Case study of sustainable sanitation projects

Household UDDTs after cyclone disaster

Padma & Rohitra villages, Barishal Division, Bangladesh

Fig. 1: Project location

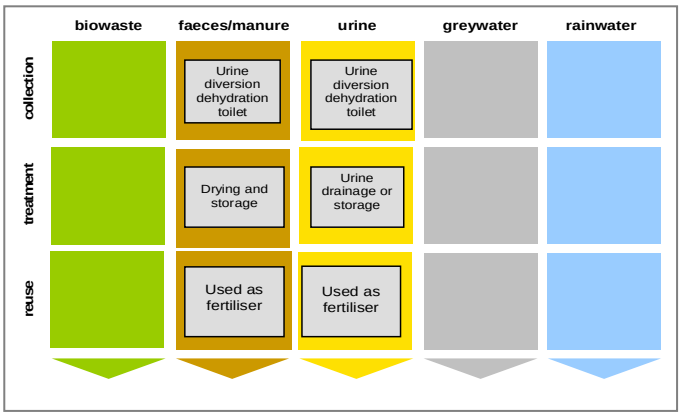

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Construction of urine diversion dehydration toilets (UDDTs); at pilot scale (model village).

Project period:
Start of construction: June 2008
End of construction: May 2009
Start of operation: May 2009
Project first phase end: January 2010
Ongoing monitoring period planned for: 2 years (2010-2012)
Part of emergency phase: project was initiated after Cyclone Sidr first hit the southern Bangladeshi coast on 15 November 2007

Project scale:
Number of inhabitants covered: 1,200 families
100 UDDTs installed
Total investment: EUR 78,000 (only covers the sanitation activity, not the entire project)

Address of project location:
Padma and Rohitra villages in Patharghata Upazilla, in Barguna District, in Barisal Division, Bangladesh

Planning institution:
Terre des hommes Lausanne
Avenue de Montchoisi 15, 1006 Lausanne, Switzerland

Executing institution:
Multitask (CBO) based in Patharghata, Bangladesh

Supporting agency:
Terre des hommes Lausanne
Avenue de Montchoisi 15, 1006 Lausanne, Switzerland

2 Objective and motivation of the project

Following the disaster caused by the cyclone Sidr in 2007, the International NGO (INGO) Terre des hommes Lausanne, which had already been working in Bangladesh, decided to develop a programme for water, sanitation and hygiene as well as a programme for mother and child health in the Patharghata area. The project targeted 1200 families consisting of 6360 people in total of which 2760 are children. The objective of the project was to improve children's lives in Upazilla, a sub-district of the Barguna district in Bangladesh.

Fig. 3: Toilet and house constructions (source: Antoine Delepière, 2009)

A component of the project included the provision of safe shelter, potable water and appropriate sanitation (UDDTs were the chosen technology in this project), where the beneficiaries numbered in total, 100 families, consisting of 478 people including 233 children. The health services and the WASH awareness campaign were extended to the wider community and closer links were built with the local authority and the Upazilla Health Complex. In total, this component of the project catered to the needs of approximately 1,200 families (6360 people), numbering 2760 children.

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3 Location and conditions

The project was qualified as a post-rehabilitation project following cyclone Sidr in 2007, which severely damaged the sanitation systems. Sanitation coverage before the cyclone was 80% and was reduced to 26% after the cyclone. However the type of latrines that existed before the cyclone were not appropriate to the local environmental conditions with its high water table and high risk of floods. Clean drinking water was scarce, because there was a shortage of hand pumps and deep tube wells both before and after the cyclone. Moreover, pond water had become salted and was not potable, due to the flooding. Hence people had to work long distances to find tube wells or non-salty ponds.
The following criteria characterise the project region:

- Climate and geographical conditions: very high groundwater level
- Population density: between 250 and 500 persons per km^2
- Type of settlement: two villages in a rural area
- Economic situation: many people are unemployed and dependent on external assistance
- Agricultural aspects and type of soil: land is salinated[1], causing limited food production and suspension of agricultural employment
- Institutional and legal framework: partnership with community-based approach and agreement with the village authority
- Socio-cultural conditions: customs and behaviour are linked to religious beliefs; limited access of sanitation for women[2].

In Bangladesh, the under-five child mortality rate[3] in 2008 was 54 children per 1,000, which is a great achievement given that in 1990 it was 151 children per 1000.

4 Project history

On 15 November 2007, the first storms of what was to become cyclone Sidr hit the southern coastline of Bangladesh. Early warning notices were sent by the Bangladeshi Meteorological Office to national and local government agencies. Together with the armed forces and local agencies, the population got alerted to the danger and hundreds of thousands of people were able to flee. Some went to cyclone shelters, some to other places of safety, while others headed inland, away from the coastal areas.

The cyclone gathered strength that evening and during the morning of 16 November, reaching up to 240 km/h and bringing with it heavy rainfall, making it a very strong category 4 tropical cyclone. The force destroyed approximately 750,000 homes, tore up trees, damaged or destroyed roads, community centres, clinics and schools and brought down power and communication lines.

In response to cyclone Sidr, Terre des hommes implemented a post-rehabilitation project in Barguna District (Barisal Division) between June 2008 and May 2009. The main focus was on housing, sanitation and water management systems, and primary health care. In order to foster sustainability of the achievements, a seven month extension with special emphasis on primary health care and WASH (water, sanitation and hygiene) was implemented from June to December 2009. These emphasised components comprised of preventative and curative health care services, raising community awareness and behavioural changes in WASH.

In particular, the extension was designed to consolidate what already had been achieved during the post-rehabilitation project. Thus, to continue with the one model village, while retaining the special emphasis on WASH and also operating a health clinic in Rohitra to provide community based health education for fostering primary health care.

5 Technologies applied

The technical aspect of the project included the construction of 100 houses each with a urine diversion dehydration toilet (UDDT) and 2 pond sand filters[4] (access to drinking water), split between the two neighbouring villages of Padma and Rohitra.

For health and environmental reasons, Terre des hommes decided to implement UDDTs. During the planning phase of the project the initially proposed technology to be used in the project was single pit latrines, but then after a technical assessment was conducted two alternative technologies were proposed namely the twin pit raised latrine or the UDDT. The final choice was the UDDT due primarily to its suitability in this context where a high water table exists and the area is flood prone.

Fig. 4: Vault and slab construction (source: Antoine Delepière, 2009)

[1] Water that contains a significant concentration of dissolved salts (NaCl) in this case due to extensive agriculture and floods. Noteworthy is that this area is also at an altitude that is below sea level.

[2] For example: in these conservative rural areas in Bangladesh, the Islamic belief dictates that women should not be seen or noticed by anyone when they proceed to go to a toilet.

[3] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before the age of five if subject to current age-specific mortality rates. The following were used as sources http://www.childinfo.org/mortality.html and http://www.childmortality.org/.

[4] A pond sand filter is a slow sand filter connected to a pond. The water is pumped from a pond and then filtered though a sand filter this is a common technology in Bangladesh.

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The main objective of implementing UDDTs was to ensure that pathogen transfer from human excreta was minimised. Providing a durable structure that was more resistant to floods and storms was also a key objective. Hence the elevation of 0.9 meters can be seen to be the depth of flooding this UDDT design can safely withstand and the level of flood resistance increases when the already elevated area around the homes is taken into account.

Some socio-cultural aspects such as religion, gender, poverty and social structures were initially perceived as possibly constituting barriers to the acceptance of the UDDTs. However, the factors in favour of the UDDT technology were: a high water table, prevention of pollution, privacy for women, safety, a clean and comfortable facility, and limited smell compared to other types of latrines. The favourable factors outweighed the factors constituting possible barriers to acceptance.

The technical choice was based on elements of the local context such as a high water table, type of soil, climate risk, cost of maintenance and socio-cultural aspects. There is a very high groundwater level in the area, be it monsoon or dry season, which makes pour-flush latrines a non-suitable option because of the risk of groundwater and surface water contamination. UDDTs in contrast ensure a technical containment of the excreta which leads to a lower risk of contamination of groundwater or surface water in flooded areas.

Fig. 5: The two UDDT designs used, on the left the faecal vaults are at the rear and on the right they are on the side of the superstructure (source: Antoine Delepière, 2009 (left) and Shahid Kamal, May 2011(right))[5].

The main features of the 100 UDDTs implemented in the two villages are:

- Separation of excreta and urine/liquids
- Containment of excreta in a vault where it can dehydrate
- Infiltration of urine and anal wash water in the soil[6]
- Alternate use of the vault, approximately every twelve months.

The design and construction of the chambers and the superstructure took the occurrence of floods and cyclones into consideration. All UDDTs were built close to the houses, and consideration was taken with respect to the sunlight, wind and the hygiene etiquette contained in the Islamic faith[7]. The layout of the UDDT was designed to dehydrate the excreta as quickly as possible. The vault, the iron cover and the vent pipes all face South in order to receive the maximum amount of sunlight and to favour the drying process of excreta (experiences in other projects has shown that this is not actually necessary, but that the UDDT should be positioned simply based on user preferences).

6 Design information

In a dehydrating system like double vault UDDTs, urine is directed away from faeces to keep the processing chamber contents dry and the volume of material small. The urine and anal cleansing water are divided by a specially designed urine diversion squatting pan. This also makes it possible to use the urine separately as a fertiliser. The squatting pan is made by local masons and costs approximately EUR 7.80 (exchange rate of EUR 1: BDT 89.70) to produce.

Fig. 6: Construction of a squatting pan by a local mason (source : Laxman Kharal Chettry, 2009).

Faeces are collected in two vaults beneath the diversion squatting pan, where they are dried for a period of 6–12 months. Ashes, crushed limestone or a drying agent are added after each defecation to lower the moisture content and raise the pH to 9 or higher (in the case of ash or lime). The system thus creates conditions of dryness, raised pH, and time for pathogen die-off. Ventilation pipes connected to the vaults help reduce odour and enhance the drying process.

The partly treated faecal material is then exposed to elevated temperatures with drying being further assisted in the faeces vaults by the heat captured thanks to the iron roof. The vaults are used alternately, with only one vault in use at a time, until it is almost full. When the first vault is full, the defecation hole is sealed and the squatting pan is transferred to the second

[5] The angled faeces vault cover on the left may allow rainwater infiltration if covers get corroded. A straight vertical faeces vault cover would be a better design to mitigate this risk.

[6] People do not use groundwater in the area due to arsenic pollution and saline intrusion. The use of urine as a fertiliser was not initially included in the information disseminated to the communities, due to the project being of an emergency response nature. During the current continued support phase the benefits of urine as a fertiliser will be discussed with the communities.

[7] The direction in which toilets and in this case UDDTs face is an important factor to take into consideration when working in Islamic communities. In short one should not face the same direction while on the toilet, as when one prays. Hence local consultation of the correct orientation is necessary.

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vault, which is now active while the contents of the first dries. The product has a sandy appearance and is generally odour free.

Fig. 7: Completed squatting pan, ready for installation (source: Laxman Kharal Chettry, 2009)

Fig. 8: Installed squatting pan (source: Laxman Kharal Chettry, 2009).

Fig. 9: The change in design of the faecal vault doors to concrete covers that took place during 2010 (source: Shahid Kamal, May 2011).

The technical details for the UDDT are (based on guidance from the WASH regional adviser of TdH):

- Floor area: 1.50 m x 1.06 m
- Floor Elevation: 0.9 m (with four steps leading to the toilet[8])
- Ventilation pipe: PVC, 4 inch in diameter
- Urinal pipe: 2 inch in diameter, leading to an infiltration pit or drainage channel according to field situation (i.e. the urine is not being reused)
- Roof: corrugated iron sheet roof with reinforcements
- Faeces vault door: concrete covers[9] see figure 9. The faeces vault is about 1.5 m x 1.5 m in floor area and 0.9 m high (2 m^3).
- Faeces covering material is either ash or, if that is not available, soft limestone which is available throughout the region.

The construction materials used were bricks for the chamber and superstructure, pre-casting pans which were made locally, concrete (iron sheets [initial design]) for the vault door and wood for the door. The design drawings can be seen in figure 10.

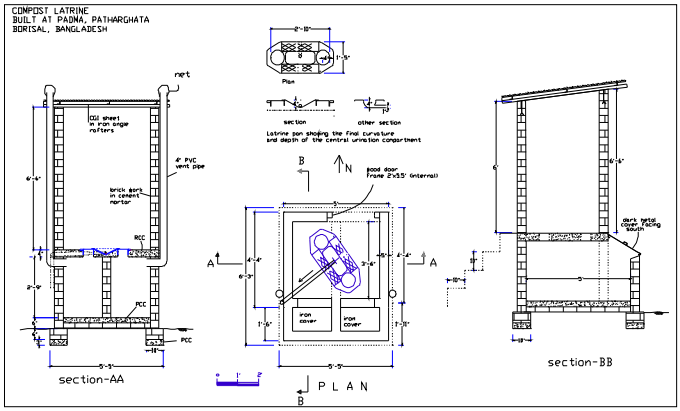

Fig. 10: UDDT design drawing (Source: Terre des hommes, 2009).

7 Type and level of reuse

The UDDTs were primarily introduced to limit groundwater contamination due to floods and a high water table. In the emergency phase, it was not possible to introduce the reuse aspect, but this will be an objective for 2011.

Multitask, which is a local Community Based Organisation and the implementing partner of TdH in Bangladesh, will continue to monitor the toilets and support the users in the operation and maintenance. Reuse will be practiced and is going to depend on the awareness campaign. Terre des homes is currently supporting Multitask with the monitoring and the awareness campaign, with the regional advisors continuing to conduct training and support in the Padma and Rohitra villages.

8 The steps are quite steep and could be difficult for elderly persons – but so far, no complaints about the stairs have been received.

9 Originally the faeces vault doors were constructed out of galvanized steel which was painted black, but after 2 years, rapid corrosion had taken place and resulted in rainwater infiltrating into the faeces vault. Since 2010 the galvanised steel vault doors are being replaced with concrete doors and the design has been altered accordingly.

8 Further project components

The post-rehabilitation project was an investment in housing, sanitation, water, and primary health care. Special emphasis was put on primary health care and WASH. These components comprised: preventative and curative health care services, community awareness raising and behavioural changes, water supply through pond sand filter construction, and house reconstructions.

9 Costs and economics

The average material cost for the UDDT was EUR 417 including labour costs and transport costs. All toilets were built with brick masonry with watertight plastering of the vault, which explains the high cost of the final work. The toilets were fully subsidised by the Terre des hommes, including material and different labour costs (see Table 1). However beneficiaries were required to provide labour during the construction of their house and toilet. The labour provided (primarily carrying building material due to the area being difficult to access) covered approximately 5% of the total labour cost.

Operation and maintenance costs are low because the beneficiaries will only have to empty the chamber once every year. Since it will take time for beneficiaries to get used to the possibility of reuse, the financing scheme for the collection-treatment-reuse chain has so far not been a priority.

Table 1: Bill of quantity of the UDDT and Costs. Note: units given in feet and cubic feet. The exchange rate of EUR 1 : BDT 89.7 from November 2009 was used.

Construction Items	qty	unit	Cost (EUR)
brick masonry in 1:6 c/s	105.94	cft	112.97
1:2:4 PCC / RCC	9.72	cft	15.71
3/8" dia steel bars for RCC	181.50	ft	36.15
Plaster 1-coat-1:4 (1/2")	259.92	sft	13.23
1:1 Cement Sand punning (3mm)	128.17	sft	6.65
PCC 1:3:6	4.79	Cft	6.87
Wood work (door frame and shutter)	1.45	cft	4.96
WC (to be prepared as per design)	1	no	7.80
pvc pipe 4"	17	ft	7.58
cowl 4"	2	no	1.78
stainless steel fly net around cowl			1.34
pvc 4" bend (110 deg)	2	no	3.34
pvc pipe 2"	7	ft	1.95
Pvc 2" elbow	3	no	1.51
1"x1" iron angle (1kg=1.5ft) for roof	28.5	ft	14.62
cgi sheet (28 g')	1	no	11.15
plain gi sheet (2.5')	12	ft	8.70
Door hold fast	6	no	5.35
door hinges	3	no	1.34
door handle	2	no	0.67
Iron sheet cover (2'2"x1'10"): 18 gauge (1.2kg/sqf) sheet in angle (0.33 kg/ft)	14.88	kg	22.39
frames, with painting			
Door Bolts	2	no	2.23
gi caps/hook, iron bar, nails etc for fixing	1	no	2.23
Form work for RCC	17.50	sft	3.90
UDDT material cost	**1**		**294.41**
Labour: Unskilled : Skilled			54.39 51.93
Add. Transportation[10]			16.72
Awareness Campaign on Wash issues, training material and hygiene promoters salaries			27.54
Total Cost			**445.00**

The total project cost (for the sanitation component) was EUR 44 593. This equates to EUR 445 per UDDT.

10 Operation and maintenance

The users are responsible for the operation and maintenance of the toilets. Regular maintenance includes cleaning the toilet and checking for urine pipe blockages. Traditionally, emptying of latrines is done by hired sweepers most of the time. Taboos on sanitation initially jeopardised the handling of dried excreta and at the end of the project in late 2009, the users expressed that they did not know what to do when the chamber was full.

Since then, the ongoing training workshops and awareness campaign together with the compilation of an operations and maintenance guideline are helping to educate the user about safe handling of the dried excreta.

Fig. 11: After approximately two years in use, the squatting pan and toilet on the whole was being well maintained (source: Shahid Kamal, May 2011).

In a May 2011 visit to a number of the UDDTs built during the 2009 project, one of the visited UDDTs is shown in figure 11, the UDDTS were found to be in good operating condition. Only 6% of the UDDTs were not being used regularly. In 40% of the UDDTs flies and odour were present. Due to the leakage (inappropriate joint) and the quality of the cover (the initial steel galvanised vault covers), rainwater had entered the vault. 40% of the UDDTS still have some water in the

[10] Additional Cost incurred by the contractors when accessing the site which was difficult due to its remoteness

faeces vault, which will impact the dehydration process. Corrective steps have been taken and now all the vault covers have been changed to the concrete cover design depicted in figure 12 (right). The new monitoring system will help Tdh to provide appropriate support to the beneficiaries in future.

11 Practical experience and lessons learnt

The quality of the campaign, which is meant to inform the direct and indirect beneficiaries, is key to the success of the implementation of the project. It is very important to make each toilet owner aware of the advantages, but also about the disadvantages of the selected toilet design.

The sustainable use of ecological sanitation requires greater motivation than for other systems. The best way to obtain this motivation is to demonstrate some of the benefits that other forms of sanitation do not have. Depending on the local context and the stage of the project, economic benefits from the fertiliser should not always be the main motivational factor. Other motivational drivers that can support the adoption and acceptance of a new technology for this area like the UDDT are the odour reduction; UDDT can be closer to the house than a pit latrine[11]; status; comfort; privacy; and also environmental benefits.

Terre des hommes has identified three main challenges facing the acceptance of this technology:

- The location of the toilet within the compound and its orientation (in accordance with the Islamic beliefs, i.e. toilet not facing towards Mecca)
- The use of the UDDT which includes daily practices and maintenance
- The reuse of dried excreta

In the context of the project and according to the findings, different socio-cultural factors influence the perceptions and the use of the facility by the local population.

At different stages of the project, religious leaders, teachers and also sweepers have to be involved. Sweepers, due to their societal status are still not consulted enough. However, they are often the only ones having a real knowledge of the potential for reuse of excreta and of the perception of excreta by the population. Religious leaders and teachers play a double role. They can advice technicians and social workers about decisions that will fit the specific needs of the local context.

One of the main challenges in this area is the use of toilets (that is any kind of toilet). In the majority of emergency situations, there are severe time constraints which do not allow sufficient promotion of the respective technology being introduced and hence the changes in behaviour that are required to use the respective technology do not always take place. Terre des hommes should therefore include the reuse chain aspect and the benefits for agriculture right from the beginning in the information provided to the beneficiaries. A low cost structure should also be designed for the emergency phase, so as to allow for more time for extensive promotion of the respective technology that is aimed to be a long term solution for the beneficiaries.

Fig. 12: Faeces vault doors originally steel, in the left picture, were later replaced in 2010 with concrete covers, in the right picture, due to corrosion (source: Antoine Delepière, 2009 (left) and Shahid Kamal, May 2011(right))

A lesson learnt with respect to the faeces vault doors was; they were originally made out of galvanised steel, see figure 12, but corrosion took place after 2 years and resulted in rainwater infiltrating the faeces vault. Subsequently the galvanised steel vault doors are being replaced with concrete doors, see figure 9 and 12.

A positive lesson learnt was about the UDDTs' robustness which was put to the test on 27 May 2009 when Cyclone Aila hit Southern Bangladesh.

Fig. 13: UDDT (on the right) prevents excreta contamination during cyclone Aila, May 2009, which hit the area shortly after construction of UDDTs was completed (source: Laxman Kharal Chettry, 2009).

Alia was categorised as a category 1 cyclone with wind speeds ranging between 74 and 120 km/h. The associated flooding that followed the cyclone can be seen in figure 13, where the UDDT withstood both the winds and the flooding.

[11] A UDDT can even be *inside* of a house, although rural people are generally not used to this option and would most likely initially not want this. UDDTs need no contact with the soil and are odour free if designed and used correctly.

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12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 2: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project ("+" means: strong point of project; "o" means: average strength for this aspect and "–" means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse[a]		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X			X					
• environmental and natural resources		X			X				
• technology and operation	X			X					
• finance and economics			X			X			
• socio-cultural and institutional		X		X					

[a] Not implemented.

Sustainability criteria for sanitation:

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

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

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

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

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

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

The aspiration of the project is to limit the human excreta pollution of water and also to reduce the rate of diarrhoea incidences among children. The lessons learnt and knowledge gained from the implementation of this pilot project will be replicated by Tdh in the future but at the moment Tdh is supporting the partner in the monitoring of the toilets built. According to the results of this pilot phase, Tdh will adapt the design and will work on the cost effectiveness of the toilets and evaluate the possibility to build low cost UDDTs.

With respect to the impact on the beneficiary's health from having access to a UDDT, it is difficult to monitor any health benefits in a short time span and there are too many factors to take into consideration. The users really appreciate the UDDTs, but it is difficult to measure this with evidence based indicators.

13 Available documents and references

The project documents (design drawings, case study of the UDDT acceptance, operation manuals, training material, and maps) can be obtained after contact with the author of this case study.

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More photos are available in the SuSanA photo database on flickr:
http://www.flickr.com/photos/gtzecosan/collections/72157620951130441/

14 Institutions, organisations and contact persons

Programme coordinator

Kimon Schneider
Terre des hommes Foundation
House 68, Road 18 Block - A,
Banani Dhaka 1213, Bangladesh

Project manager: Md. Eunus Hossain

Laxman Kharal Chettry WASH Adviser for South Asia, Terre des hommes - Lausanne (technical support and monitoring)

Antoine Delepière – WASH adviser and referent (technical support and evaluator)
Terre des hommes Foundation
Montchoisi 15, 1000 Lausanne 25, Switzerland
Tel: +41 58 611 06 74
Email: ade@tdh.ch
Website: www.tdh.ch

Implementation Partner and Contractor for Construction:

Multitask (CBO) based in Patharghata,
Md. Azad Mollik , Executive Director, Multi Task, Hospital Road, Post Office and Upazila : Patharghata, District: Barguna, Division: Barisal, Bangladesh

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Author: Antoine Delepière (Terre des hommes, ade@tdh.ch)
Editing and reviewing: Elisabeth von Muench, Trevor Surridge (GIZ, ecosan@giz.de)

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