150	75	150	75	150	75	150
Bâche en plastique	m2	20		20	400	20	400	20	400	20	400
Téflon (rouleau)	p	13		1	13	1	13	0	0	1	13
Tuyau pour ventilation 160 mm, 3m	p	90		1	90	1	90	1	90	1	90
Coude 45° 160 mm	p	35		1	35	1	35	1	35	1	35
Collier 160 mm	p	30		1	30	1	30	1	30	1	30
Coude 45° 110 mm	p	9		5	45	0	0	2	18	0	0
Coude 90° 110 mm	p	12		5	60	0	0	3	36	3	36
Réduction 110/100 mm	p	10		0	0	0	0	1	10	0	0
Pièce T 110 mm	p	15		0	0	0	0	2	30	0	0
Tuyau 100 mm en PP	p	13		12	156	5	65	14	182	6	78
Réduction 100-50 mm	p	7		1	7	1	7	1	7	1	7
Tuyau 50 mm en PP	m	8		13	104	14	112	16	128	20	160
Pièce T 50 mm	p	6		3	18	2	12	3	18	2	12
Coude 90° pour tuyau 50 mm en PP	p	3		11	33	11	33	7	21	10	30
Coude 45° 50 mm	p	3		6	18	6	18	6	18	8	24
Pièce Y 50 mm	p	6		2	12	2	12	1	6	2	12
Réduction 50/40 mm	p	3		4	12	4	12	4	12	4	12
Collier 50 mm	p	2,5		8	20	8	20	8	20	8	20
Cheville 8 mm	p	0,2		8	1,6	8	1,6	8	1,6	8	1,6
Colle PVC	kg	90		1	90	1	90	1	90	1	90
Urinoir céramique "Porcher"	p	**40**		1	40	1	40	0	0	1	40
Urinoir plastique "Addicom"				0	0	0	0	1	0	0	0
Siphon 50 mm	p	70		2	140	2	140	2	140	2	140
Entonnoir	p	0		2	0	0	0	0	0	0	0
Robinet à boisseau sphérique	p	25		1	25	1	25	1	25	1	25
Lavabo	p	220		1	220	1	220	1	220	1	220
Fixation pour lavabo (vises et chevilles)	p	13		2	26	2	26	2	26	2	26
Robinet lavabo	p	60		1	60	1	60	1	60	1	60
Tuyau métalloplastique	m	6		1	6	1	6	1	6	1	6
Pièce T pour tuyau métalloplastique	p	22		1	22	1	22	1	22	1	22
Silicone	p	33		1	33	1	33	1	33	1	33
Moustiquaire	p	15		0,2	3	0,2	3	0,2	3	0,2	3
Bois de coffrage (Madrier)	m	20			0		0		0		0
Chapeau métal pour ventilation	p	50		1	50	1	50	1	50	1	50
Chapeau métal pour fourneau	p	30		1	30	1	30	0	0	1	30
Tube métal pour fourneau	p	20		1	20	1	20	0	0	1	20
Fourneau (fourni par bénéficiaire)	p	0		1	0	1	0	0	0	1	0
Porte métallique (pour fosses)	p	250		3	750	3	750	2	500	3	750
Réservoir 200l	p	200		0	0	1	200	1	200	1	200
Réservoir 1000l	p	1000		1	1000	0	0	0	0	0	0
Carrelage fond	m2			5	0	5	0	3	0	5	0
Fenêtre	p	180		1	180	1	180	1	180	1	180
Porte	p	480		1	480	1	480	1	480	1	480
Rideau de douche avec fixation	p			1	0	1	0	0	0	1	0
Chaux pour mortier	kg			75	0	75	0	75	0	75	0
Siphon pour douche	p	40		1	40	1	40	0	0	1	40
Réservoir eau potable 20l	p			0	0	1	0	1	0	1	0
Poubelle 25l	p	179		1	179	0	0	0	0	0	0
Couleur noire	kg			0,25	0	0,25	0	0,25	0	0,25	0
Diluant	l			0,25	0	0,25	0	0,25	0	0,25	0
Gravier 10-30mm (pour filtre planté)	m3			0,2	0	0,2	0	0,2	0	0,2	0
Pompe manuelle pour urine	p	140		1	140	1	140	1	140	1	140
Tuyau 110?	m				0		0		0		0
Coude 100 mm 90°	p				0		0		0		0
Seau pour cendre	p			1		1		1		1	
Pelle pour cendre											
Préservatif (comme vanne d'odeurs)	p										
Main d'oeuvre	jour										
Total					11973,6		9660,6		8538,6		10548,6

12.2. Progress of work at each construction-site

Table 5: Timeline Ferhaoui

Sunday	13.12.2009	site-visit, decicion for place of UDDT
Monday	14.12.2009	start excavation, formwork for floor of faeces-chambers
Tuesday	15.12.2009	pouring foundation and groundplate
Wednesday	16.12.2009	start building faeces-chamber-walls
Thursday	17.12.2009	no mason to continue walls, building stairs instead
Friday	18.12.2009	finish faeces-chamber-walls
Saturday	19.12.2009	preparation for groundplate
Sunday	20.12.2009	pouring groundplate
	between	curing groundplate, finish stairs (not so accurate)
Monday	14.06.2010	-
Tuesday	15.06.2010	-
Wednesday	16.06.2010	-
Thursday	17.06.2010	build walls
Friday	18.06.2010	continue walls, except beam above door
Saturday	19.06.2010	last layer of bricks and beam above door
Sunday	20.06.2010	start with plaster inside and outside
Monday	21.06.2010	plaster outside, sanitary, formwork for roofplate
Tuesday	22.06.2010	digging for wetland, finalise formwork for roofplate
Wednesday	23.06.2010	pour roofplate
Thursday	24.06.2010	excavation wetland, plaster inside/outside
Friday	25.06.2010	provisorical sanitary installation
Saturday	26.06.2010	fixing faeces chamber doors
Sunday	27.06.2010	plaster inside and ceiling, sanitary installations, urine-pipeline, beam above faeces-doors
Monday	28.06.2010	walls of wetland, urine-pipes
	between	tiles on walls, start sanitary installations
Monday	19.07.2010	plaster roof and walls beigewater-infiltration
Tuesday	20.07.2010	digging for urine-pipeline, remove broken floor of wetland
Wednesday	21.07.2010	repair of floor of wetland
Thursday	22.07.2010	floor-tiles , painting vent-pipe, digging hole for urine-tank
Friday	23.07.2010	fixing vent-pipe,digging hole for urine-tank
Saturday	24.07.2010	digging hole for urine-tank, sealing wetland
Sunday	25.07.2010	filling wetland with gravel
Monday	02.08.2010	finalise sanitary installation
Tuesday	03.08.2010	finalise sanitary installation inside, plant wetland

Table 6: Timeline Jane

Sunday	13.12.2009	-
Monday	14.12.2009	-
Tuesday	15.12.2009	-
Wednesday	16.12.2009	-
Thursday	17.12.2009	-
Friday	18.12.2009	-
Saturday	19.12.2009	-
Sunday	20.12.2009	-
	between	start excarvation
Sunday	13.06.2010	-
Monday	14.06.2010	-
Tuesday	15.06.2010	continue excavation, preparation of formwork
Wednesday	16.06.2010	finish excavation, pour foundation
Thursday	17.06.2010	start and finish faeces-chamber walls; start formwork for plate
Friday	18.06.2010	finish preparation for plate,
Saturday	19.06.2010	pour plate
Sunday	20.06.2010	curing of plate
Monday	21.06.2010	start build walls
Tuesday	22.06.2010	building walls
Wednesday	23.06.2010	finish walls, start formwork
Thursday	24.06.2010	formwork for roofplate, pour roofplate
Friday	25.06.2010	excavation for wetland
Saturday	26.06.2010	preparation (iron) for floor of wetland, excavation for urine-tank
Sunday	27.06.2010	installation of faeces-chamber-doors, walls of wetland, GW-pipe
Monday	28.06.2010	plaster of wetland, install vent-pipe
	between	tiles on walls, start sanitary installations
Monday	19.07.2010	digging for infiltration, repair of broken roof
Tuesday	20.07.2010	last plaster of wetland, repair of hole for slabs
Wednesday	21.07.2010	increasing infiltration-area
Thursday	22.07.2010	filling infiltration, floor-tiles
Friday	23.07.2010	filling wetland with water. Filling with gravel
Saturday	24.07.2010	continue filling wetland with gravel, floor tiles
Sunday	25.07.2010	provisorical sanitary installtion and pipes, plant wetland
Monday	02.08.2010	finalize sanitary installations
Tuesday	03.08.2010	finalize sanitary installations

Table 7: Timeline Ahnuch

Sunday	13.12.2009	-
Monday	14.12.2009	-
Tuesday	15.12.2009	-
Wednesday	16.12.2009	-
Thursday	17.12.2009	-
Friday	18.12.2009	-
Saturday	19.12.2009	-
Sunday	20.12.2009	-
	between	
Sunday	13.06.2010	-
Monday	14.06.2010	-
Tuesday	15.06.2010	start excarvation, prepare formwork
Wednesday	16.06.2010	pour foundation
Thursday	17.06.2010	start faeces-chamber-walls
Friday	18.06.2010	finish faeces-chamber-walls
Saturday	19.06.2010	prepare lower formwork for plate, build stairs
Sunday	20.06.2010	prepare formwork for plate
Monday	21.06.2010	prepare iron for plate, finish formwork for plateand pour plate
Tuesday	22.06.2010	curing of plate
Wednesday	23.06.2010	start building walls
Thursday	24.06.2010	continue walls, plaster walls
Friday	25.06.2010	provisorical slabs
Saturday	26.06.2010	finalise walls, prepare iron for roofplate
Sunday	27.06.2010	beam above door, plaster walls, formwork for roofplate
Monday	28.06.2010	pouring roofplate
	between	tiles on walls, start sanitary installations
Monday	19.07.2010	excavation for urine-tank and wetland
Tuesday	20.07.2010	preparation of ground-plate of wetland+pour plate
Wednesday	21.07.2010	walls of wetland
Thursday	22.07.2010	plaster of wetland, walls for urine tank
Friday	23.07.2010	floor tiles, digging infiltration-hole
Saturday	24.07.2010	fill wetland
Sunday	25.07.2010	fill beigewater-infiltration
	between	
Monday	02.08.2010	connection kitchen GW-pipe
Tuesday	03.08.2010	finalize sanitary installations, plant wetland

Table 8: Timeline Khaled

Sunday	13.12.2009	-
Monday	14.12.2009	-
Tuesday	15.12.2009	-
Wednesday	16.12.2009	-
Thursday	17.12.2009	-
Friday	18.12.2009	-
Saturday	19.12.2009	-
Sunday	20.12.2009	-
	between	
Sunday	13.06.2010	-
Monday	14.06.2010	-
Tuesday	15.06.2010	start excarvation
Wednesday	16.06.2010	continue excarvation, prepare formwork
Thursday	17.06.2010	pouring foundation
Friday	18.06.2010	start faeces chamber walls,
Saturday	19.06.2010	continue chamber-walls,
Sunday	20.06.2010	, build stairs, prepare formworksnf iron for plate
Monday	21.06.2010	pour plate
Tuesday	22.06.2010	build walls with participants
Wednesday	23.06.2010	build walls with participants, start excavation for wetland
Thursday	24.06.2010	coninue building walls
Friday	25.06.2010	build walls, excavation for wetland, iron and formwork for roof
Saturday	26.06.2010	prepare iron and formwork for wetland, pour roof
Sunday	27.06.2010	pour floor of wetland
Monday	28.06.2010	
Tuesday	29.06.2010	walls of wetland
	between	tiles on walls, start sanitary installations
Sunday	18.07.2010	-
Monday	19.07.2010	-
Tuesday	20.07.2010	plaster of wetland
Wednesday	21.07.2010	Walls for urine-tank, excavation for beigewater-infiltration
Thursday	22.07.2010	plaster of walls for urine-tank
Friday	23.07.2010	urine-, grey- and beigewater-pipes
Saturday	24.07.2010	floor-tiles, filling wetland with gravel
Sunday	25.07.2010	filling beigewater-infiltration
	between	
Monday	02.08.2010	finalize sanitary installations
Tuesday	03.08.2010	finalize sanitary installations, plant wetland

12.3. Plans of toilets

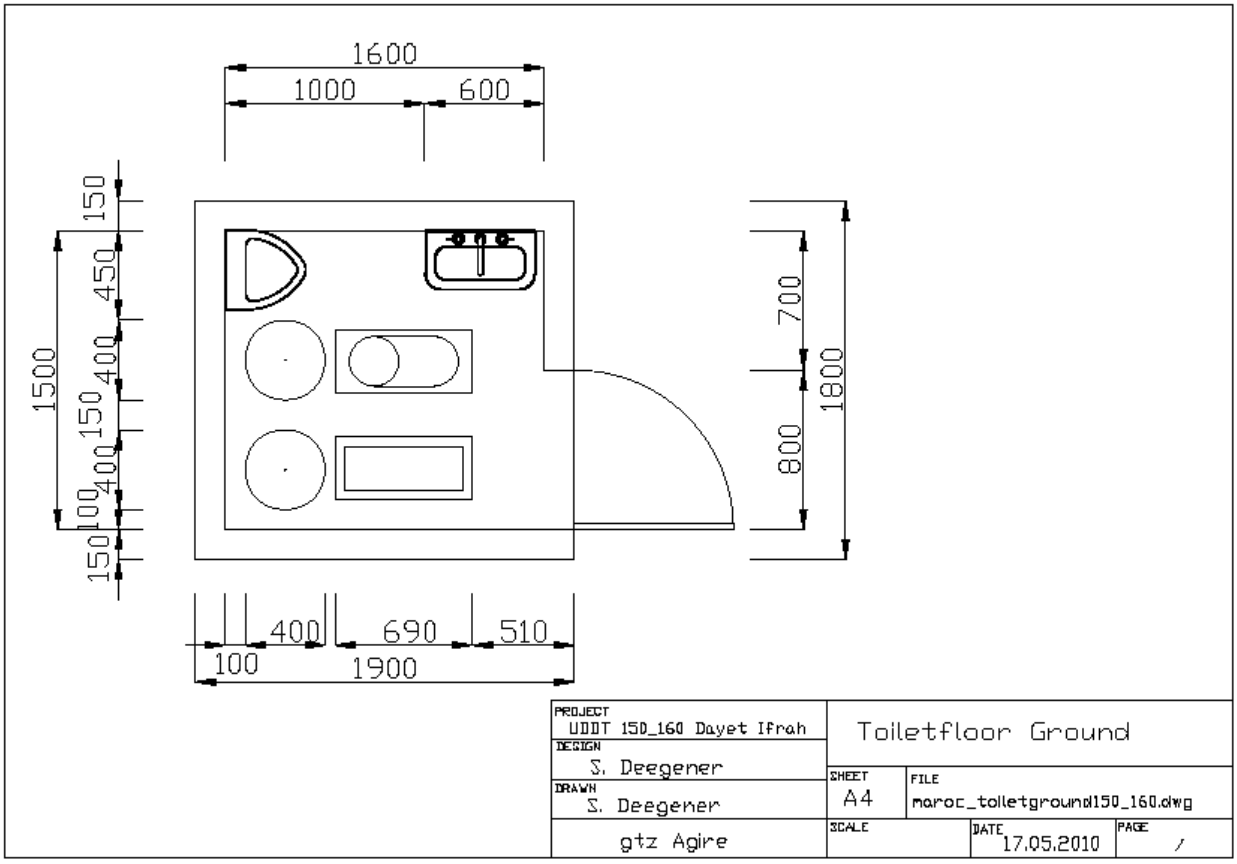


Fig. 107 : UDDT standard

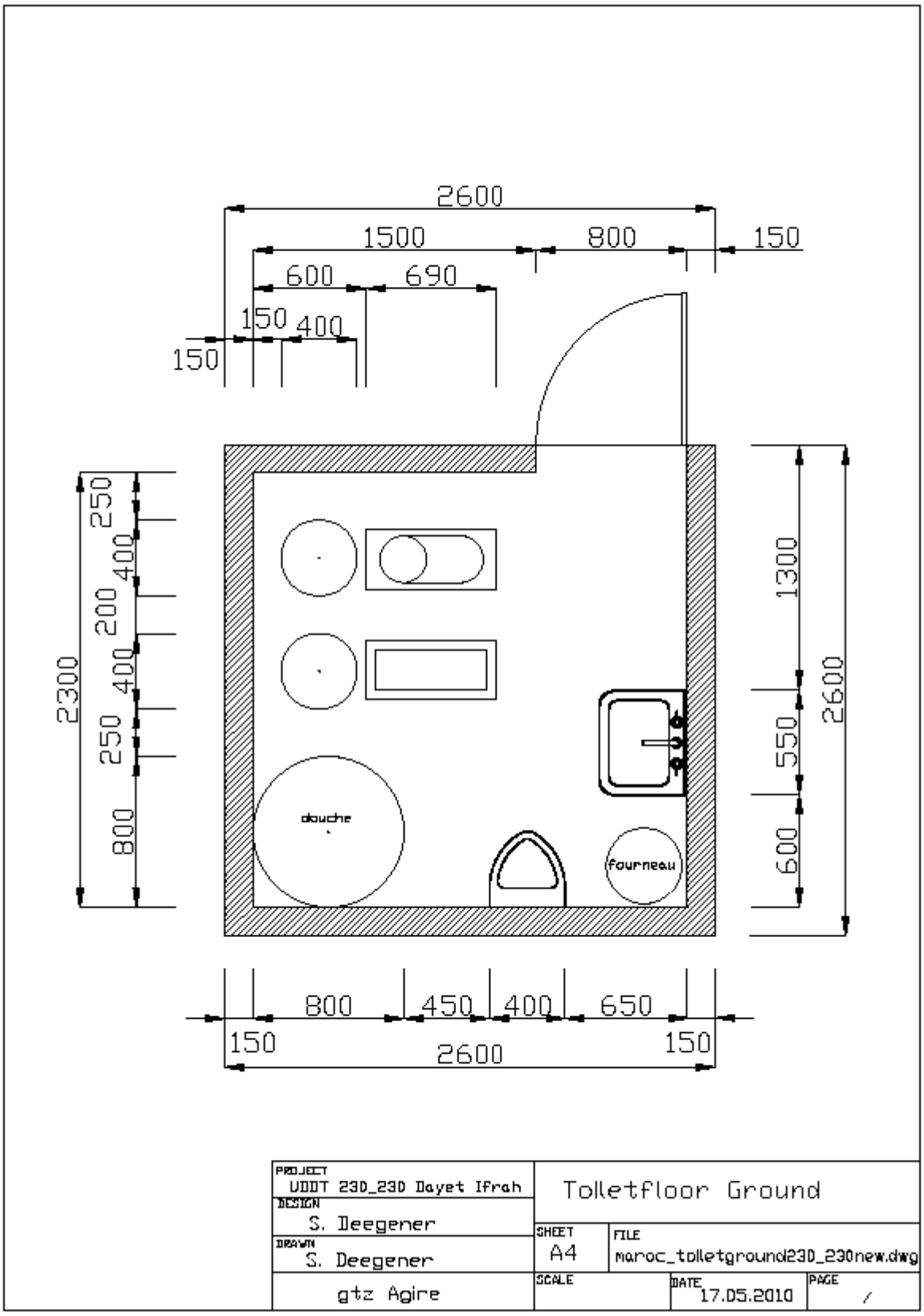
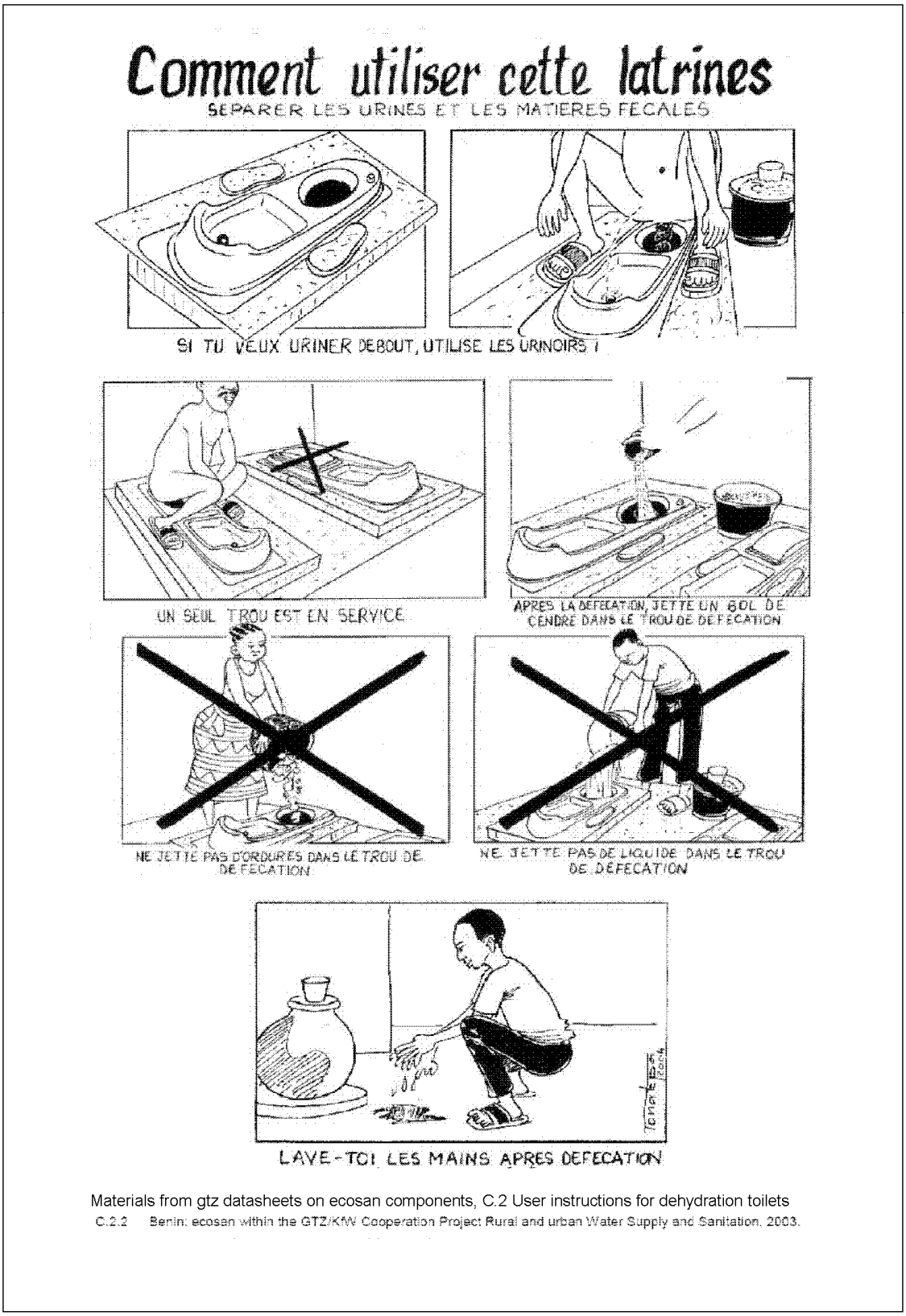


Fig. 108 : UDDT with shower2,3 *2,3m

12.4. Poster “How to Use the UDDT”



Materials from gtz datasheets on ecosan components, C.2 User instructions for dehydration toilets

C.2.2 Benin: ecosan within the GTZ/KfW Cooperation Project Rural and urban Water Supply and Sanitation, 2003.

Fig. 109 : Poster “How to use the UDDT”