Development of a Disaster-Resilient Toilet: lessons from the States of Assam and Gujarat, India

SUMMARY

This Field Note describes the development process of designing a Disaster-Resilient Toilet (DRT) which was carried out in the States of Assam and Gujarat in India. Both of these States are affected annually by flooding and cyclones, and they are also both located in earthquake-prone areas. The impact of flooding and cyclones has meant that existing toilets are damaged, often beyond repair, as the design of these toilets does not take into account the specific features needed for them to be disaster resistant. To ensure that the efforts in rolling-out the Swachh Bharat Mission (which aims at a 100% ODF status in India) are not undermined by continuous backsliding due to the impact of floods and cyclones, the states of Assam and Gujarat with the support of REDR India and UNICEF have developed a new design for DRTs that can withstand these annual environmental disasters. This Field Note outlines the challenges faced with the currently used toilet designs during disasters and the process for developing the design of the DRTs. Furthermore, this Field Note will present i) the DRT design recommendations, ii) the lessons learnt from the training on DRT construction, and iii) the next steps for the DRT implementation based on recommendations made by participants of the DRT training and the Conference on Sanitation in Assam

Introduction

Over the past two decades, India has seen the implementation of multiple schemes to achieve a cleaner and healthier India; the Total Sanitation Campaign, Nirmal Bharat Abhiyan, and most recently the Swachh Bharat Mission (SBM). It is particularly in the latter scheme that a significant increase in toilet coverage was observed; in the State of Gujarat, for example a 100% ODF status was achieved in October 2017, according to the Ministry of Drinking Water and Sanitation (MDWS). In Assam sanitation coverage also grew steadily, reaching 62.8% at the end of the Financial Year 2015-2016. This progress, however, has been constrained by the destructive impact of floods and cyclones that have caused damage to existing toilets and led to constant slip-back in progress made.

As a result of a lack of access to safe sanitation during most parts of the year, mainly due to flooding and waterlogging, the communities of Assam and Gujarat in disaster-affected districts endure both hardship and physical discomfort. Women and young girls are particularly affected as they are left with little options to maintain privacy and personal hygiene in these conditions, exposing them to increased health as well as safety risks. This necessitated an urgent need to develop and design a disaster-resilient toilet with features that will enable toilets to resist both flooding and cyclones.

Hence, both the States of Gujarat and Assam, with the support of UNICEF India, looked at how to improve on the current design of the twin pit toilet system and add, or upgrade, features that will make the toilets ‘disaster-resilient’. In Assam, a pilot project was designed with experts from REDR India to demonstrate the new Disaster-Resilient Toilet model in a flood prone district: the Dhemaji district. The pilot also ensured that engineers from the Public Health Engineering Department (PHED) and local partners gained the understanding and capacity to construct these types of toilets based on the improved design whilst keeping in line with the prevalent codes of practice.

This Field Note highlights the challenges and opportunities that were found in the process of developing this disaster-resilient toilet design, the lessons learnt, and implications for the future.

Description of Intervention

In order to understand the situation on the ground in the Dhemaji district and the shortfalls of the toilet design currently being used with respect to withstanding floods and cyclones, a complete assessment was carried out by two WASH experts with experience in post-disaster situations. The assessment consisted of an in-depth desk review looking at both physical and social characteristics, the hazard profile of the area, the disaster preparedness and the existing toilet design. Furthermore, a week-long field study was carried out, visiting a total of 12 villages across the district in order to observe and collect primary data on challenges in the implementation and sustainability of the sanitation infrastructure in the district. The experts met with local NGO staff and community members to capture their user experience and recommendations for improvements, specifically with respect to the situations during flooding and cyclones. Meetings were held with the PHED staff at State, district and block levels to ask them about the issues they faced in the implementation of the sanitation program, their opinions on the current toilet design and their suggestions for improvements. Finally, a topographical and geological assessment of the district was carried out to understand the natural environment where the toilets are situated and how this may impact their design. The results of this latter assessment were as follows:

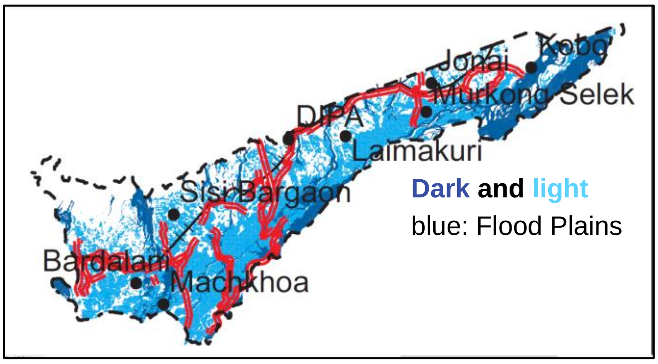
The district is made up of three zones:

1. A Piedmont zone which is the foothill zone in the north-east of the district, it has deep, well drained sandy loam soils on a very gently sloping plain with moderate erosion and slight flood hazard.

2. An active flood plain near the river Bramhaputra and its many tributaries, this area also has sandy loam soil, with a gentle sloping flood plain with slight erosion and moderate flood hazard.

3. A Low-lying alluvial belt which covers the middle zone and is the saucer-shaped built-up zone with a mixture of sand and loam and constantly inundated.

Figure 1: Dhemaji Flood Inundation map (1998-2007)



Due to the generally low-lying nature of the land, the groundwater varies from 20 feet below ground level in the dry season to completely saturated and above ground level during the wet season which extends from April to September. Hence, almost all the regions in the district are exposed to flooding. Based on the field interviews, community members reported that flooding happens in 4 to 5 cycles during each rainy season, with water levels taking up to 2 weeks to recede.

Furthermore, in Dhemaji, when the surrounding hills of Arunachal Pradesh experience heavy rains, the surface runoff also impacts the lowland areas of the Dhemaji district, making flooding patterns frequent and unpredictable. The toll this has taken on sanitation infrastructure has been considerable. In July 2017, the Banaskantha District in Gujarat, as well as 6 adjoining districts, were hit with one of the worst floods in 112 years. It caused 224 deaths and damaged 13,149 toilets out of 268,422 constructed in the Banaskantha district.

The need for Disaster-Resilient Toilets (DRT's) in these vulnerable areas is clear, as both regions suffer from both physical and social vulnerabilities as outlined in box 1. Further to these existing vulnerabilities in the risk-prone regions, there are also the challenges in the currently used toilet design to consider.

The twin-pit toilet system design that is currently being used in all the states in India is a standardised design used under the Swachh Bharat mission. This design is deemed appropriate considering the need for a low-cost sanitation option. Also, the design has fared well in most situations, as long as there are no special environmental or natural hazards. In the case of the flood-prone regions in the states of Assam and Gujarat, the following challenges were however observed with the twin-pit toilet system design:

• The plinth level of the toilet structure is inadequate (too low) in times of flooding

• The pits are submerged during heavy rains/floods, creating environmental and health risks

• The design is not appropriate for coastal and riverine areas

• Pits designed as dry pits will be submerged as groundwater table is often above the bottom of the pit (as seen in field visits)

• As the bottom of the pit is not sealed, the design becomes inappropriate for high water table and water-logged situations

• Roof structures are not sufficiently strong considering the likelihood of high-speed winds and cyclones

• Doors are under-designed and not sturdy

Box 1: Vulnerability Conditions

Physical Vulnerabilities:

- High groundwater table (saturated conditions during floods)
- Low-lying areas that cause water logging or flood situations]
- Close proximity of many villages to rivers and tributaries
- Poor graded soil and sand/silt in most locations requiring attention when building foundations
- Limited access to road networks, and an increase in transportation costs

Social Vulnerabilities:

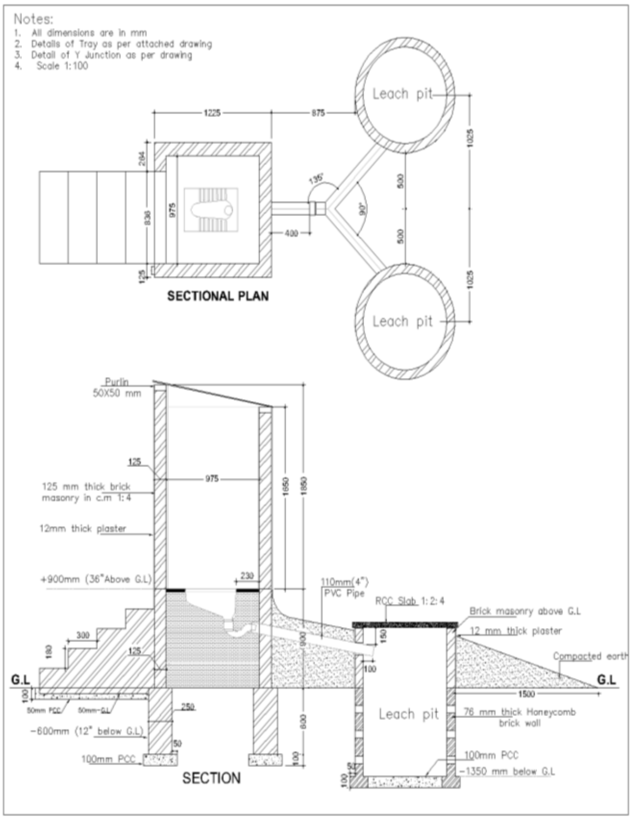
- Low literacy rate of population
- Low income levels often leading to less financial contribution to the construction of their own toilets.
- Limited awareness of the population about the need for safe sanitation has led to improper use and maintenance of toilets
- Young men migrating to other states had led to reduced availability of workforce

With this information at hand, the WASH experts, with the support of the PHED engineers and UNICEF experts, developed a new design option for DRTs. Issues of, cost, availability of materials and skilled labourers were also taken into consideration when developing the design.

Outcomes

The main outcomes of the assessments described above are summarised as; 1) recommendations and modifications proposed for a revised toilet design and construction details for this new design, 2) development of a training module for engineers, district coordinators, local NGO staff and masons in the implementation and construction of the DRTs in a participative manner and the construction of 2 demonstration models of DRTs in the District.

Figure 2: Plan of the Disaster-Resilient Toilet



Although it is important to understand that no construction can be entirely 'disaster-proof', it is possible to design and construct toilets that can withstand and recover from the impact of multiple floods, cyclones and potentially even earthquakes. For this, the upgraded toilet is designed to take into account:

• Maintenance of acceptable levels of functionality during and after a natural disaster

• The recovery to full functionality within a specified period

• The choice of materials and their availability locally so as not to increase costs due to important transportation requirements

• The financial viability of constructing these toilets within the existing sanitation programs in the states.

Following the assessments of the current situation both on the ground and from the discussions with the PHED engineers and the community members, the new design is based on improving the twin-pit system to include hazard resistant features; this will allow for the improvement of the disaster resilience of the structure whilst optimising existing resources.

Suggestions on improving the design from the PHED engineers and the communities interviewed were as follows:

➢ Remove the water tank from the current design; community members do not want it as they do not use it. It could be replaced by a 100L plastic drum with a lid that would be more user-friendly and cheaper

➢ Increase the depth of the foundations to at least 2 feet below the ground to increase the stability of the structure

➢ Increase the current height of the plinth to at least 2 feet to maintain functionality during low floods

➢ Design the toilets with pillars/columns at the four corners as this will prevent the toppling of the latrine

➢ Include a door-frame in the design

These suggestions led to the design recommendations for the DRTs in table 1.

Table 1: Design Recommendations for a Disaster-Resilient toilet			
Component	**Sub component**	**Recommendations for Disaster Resilience**	**Justification**
Super Structure	Roof (Structure and Sheet)	• Lap and butt joints need to be secured in position using double skewed nails or screws. • The connection between wall plate and the purlin is to be secured using wooden cleats and horizontal nailing (avoid vertical nails to prevent lifting of by the wind) • J-bolt/hook or twisted umbrella nails to be used to secure CGI sheets on purlins. The CGI sheets are reinforced with a C-Channel so as to sustain heavy winds and cyclones.	Joints and fixtures are to be used to ensure connectedness of roof structure components to increase the resistance to earthquakes and high speed winds
	Door (style and panel/shutter)	• A 220mm or any appropriate holdfast fixed into the concrete bed block in the wall. • Doors in timber need diagonal bracing. Timber sections to be no less than: 37.5x50mm. • Nails on the wooden styles need to be adequately spaced and staggered, screws are preferable.	Connections of doors with the system and connections of doors with the wall should be secured in position.
Plinth	Plinth height of toilet structure above Ground Level (GL)	• 600mm to 1500mm above GL should be considered, however it should not be higher than the plinth level of the homes (as people would move away if water enters their home) 900mm to 1200mm should be reasonable in the situation of Dhjemaji • Steps provided to reach the door of DRT unit	Ideally the plinth should be at least 300mm above the high flood level, however not above the plinth level of the shelters. This is to provide access even during the flood situation
	Foundation	• 600mm depth of foundation including 100mm thick PCC (1:3:6) course at the bottom. • 250mm thick brick masonry up to GL.	Anchor the foundations well to prevent uprooting
Leach Pits	Pit Lining above GL	• Recommendation is to raise the pit lining from 600mm to 900mm above GL. It should be in relation to the plinth level of the toilet structure • Diameter of pits is 1.2m from each outer end	To have increased capacity and ensure the pits function during flooding
	Plastering the pit lining	• Only the portion above the GL needs plastering, both internal and external. • The part of the lining that faces a foundation of an adjacent building will also require plastering.	To ensure that leachate does not leak into the soil surface or other buildings
	Pipe	• 75mm diameter laid in a slope of 1:15 to 1:10	Recommended slope of pipe line from the trap/water seal to delivery end at the pit
	Free board	• 150mm	At the top of the pipe end
Pan	Pan	• Rural pan with a steep slope is required to facilitate easy drainage and cleaning with little water (1 to 1.5 litres)	This is to ensure the pit does not fill up due to flushing water

Another outcome of the design process was the development of a training module for the participants nominated by PHED. The training was held at the campus of the Water and Sanitation Support Organisation in February 2017. Participants were a mix of PHED engineers and local NGO staff from four disaster prone districts in Assam. Equally, in Gujarat a similar training was held with Gujarat Institute of Disaster Management (GIDM) and UNICEF with the goal of facilitating the SBM engineers working for the Rural Development Department (Government of Gujarat) to understand the design of DRTs and construct DRTs as per the design and technical specifications aligning with standard Codes of practice. The training programme and the two DRT model units are part of the process to demonstrate their effectiveness to the Governments of Assam and Gujarat.

The objectives of the training were as follows:

- The participants understand and plan the risk of disasters on sanitation infrastructures;
- The participants can monitor the construction process from the disaster resilience point of view
- To exchange ideas during the training program regarding sanitation infrastructures and its planning from the Disaster Risk Reduction point of view
- Undertake appropriate and timely actions in response to the planning for the SBM

In order to facilitate the hands-on learning of the participants, the facilitators worked with the masons and labourers to prepare practical sessions. Overall, the training consisted of 30 per cent indoor technical/theoretical sessions and 70 per cent outdoor hands-on exercises. All the sessions were highly participatory using games and roleplay to present the setting of a hazardous environment and the main issues faced by communities as well as key concepts of disaster resilience. Practical sessions ensured that participants understood the main technical differences between a normal twin-pit toilet and the DRTs. For this session, two circular pits and two square foundations were dug and brickwork was completed up to the ground level for one of the pits. From there on a model DRT was constructed by the participants using all the DRT technical criteria.

The training was completed with a session on cost estimation. The participants worked in groups to estimate the cost of the DRT that they had constructed over the past 2 days.

In Gujarat and Assam, work was carried out on differentiating the fixed budget component and the variable budget for the DR features. The fixed component assumed the following conditions: The pit is designed as a WET pit considering the context of the high groundwater table, this refers to waterlogging up to 30cm above ground level during floods, the soil is sandy or sandy loam, not clayey. Plinth height is fixed at 600mm above ground level, and total depth of each leach pit is 1.35m, including height of pit lining provided above the ground level.

The variable budget considered the provision of an envelope of sand or sandy soil of 250mm to 500mm thickness around the leach pits in case of clayey soil, raising the plinth height of toilet structure beyond 600mm is assumed in the design depending on flood level at the site. Provision of a Reinforced Cement Concrete (RCC) slab in place of Corrugated Galvanized Iron (CGI) roof in villages lying on the coast, the horizontal bands in earthquake-resilient superstructures, the J-hook for the proper joining of roofing panels to steel frames for cyclone resilience, and the raised plinth level for flood resilient structures, as well as pit lining if necessary, depending on the soil composition.

Lessons Learned

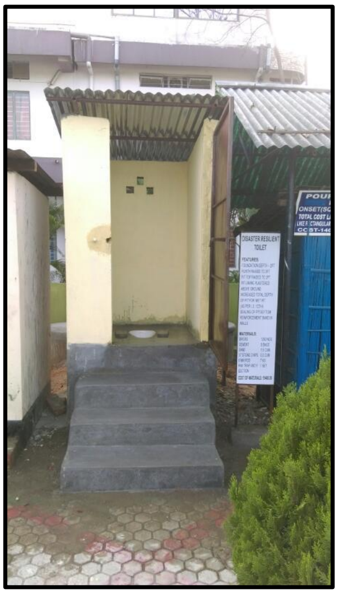
Some of the key lessons learnt from both the development of the DRTs design and the training on DRT implementation and construction are as follows:

• Considering the increased cost of a DRT compared to the 'regular' twin-pit toilet due to its additional features, the current subsidy provided to disadvantaged households of Rs. 12,000 per toilet is seen as insufficient by the families. It will probably be necessary to revise subsidies and community contributions when rolling out the DRTs in disaster-prone areas. Further community participation may need to be explored. This will require additional support from NGO's in social intermediation in affected communities.

• Selection of materials is also a key factor that can affect the cost of the final DRT. In particular, cost of transporting certain materials can increase an overall budget by 30 per cent, an example of this is the cost of a brick: in Dubhri the cost is Rs. 5/brick, whilst in Dhemaji the cost is Rs. 8/brick due to transport costs. In remote regions, it was observed that communities prefer to use cast-in-situ concrete bricks rather than pay for the more expensive bricks from the market. A solution to this situation may be to have a more flexible policy with regards to materials used in constructing the DRTs. If locally available materials are equally 'Hazard Resistant' as those proposed in the DRT design, modifications to the DRT will be considered wherever possible to allow for greater cost effectiveness.

• Following the training and a well-attended conference on sanitation in Assam in February 2017 (attended by 6,000 Gram Panchayat representatives), 35 DRTs were built in Morigaon, Assam (using regular SBM funding), these toilets have withstood the effects of the last flood season and hence are a clear sign of the success of the 'DR' features. Further assessments will be needed to review the medium to long-term impact of flooding seasons on the DRTs.

Figure 3: Demonstration model DRT in Betkuchi, Guwahati



• The state government of Assam, convinced by the need for DRTs in specific regions, has allocated INR 50 lakhs (USD 67,000) for the scaling-up of the model. However, disbursement of the funding was made contingent to the 'loss and damage reports' that are to be filled out by each district. This was unfortunately not carried out properly and the funding allocated was returned to the coffers of the state. Due to this missed opportunity, the Government of Assam has asked UNICEF Assam to support the districts in improving their reporting through training, a new area of collaboration for UNICEF with the Government of Assam in improving access to suitable sanitation for disaster-affected communities.

• In the state of Gujarat, following the training, the DRT model was accepted by the state as the official design to be used in disaster-prone areas. As part of the continued training on DRTs two toilet models were built in the Banaskantha district of Gujarat for disaster-prone communities. As Gujarat has already been declared ODF, the focus is on ODF sustainability. Under the sustainability initiative, the central government is now pushing for the states to undertake sustainability activities such as retrofitting defunct or sub-optimal toilets such as those in disaster-prone areas. The evidence-based advocacy and impact from the model demonstrations are expected to mobilise funding for the construction of DRTs in risk-prone areas. The local government at Gram Panchayat level and at the district level are eager and working towards enhancing resilience through adopting DRT models.

Next Steps

Following the trainings on DRTs as well as the conference in Assam, participants proposed some next steps for future activities that could be considered for promoting the DRT design and its implementation:

• The construction of a shared DRT for groups of households in high-risk areas to ensure safe excreta disposal during floods. This would entail a community-managed approach of the DRT by all households using the DRT.

• Sensitisation of local populations on the concept of DRTs and encourage households that can afford to invest the additional cost to do so for their benefit, or at least encourage at-risk households to include as many DR features as can be afforded by them.

• Assessments of existing toilets should be carried out in all disaster-prone districts to assess the impact of floods and other hazards. It is suggested that a map is developed designating 'high-risk areas' and calculate the number of 'at- risk households. This information can then be used to adequately plan the need for DRTs and the funding required.

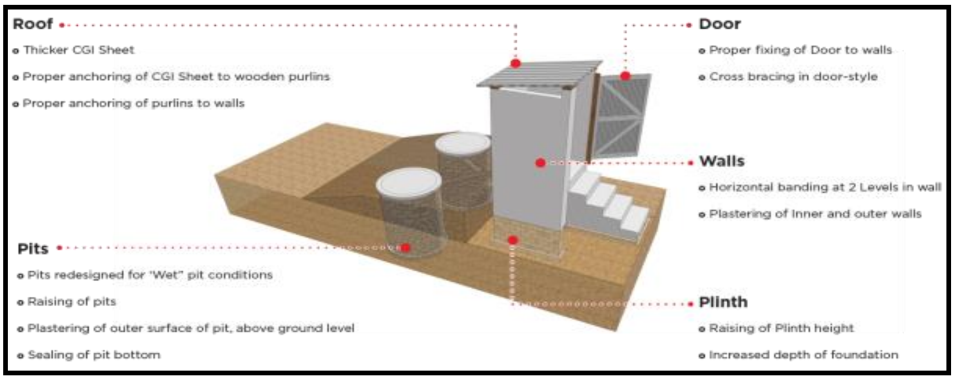
• UNICEF will support the Government of Assam in improving their reporting methodology through trainings. Once these trainings completed, the local Government of Assam, with the support of UNICEF, will advocate for supplementary funds to roll-out the DRT program in vulnerable communities.

• A system for district and block level monitoring of DRT construction needs to be established for quality assurance, monitoring and tracking.

Consideration should be given to setting-up a panel of trained engineers with and oversight role in each district from those who attended the DRT training.

• For future training courses on DRTs, it is important to ensure the participation of Self Help Group (SHG) representatives as they are the implementing agencies for toilet construction. The pilot training had no representation from SHGs. These groups should be certified as primary service providers to install DRTs, and a roster of these groups should be shared within the local communities. Also, the assistant district technical coordinator and the capacity building assistant should attend the full training to function as the focal points for information on DRT design and specifications.

Figure 4: Poster showing proposed modifications for a DRT in Assam



• In each of the districts identified as 'risk prone', a workshop should be organised on the 'implementation mechanisms for DRT construction'. This workshop should ensure the involvement of all the stakeholders and particularly the SHGs, to work out the most appropriate mechanisms for implementation. To carry this out the following parameters will need to be considered: 1) adherence to design standards and material specifications (whenever possible, flexibility needed when costs are too high), 2) Quality of RCC rings, cover slabs and other products, 3) quality of workmanship in construction, 4) cost of toilet unit, and, 5) timely delivery of products and services.

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