Emergency Sanitation Project

International Federation of Red Cross and Red Crescent Societies

OXFAM

WASTE advisers on urban environment and development

Emergency Sanitation Project Progress Report

March 2014

International Federation of Red Cross and Red Crescent Societies (IFRC), lead agency
WASTE
Oxfam Great Britain

Executive Summary

The Emergency Sanitation Project (ESP) aims to increase the global understanding of current and future emergency sanitation solutions and to propose new concepts and modular technologies for safe excreta disposal and hygiene in emergency settings that are applicable in a variety of situations and contexts.

This report summarizes progress of the ESP's work funded by the US Office for Foreign Disaster Assistance (OFDA). The ESP commenced in October 2012 and is a consortium of the International Federation of Red Cross and Red Crescent Societies (IFRC), WASTE and Oxfam Great Britain, with IFRC leading the consortium and managing the funds from OFDA.

The ESP includes the following work streams:

- Alternative toilet and no toilet Options
- Biodegradable bags
- Desludging
- Handwashing (household and communal)
- Latrine pit linings, superstructures, and raised latrines
- Locally produced latrine slabs
- Multipurpose and non-stick latrine slabs
- Urinals
- Wastewater disposal

Equipment developed as part of the ESP is for use by the entire humanitarian community and dissemination of results is a key activity. Although different members of the consortium have different responsibilities in relation to each area there is some overlap in certain areas and all members of the consortium comment on equipment developments by other partners.

Achievements to date has included desk study of available options, collaborative design work, and field testing. Equipment has been tested in various locations, including technical trainings and field conditions. The project has produced a number of items, including latrine designs and desluging equipment, that has been deemed ready for deployment in emergency operations.

Work related to untreated faecal sludge is centered in Blantyre, Malawi. The desludging trials are nearing completion. However, this activity will continue in order to provide a supply of human waste for research on effective sludge treatment, a surprisingly challenging barrier to sanitation research.

A pipeline analysis has been performed to determine which work streams of the original workplan are most likely to result in concrete outcomes, which can be closed, and which are ready for deployment in emergencies and dissemination to other stakeholders. The work done to date has naturally opened up new areas of possible research. As with any research project, there is a danger of taking on too many activities or pursuing too many leads. Discussions are currently underway on how workstreams can be streamlined, combined, or closed down to ensure that the most promising are allowed to receive the necessary time and resources to succeed..

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Alternative Toilet Options

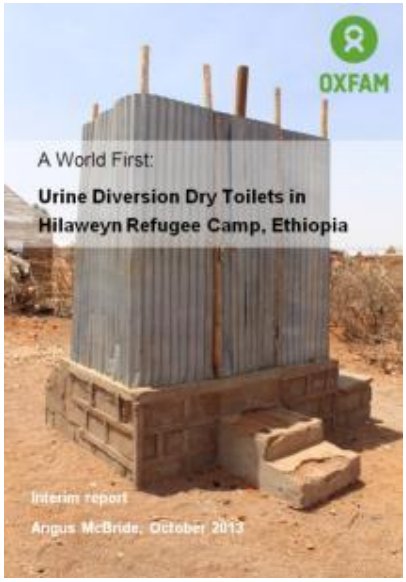
Objectives:

- Keep abreast with the new alternative options for excreta disposal.
- Development of technical resources for alternative toilet options such as box latrines, urine diversion, terra petra, chemical reduction of solids and tiger worms in related to excreta disposal/management.

Activities Undertaken

Report on Dollo Ado UDDT latrines

In Dollo Ado, Ethiopia, where there is rocky ground and an excavator is needed to dig 'normal' pit latrines, Urine Diversion Dry Toilet, UDDT latrines are being used. A report on this is being written to disseminate lessons learnt.



Field visit to tiger worms latrines

A field visit to Dire Dawa, Ethiopia, to see the progress of the tiger worm latrines there and to see if/how they could be useful in emergencies.

Field visit to Sanergy, Peepoo, Sanivation and Umandi trust in Kenya
Visits were undertaken to see what other organisations in Kenya are doing that could be useful in humanitarian situations. Activities these groups are undertaking include anaerobic digestion, faeces briquetting, mobile toilets, composting, peepoo bags, black soldier fly larvae.

Attendance at IWA Conference
Attended the International Water Association Development Conference to find new ideas and research relating to sanitation.

Gates Foundation 'Reinvent the Toilet for Emergencies'
We attended the Reinvent The Toilet Fair in Delhi to find toilet designs that could be applicable to emergencies. Many of the designs are years away from becoming robust enough to be used in emergencies but others, such as improved squatting plates, could be useful far sooner.

Activities Planned

SanCoP Emergency Sanitation Event
Oxfam will host a UK Sanitation Community of Practice event in February to discuss the latest sanitation ideas that may be applicable in emergencies and disseminate the results so far from the ESP.

No Latrine Option

Objective: Test at least 3 existing 'no latrine' options in an appropriate emergency situation. These products will be easy to freight, acceptable to users in a variety of contexts, and have established appropriate management structures.

Activities Undertaken

Desk study
A desk study has been completed of the options available, although many would not be suitable for humanitarian use.

Trial in Informal Settlements in Jordan
Peepoo bags, the camping toilet and the 'bog in a bag' were all tested in informal refugee settlements in Jordan. Existing pit latrines were of poor quality and the majority of children continued to practice open defecation. Due to the mobility of the Syrian refugees and regulations preventing the infiltration of any grey or blackwater into the ground portable sanitation options seemed like a good solution.

The trial proved that some models can constitute valuable alternatives for specific target groups facing issues accessing existing sanitation structures. However, accessibility and maintenance can be challenging especially for bag-based models. A more suitable option might be the camping toilet for both elderly and disabled people.

Scoping for a field trials of the MoSan toilet
MoSan toilets have been given to Oxfam's Ethiopian, Kenyan and Jordanian programmes but there has thus far been no interest from the teams there in trialling them further.

Jitegemee Phase II Development
We have been working with the Oxfam Kenya programme on the development of the new Jitegemee – a urine diversion toilet for use in the slum areas of Nairobi, but which could potentially also be useful in emergency contexts.

Cranfield University Project: Development of improved bucket toilet
We are sponsoring a project at Cranfield University to develop an improved bucket toilet that will allow waste to be safely separated from the user. The project is running for three months from February – April 2014, and involves six postgraduate students.

Activities Planned:

- Further development of the MoSan and trial in Kakuma refugee camp, Kenya, lead by Sanivation.
- Finishing the Cranfield University project, deciding upon whether to continue once it's finished
- Supporting Loowatt in the continued development of their emergency toilet
- Continuing to work with Oxfam's Kenya programme to support the Jitegemee development and to trial it in an emergency situation if appropriate.

Biodegradable bags.

Objectives:

- Promotion of the diversification of the number of producers of biodegradable bags for pee and poo given current monopoly.
- Contributing to solving the plastic problem by making all plastic bags biodegradable.
- Investigation into using standard biodegradable shopping bags for pee and poo.

Activities undertaken:

§ A first research study showed that the production of biodegradable bags is not a solution to the plastic (litter) problem in Africa. Research indicated that there was no market for biodegradable shopping bags and that manufacturing in Africa would not be economically feasible for this purpose as people are used to shopping bags being handed our for free. However, for specific uses as for sanitation purposes in emergency situations, these bags can offer a practical solution and it was found that any factory manufacturing plastic bags is able to produce biodegradable bags. Therefore a try-out was recommended of the production of biodegradable bags to verify the technical feasibility combined with really using the bags to gain more insight in the time needed for composting in an African country. The selected country is Malawi where this try-out can be linked with other ongoing activities. As the raw material for the biodegradable bags is not available in Africa, this material needs to be transported from Germany to Malawi.

§ A second research was started with more focus on key criteria needed to be addressed to discern the feasibility of using biodegradable bags as an emergency sanitation solution. The research indicated the two key issues that influenced the feasibility of using biodegradable bags manufactured in Malawi for an emergency situation: the guarantee of availability of the product within the first stage of the emergency; and establishing an economically competitive product.

A summary of some of the results of the research are shown overleaf.

Availability of Product within first stage of the emergency.

Quick deployment is a key criterion for an emergency sanitation solution. Two options considered and associated issues are provided in the following table. It was concluded that both options considered could not guarantee the availability of the biodegradable bag product for the relief stage of an emergency.

Option	Key Issues
1. Prefabrication and Storage Biodegradable bags would be prefabricated and stored ready for dispatched upon the occurrence of an emergency	**Shelf-life** Biodegradable bags only have a shelf-life of 2 years before they start decomposing and on-set of an emergency is unpredictable therefore availability cannot be guaranteed
2. Manufacture upon Demand Upon the occurrence of an emergency, biodegradable bags are produced by the manufacturer and dispatched to the emergency site	**Raw Material** Raw material for biodegradable bags is not available in Africa and therefore has to be sent from Germany. This will add additional transportation time and increase the deployment time of the bags to the emergency site. Alternatively the raw material could be stored at the Malawi manufacturing site for contingency, however due to the fact that the raw material also biodegrades, this would not be feasible. **Manufacture Risk** There is an additional risk associated with the production guarantee from the manufacturing company. As an emergency situation is unpredictable, it would be hard to set up a contract with the manufacturer. There is therefore a risk of the manufacturer not being willing to stop regular production and produce biodegradable bags for the emergency situation

Economically Competitive Product:

For the product to be successfully implemented, it would need to be more economical than other competitive products e.g Peepoo bags that are already being manufactured and hence can be readily distributed in the event of an emergency. Based on the price of 28 PeePoo bags being in the range of €2.5-3.5, the cost of merely manufacturing the bags in Malawi made the prospective product already not economically superior.

Activities Planned:

After carefully having analysed all issues concerned, involved costs and consultations with the local partner it was concluded that it is a very interesting approach but that the scope for emergencies of this approach is rather limited and that it is not really worth the effort of starting an elaborate trial in Malawi.

Alternative coating – non-stick coating

Objective:

- Research the feasibility of applying non-stick coating to latrine slabs to facilitate easy cleaning and thus minimize the use of water and chemicals for cleansing.

Activities undertaken

A desk survey of existing films and coatings has been carried out along with an assess the possibilities to apply the films/coatings to latrine slabs including raised latrine;

Besides Nylon, any plastic can be applied as material for latrine slabs with respect to water resistance. However, there is only one kind of non-sticky plastic, which is Fluor Polymers. Non-sticky means hydrophobic conditions. Even though these materials (or coatings) are applied in lots of products to create non-sticky-effect, it is not recommended to apply them on latrine slabs: Fluor Polymers are very costly, are hard to apply as a coating in products, they are soft meaning they are sensitive to damage and lastly they are not repairable in the field.

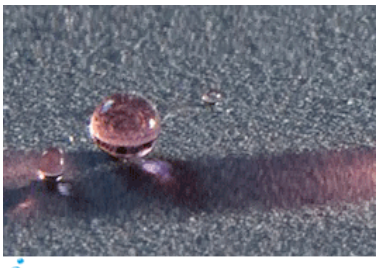
A non-sticky coating would be a good alternative since coatings can be applied later on, even when the latrine slab is at location in the field. Besides, a coating can also apply on other relevant parts, not only for the slab. These coatings are promising according to the suppliers (easy to apply, durable, etc.) however this should be tested since these are subjective sources. Testing is an elaborate and costly affair and outside the financial means of ESP. We advise to follow the results of the different researches done by K.K. Nag and by in the framework of the Bill and Melinda Gates Foundation (BMFG) 'Reinvent the toilet challenge'.

K.K. Nag research. K.K. Nag is the producer of the Nag magic slab. They have ordered 'ultra ever dry' to test out. See:
http://www.youtube.com/watch?v=BvTkefJHfC0

BMGF reinvent the toilet research. One of the projects that looks into this issue is the 'pressure cooker' toilet of Loughborough University. The research will take 1 more year before it produces results. However this is a 'cross-cutting' issue and we are in contact with Mr. Carl Hensman, Programme Officer WASH (carl.hensman@gatesfoundation.org) to be updated on the findings.
Non-sticky sprays from several different companies were found in a market research: WaterBeader, NeverWet, Hydrobead & Ultratech.

WaterBeader

Applications: include urinals, underside of toilet seats, waterless urinals, bathroom walls, public toilets
Contact angle: Unknown
Dry time: 15 min – 24 hours
Price: € 15- 30 per litre.



NeverWet
Applications: metal, wood, plastic, aluminium, vinyl, asphalt, masonry, Not glass
Contact angle:160 – 175 degrees
Dry time: 2 x 30 min
Price: 10 to 15 square feet for $19.97

Hydrobead
Applications: fabrics
Price: see appendix

AlwaysDry
Application: fabrics
Dry time: 24 hours
Contact angle: 120-180
Price: 500ml concentrated formula €29.95

Latrine Pit Linings, Superstructures, and Raised Latrines

Objectives
Latrine Linings
Develop, test and have ready for production at least 2 different emergency pit linings. They must be appropriate for use in first phase emergencies, suitable for air freight, be easy to use in a variety of circumstances and cost around £40 each.

Latrine Superstructure
Develop, test and have ready for production least 2 different new emergency latrine superstructures. One will be suitable for standalone pit latrines, the other suitable for trench latrines. They will be suitable for air freight, cost around £50 and be easy to install.

Raised Latrine
At least 2 different emergency raised latrine models tested and available for purchase. They must by easy to freight, cost around £150 and have > $1m^3$ storage.

Development of New Products
Having completed the desk study for existing products 'Design a Bog Day' was conceived to generate new ideas and attract manufacturers interested in producing new latrine kits. Following this a 'Call for Proposals' was launched with small sub-

grants being given to various manufacturers and universities to develop kits, and some manufacturers working for free.

Design a Bog Day
Design a Bog day gathered together a mixed group of NGO workers, representatives from suppliers, academics and product designers to come up with solutions for latrine linings, raised latrines, latrine superstructures and handwashing devices. Attendees from beyond the field of sanitation were sought, with adverts put out in relevant press to search for product designers and potential manufacturers. This brought together people who would approach things differently and meant networks could be built between people who might not normally meet.

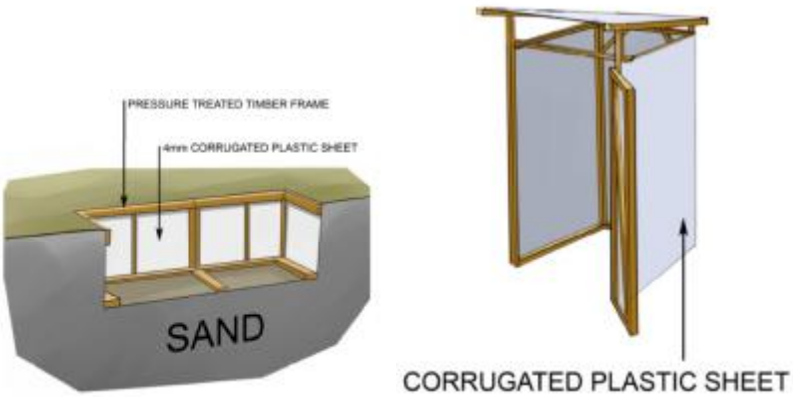
Of the many ideas generated and discussed, there were a few ideas that after voting were particularly popular:

- A wrist or foot operated *pump atomiser,* which releases a controlled spray of water from an existing container by pulling a large loop. It's hands-free, water saving and can be used by disabled people.
- A *spray lining* using a foam or maybe spraycrete that can be sprayed onto a chicken wire mesh. Challenges here involve identifying a suitable spray material that is suitable for air freight.
- A *snake-like latrine lining* consisting of a very long bag, or bags, which are filled with a material that hardens on contact with water, possibly mixed with soil. Questions remain regarding its strength, and what could be that material in the middle?
- A *raised latrine block*, inspired by Flexxolutions' raised latrine design, that will have a very large containment volume underneath, making it easier to empty.

Outcomes are documented in an article which was published in Waterlines, and a written and audio article on the IRIN website:
http://www.irinnews.org/report/98787/new-look-emergency-sanitation

Grant to Dunster House
Dunster House are a UK based manufacturer and supplier of predominantly wooden garden buildings. They submitted a proposal for a very lightweight and competitively priced pieces of kit and we have given them a grant of £10,000 to undertake the development. The latrine lining, superstructure and raised latrine they are producing are all made of a treated timber frame which supports corrugated plastic panels.

They are now on their second prototype and, subject to good feedback from the WASH cluster, are ready for field testing.



Oxford Plastics
Oxford Plastics are a plastics manufacturer who are designing and producing a trench lining with us. It is currently at the concept phase.

Working with AMG Group (Vango)
AMG Group have extensive experience in producing tents and sell to consumers under the brands Force Ten and Vango and produce a family shelter for Shelterbox. Now they are working on a latrine superstructure for us.

Grant to Coventry University
We have given Coventry University's Humanitarian Engineering and Manufacturing Departments a grant to develop two different latrine superstructure kits that should pack very small, and makes innovative use for a curtain as a door. The first prototype has been finished and work is ongoing on the second prototype.

Edinburgh College of Art Design Project

Industrial design students at the Edinburgh College of Art undertook the design of raised latrines for a seven week project as part of their degree course. 48 students ranging from undergraduate to PhD level were split into six groups to undertake the design. Oxfam staff travelled to Edinburgh for the project launch and the project finish.

Further development was undertaken on the best design and the prototype is now ready for presentation at the Global Wash Cluster meeting in Oslo.

Working with and grant to Compact Shelters
We have been working with Compact Shelters in Australia to develop a new latrine superstructure. It has now reached the second prototype stage. It is modular and can be expanded into a block of latrines by clipping them together.

Grant to Flexxolutions
Flexxolutions have been developing a raised latrine for over a year, and we have funded them to adapt their initial solution into a block.

Product Testing

Test of nCircle latrines in South Sudan – Maban
Innovations Unlimited, an Indian company, have produced an innovative 'pop-up' latrine that packs small and can be erected very quickly. 50 nCircle latrines were sent to Maban, South Sudan for field testing as part of Oxfam's response to the refugee crisis there. Unfortunately, due to logistical difficulties, they arrived after the first phase of the emergency and so were not set up as part of rapid trench latrines as intended. Instead they were set up in schools in Gendrassa Refugee camp for use by teachers, and were adapted to fit in with the style of other latrines constructed in the area by adding a layer of plastic sheeting around them. As the teachers weren't there all the time it was hard to assess how durable and accepted they would be in their intended situation. They were broadly liked by the teachers, however.

Test of Evenliner in Niger
In some refugee camps in Niger Oxfam had been experiencing difficulties with pits collapsing due to the unstable soil. Ten Evenliners were sent to Niger to determine whether they were an appropriate solution. Due to staff turnover there is currently difficulty in assessing how they performed.

Test of Evenwaste and nCircle latrines in Bundibugyo, Uganda
Three 'Evenwastes' and fourteen nCircles were sent to the refugee transit centre in Bundibugyo, Uganda, where Oxfam has been responding to an influx of refugees from the Democratic Republic of Congo.

In the transit centre high groundwater tables had been encountered meaning that the Oxfam team were having difficulty building latrines, and they were also interested in deploying the quick to set up nCircles in areas where the ground water was lower. Both types of latrine performed well and were generally liked by the beneficiaries.

Activities Planned

- Taking kit to the Global Wash Cluster Meeting
- Dissemination to Oxfam field staff at the Humanitarian Learning Forum
- Field Trial of Newly Developed Products

Local production of latrine slabs

Objective:

To stimulate the Regional and local market in production of latrine slabs.

Activities undertaken

Feasibility study of different manufactures who have the technical competencies and capacity to produce latrines slabs locally has been completed.

Prepare design and mould.
During joint discussions between WASTE and Oxfam GB it was strongly suggested to use the design of the KK Nag slab, that is now becoming a recognized standard and not start a new design process all over again. As far as moulds are concerned: the costs for the mould of the rotomoulding process are quite limited: € 1000-2000. A mould for injection moulding is far more expensive: € 100,000.

Identify production capacity and pilot country & Inventory plastic producers.
Intensive interaction were held with Kentainer in Kenya. However, Oxfam has tried to use Kentainer slabs in the past and found them unsuitable for use in rapid emergency situations mainly due to their size and weight and the squat hole cover. Kentainer was not willing to modify their slab design. So the issue was left aside, as agencies responding to emergencies are unlikely to buy it.

Discussions were also held ARKAY plastics in Malawi. As the funds for an injection mould are outside the scope of ESP, WASTE has teamed up with ARKAY plastics in the framework of the UNICEF/DFID Challenge fund in Malawi. WASTE has now passed the first round of the challenge and awaits further information.

Inventory feasibility recycled plastic.
Our study on the feasibility of recycled plastic for squatting slab use revealed that is an easy thing to do. However, according to KK Nag, the colour has to be black, which is less attractive as it might attract flies. As black tends to become hotter, the plastic might become a bit 'brittle'. KK Nag produces these slabs on the request of Unicef. See picture below.

Nag Magic slab out our recycled plastic

Production and product testing
Depending on funding from UNICEF/DFID Challenge fund in Malawi.
Overall conclusion. This topic has been taken up by the market and there are many alternatives. There is hardly any additional value to put extra ESP resources in this topic. The UNICEF/DFID Challenge Fund in Malawi is exclusively for the daily market. It is not meant for the emergency market. With a limited input of ESP WASTE could add the aspects of emergency requirements and the feasibility to link the two markets.

Multipurpose Latrine Slabs

Objective: Design an improved slab to allow add-on (ancillaries) for a multiple of purposes and users. Develop, test and have ready for production at least 2 different add-ons to the existing pit latrine slab that increase its versatility for emergency situations. One will improve its usability by less abled users, and the other will improve its suitability for pour flush.

Activities Planned

Investigation of feasibility of using Sanergy's UD slab
Sanergy in Nairobi have developed an improved urine diversion slab that could be very useful in emergencies. We plan to test this in an emergency setting.

Testing KK Nag's new slab seat for disabled users

Urinals

Objective:

Provide urinals (for men and women) to decrease the filling up of the pit latrines.

Activities:

To raise the interest of the general public in the topic of emergency sanitation, WASTE was requested to organize a design contest on this issue. The Contest was launched just before World Water Day 2013 on 18 April on line through WASTE, SuSanA, TUD, etc. The rules were explained in a Leaflet and the Emergency Sanitation Project site. Later an attractive Flyer was distributed at universities, schools, Oxfam (Design a Bog day on 13 September 2013), S(P)EEDKITS, etc. The Contest was mentioned in the newspapers in The Netherlands and an interview was broadcasted. The Contest closed 18 October 2013, 1 month before World Toilet Day.

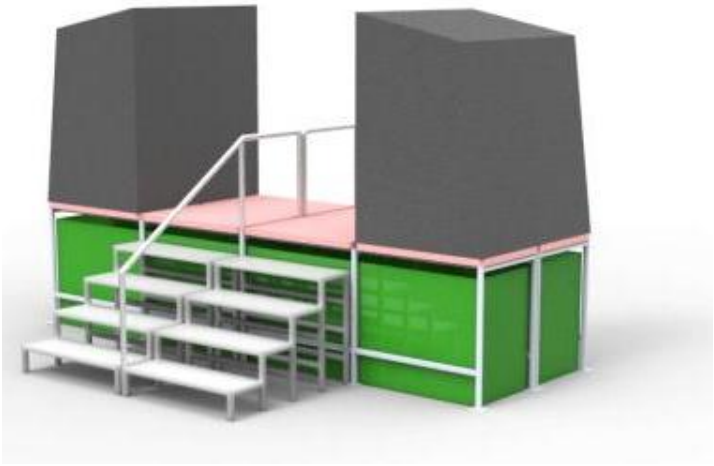
The design contest resulted in 14 applications from 11 different countries. See map below:

The entries have been scored and the top four entries have entered a voting on the WASTE website. Based on this voting three have been given a prize of €500.

Activities Planned

A general comment of the relief organizations on these entries was that the designers lack the insight of the in's and out's of the 'real' conditions during emergencies. Hence, we challenged the three contestants to come up with a clear distinct proposal how they would envisage that their proposal could be brought from the drawing table to the manufacturer. This proposal would include a field visit to a refuge camp emergency situation, thus answering the concerns that the designs did not yet show they had grasped the real challenges that relief organizations are meeting in the field. Out of your three proposals one would be selected for funding up to € 5000. This would include the field trip.

By 19 January 2014 two contestants had handed in a proposal. We studied this proposal in the ESP meeting in London during the HIF meeting and we decided to discontinue the contest. One important reason is the doubt of IFRC and Oxfam GB that a separate latrine would ever work in an emergency situation and whether relief organizations would ever purchase it.



Hence, we decided to make it an 'add-on' to the raised latrine developed by WASTE in the framework of S(P)EEDKITS. See figure below.

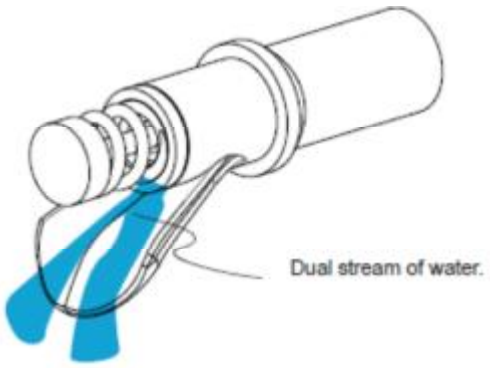
Handwashing – Household

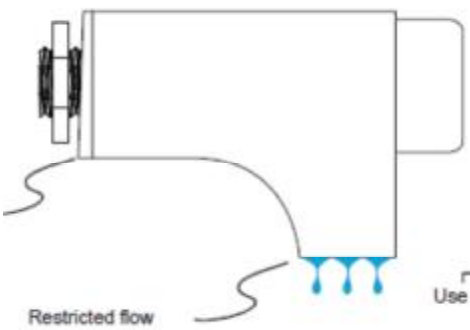
Objective: Develop, test and have ready for purchase two new hand washing devices suitable for emergency situations. They will be lightweight, hygienic, water saving and cost less than £3/unit.

Activities
Design a Bog Day - As per 'latrine kits'.

Product Designers
We took on Alex Bone & Steve Matthews, a pair of product designers, to conduct a review of existing handwashing devices and produce sketch prototypes and concepts of potential new handwashing products.

The review found the Handy Wash and the 'Haiti Foot Pump' to be the most effective hand washing products so far. Their new concepts included taps made of rubber for increased durability and a time-delay tap which dispenses a fixed amount of water after the user has pressed a button.



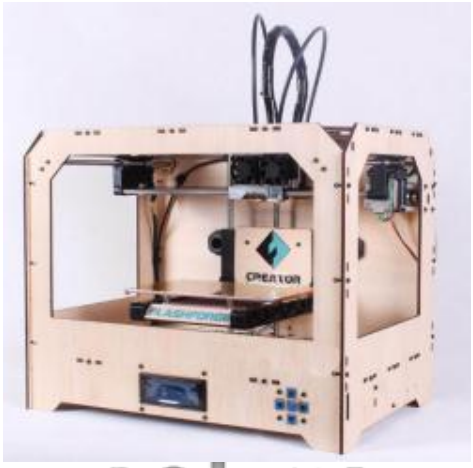


3D printing of handwashing devices
We are working with Makr, a 3D printing company, to crowd source designs for handwashing devices on their 'MyMiniFactory' website. We have a 3D printer in Lebanon which will allow us to instantly print and test the designs in our

programmes. Should a successful design be found then we will then look at how it can be mass manufactured.

Native Design

Native are a design consultancy that are producing concepts for a new handwashing device in emergencies for us in their 'lab'. They will be presenting their final concepts later in April.



native
Integrated Experience Design

Activities Planned

- Production of one of the concepts developed so far

Hand Washing - Communal

Objective: Develop, test and have ready for purchase handwashing devices suitable for communal toilets in emergency situations..

Activities

- A specification detailing the requirements of the communal handwashing product has been developed in consultation with WatSan practitioners in Red Cross national societies. The built upon work by IFRC in 2012 which looked into all handwashing products available on the market.
- IFRC researched potential suppliers that may be involved in the development of the communal handwashing equipment. This task was undertaken in April 2013 and involved internet searches and recommendations from those within and outside of the field of humanitarian sanitation. This resulted in a list of 24 potential suppliers.
- The request for proposals was issued to this list and advertised generally in April 2013 calling for suppliers to provide a proposal concept design, cost, and timeline for sample to be manufactured. Only 3 responses were received, and none of these met the specification entirely. The responses came from Aircell Structures, Nagmagic and Butyl Products. Following the unsuccessful tendering further discussions were undertaken with two further suppliers: Satellite Industries SPRL, and WaterSHED Vietnam which supplies the product called HappyTap which has been used primarily at household level in Cambodia. The procurement of some trial Happy Tap items is currently being progressed.

Planned activities

The work ongoing and planned between March 2014 and August 2014 (the end of the current OFDA funding) includes:

- Rerelease of request for proposal with further information on potential volume of orders that could result from successful proposal, after trial phase, to further incentivize suppliers to respond.
- Use of Red Cross Red Crescent network to innovate. Communal handwashing will become an essential item to be held by the national societies in relation to the Mass Sanitation Module Emergency Response Unit (MSM ERU). This will require the Spanish, British, Swedish, German, and Austrian Red Cross to source a suitable product stimulating greater investigation into this issue.

Despite significant effort to engage developers and suppliers it is currently unclear if the objectives of the current OFDA funded ESP will be achieved by August 2014. It has also been identified that some (if hopefully limited) further research is required to investigate equipment that can be used to ease refill of communal handwashing stations. This is because it has been seen that even when locally sourced communal handwashing equipment has been setup communities do not always keep it maintained with water. It is appreciated that this is partly a software and partly a hardware issue.

Options for desludging – Difficult Areas

Objectives:

- Improved ability of field teams to rapidly mount desludging activities.
- Development and testing of single desludging kit using existing materials, including desludging pump, transport storage, and all accessories.

Activities:

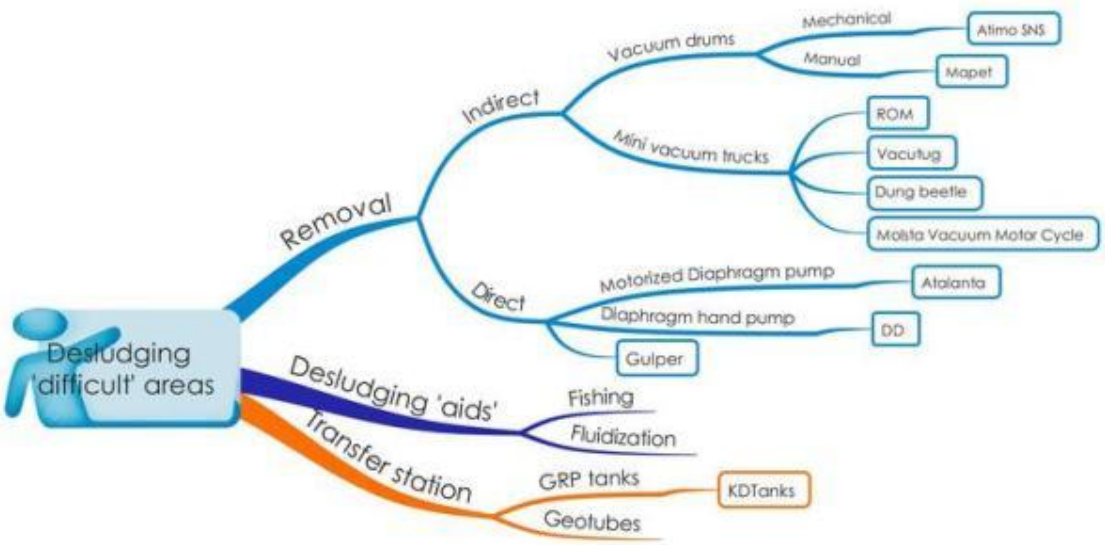
The following activities were executed (see mindmap below):

§ Review desludging difficult areas;

§ Design and produce prototypes;

§ Testing in the field.

Review desludging difficult areas. We studied what is available at the market and visited producers such as the producer of the Atimo drum solution in Italy.



Design and produce prototypes. We opted for the ROM2 vehicle and had it tailored for emergency situations and 'difficult' sludge: in-built fluidizer, larger (3" in stead of 2" hose), etc. The Netherlands Red Cross insisted on having a fair comparison with the current standard at the market, the Vacutug. As this one does not have a fluidizer, an off-the-shelf fluidizer was selected. IFRC insisted on having a membrane pump solution as comparison and purchased one. As transfer stations we purchased a 13-m^3 bladder and a 3-m^3 sludge tank (flat pack).
The setup chosen is as follows:

§ Fluidization;

§ Fishing of rubbish;

§ Emptying of pit;

§ Temporary storage in transfer station;

§ Transport to Treatment facility.

Testing in the field. The tests in the field, Malawi, have started in November 2013 and will continue up to the end of March 2014. From the testing in the field of the ROM2 is becomes apparent that it is easier to have a separate fluidizing kit. Hence, the fluidizer attached to the suction hose of the **ROM2** was detached. It was also clear that at least 30 m' of 3" suction hose is needed to operate successfully in order to access toilets. Despite all the 'fishing' activities, still debris is entering the ROM 800 litre vacuum tank; hence a separate manhole is to be put in place to facilitate maintenance. Otherwise the ROM2 functions perfectly. It has been tested on over 350 toilets, is robust and reliable, and requires maintenance after 250 toilets. It has also been mounted on a trailer to be towed by a 1-ton truck in order to further enhance accessibility. It is recommended undertake actions to have it entering into the catalogue of relief agencies.

The field tests of the **Vacutug** are still underway, but so far it has proved difficult to assemble, slow to deploy, and fragile in operation.

The use of the bladder is successful as it reduces transport movements. It was slightly damaged and a repair kit on-site is needed.

Emptying bladder

Desludging – flat-pack and vehicle mountable

Objective: Develop desludging equipment that can be rapidly deployed by air freight, has adequate capacity and can be assembled by personnel not familiar with the equipment and loaded onto a locally hired vehicle.

Activities Undertaken

- Existing equipment was investigated as part of a short project funded by BUZA, the Ministry of Foreign Affairs within the Netherlands Government, which included a review of the existing equipment and developed design criteria for sanitation equipment needed. Immediately prior to this there was also a workshop held in Delft in June 2012 where existing desludging equipment was reviewed with many of the suppliers in the field.
- In March 2013 IFRC developed a specification for equipment which built on the BUZA funded criteria.
- The specification was issued to a number of relevant companies including non-traditional suppliers to this sector, however there was limited response. It was decided to undertake the development directly through a company known for taking off-the-shelf products and creating solutions to gaps in equipment in the humanitarian sector. This was justified because it was felt that the significant innovation in relation to this equipment occurred during the conception stage prior to issuing the specification. This specifically relates to the flat-pack nature, mountable on a flatbed truck, rigid body, and a manifold arrangement which minimizes the need to connect and disconnect soiled pipes.
- Over several months Butyl Products worked closely with IFRC to put together the equipment. Glass reinforced plastic (GRP) flat pack panel option was chosen to form the body of the rigid tank because of the density (for air freight considerations) and strength (considering risk of vandalism). A membrane pump rather than vacuum pump for simplicity pump size, and ease of maintenance was also decided upon.
- Field testing of the product developed is ongoing.

Testing

IFRC decided to test the unit in two phases:

- Assembly of the equipment by personnel unfamiliar with the equipment.
- Testing in Malawi in test desludging operations.

The first testing was completed in July 2013 in the UK.

British Red Cross Sanitation Personnel assembling GRP tank

The second phase of testing was started in October 2013 in Malawi, and is ongoing.

Desludger transporting sludge from market latrines

Preliminary results indicate that the tank and pump have performed well. As of March 2014 the pump has been used to desludge 144 m^3 of sludge. The diaphragm pump has been tested in nearly 200 septic tanks in Malawi, and is easy to use, has good

access, reliable and economical. It is yet to be tested on difficult sludge as a stand alone fluidiser is required.

The ROM2 and Desludger kit are so far the most promising units found and tested. It is foreseen that they could work in a hub and spoke configuration, with the ROM accessing more difficult areas and the larger desludger transporting waste to the disposal site.

Activities Planned

Further trials are required to test the suitability of the pump to test wetter sludge, and for these tests a liquidizer has been ordered, and these trials will continue once the equipment is in place. The tank will also be trialed over a longer period of time, primarily to check for deterioration in fittings and seals

Dissemination of awareness of equipment developed is an important part of this project and the work will be presented at the Global WASH Forum due to occur in April 2014 in Oslo. The web based emergency items catalogue of the IFRC and ICRC (http://procurement.ifrc.org/catalogue/) which is publically accessible will also be updated to include this item, and a one pager on this equipment with key technical information, costs, and contact information will be included in the information published on the SuSanA website. The “flat pack desludger” will also be presented to national societies involved in sanitation at the Health and WatSan Emergency Response Unit Working Group meeting held in Washington DC June 2014.

Further research needs

This workstream of the ESP is significantly developed, and the equipment has been received positively by practitioners aware of the equipment. A set of the equipment is due to be purchased and stored in Dubai for rapid deployment in IFRC operations. A real emergency is the next further trial needed for this equipment.

However, it has been observed that there are a large number of pumps which may be suitable to this application and other pumps should be tested for their usefulness in desludging. One such pump is the Tesla Pump which is a bladeless centripetal flow turbine particularly suitable to desludging but which needs further development and trialing in this context before it can be used.

The trials relating to desludging have also highlighted the need to investigate and develop an appropriate Transfer Station for this emergency context which is discussed later in this report.

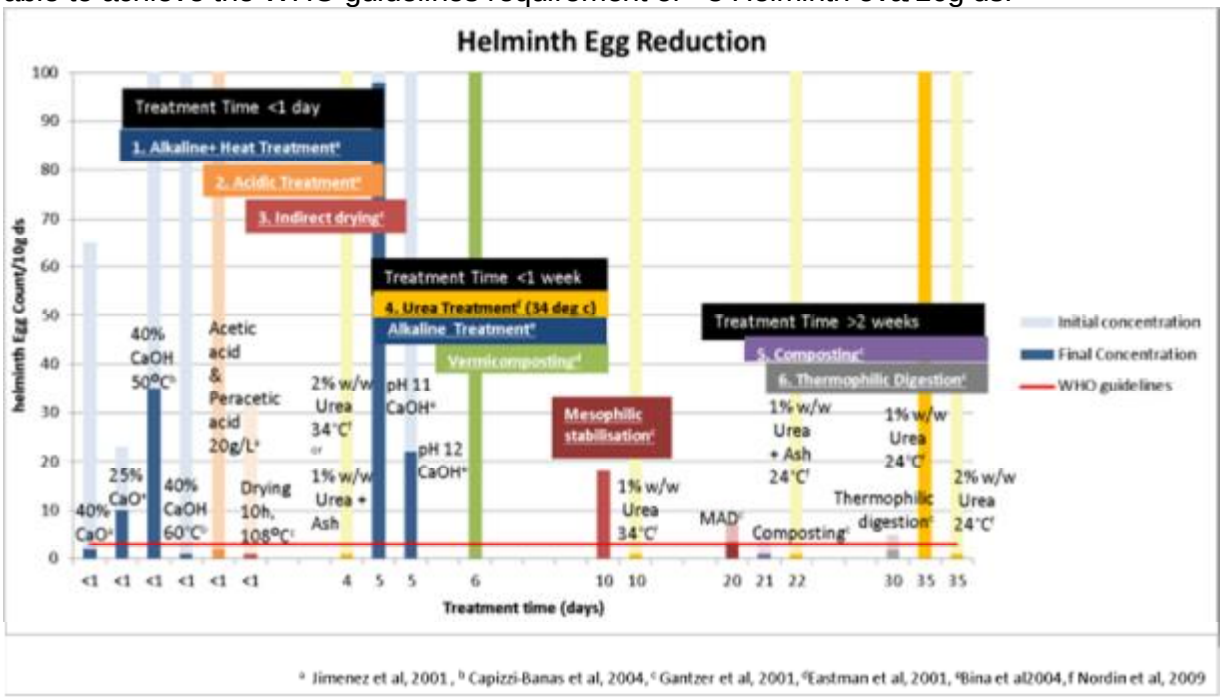
Sludge Treatment – Ammonia, Lime, Lactic Acid

Objectives:

- Simple and scalable equipment is available for large-scale wastewater treatment.
- Collaborate with academic and private industry to develop prototypes
- Test and improve designs

Activities.

Literature review.
The key aim of faecal sludge treatment is to sanitize and stabilize the sludge to produce a product that will not be detrimental to public or environmental health. In order to reduce the pathogenic content of faecal sludge to acceptable limits, a number of treatments exploiting one or more deactivation mechanisms can be employed. The Helminth egg removal from experiments using different faecal sludge treatment technologies documented in literature was studied en summarized in the following figure. The lighter colour illustrates the initial Helminth egg count and the darker colour illustrates the final Helminth egg count Six key treatment methods were able to achieve the WHO guidelines requirement of <3 Helminth ova/10g ds.



Progress field trials in Malawi. See summary next page.

Emergency Faecal Sludge Treatment

Field Testing Update from Malawi

Three Emergency Faecal Sludge Treatment Options have been investigated through small scale experiments using Fresh Faecal Sludge over the past 3 months in Blantyre, Malawi. Preliminary testing has indicated that Lime, Ammonia and Lactic Acid Treatments all have the potential to treat fresh faecal sludge to meet WHO guidelines within a treatment period of approximately one week.

The characteristics of the Faecal sludge collected from the Bangwe Market Pit Latrines each week has varied considerably from week to week. To date, the treatment methods have been able to treat the varying faecal sludges, but further testing is recommended.

Faecal Sludge Characteristics

Total Solids: 4-15%
Volatile Solids: 45-75%
E-coli : 10^6-10^7 CFU/100ml
COD: 50-150 g/L
Ammonia: 1.2g NH4-N/L

Further upscaling and scientific testing is required to ensure that these treatment methods can consistently meet sanitation requirements and a robust procedure that safeguards public health during an emergency situation can be established.

Treatment	Ammonia	Lime	Lactic Acid
• Treatment Time	• 4-8 days	• 2 hours	• 7-9 days
• Final Concentration of E-coli, Salmonella and Faecal Coliform	• <1000 cfu/ 100ml	• <1000 CFU/ 100ml	• <1000 cfu/ 100ml
• pH	• pH 9	• pH 11	• pH 4
• Quantities of Chemical Addition for Treatment	• 2% Urea w/w (20g urea/kg Sludge =9g TAN/kg Sludge)	• 12-16g Lime per kg Sludge (The buffer capacity varied considerably between sludges)	• 20-30 g/L Lactic acid concentration (using 10%w/w preculture, 2g simple sugar/kg sludge)

Over the coming year monitoring of the sanitation effectiveness of the Flexigester, Worm Toilet and Terra Preta Toilet will be undertaken.

Sludge Treatment – Bioadditives, Worms, Anaerobic Digestion

Objective: Develop and test processes and equipment for the safe disposal of faecal sludge.

Activities:

The work undertaken on developing sludge treatment processes for emergencies builds upon the progress made as part of a project funded by BUZA, the Ministry of Foreign Affairs within the Netherlands Government, which included a review of the existing options available and developed requirements for sludge treatment in emergencies for future research. Among the various known sludge treatment methods, anaerobic digestion (and the various associated methods), addition of a bioadditive to catalyze the reduction of sludge and pathogen removal, and the use of worms have shown the most promise for the humanitarian emergency context.

Building on the Buza project the detailed core requirements of the process were defined. These can be found on the project's website.

To enable trialing and development in this workstream it was essential to organize a test location, since it is not possible to source large volumes of faecal sludge in many countries. The decision was therefore taken to set up a testing location in Blantyre, Malawi in order to take advantage of the ESP's desludging activities and existing staffing. Nevertheless, as part of the ESP a testing laboratory needed to be further expanded and relationships with organisations which had access to fresh sludge developed. This has taken time and the dependency of this workstream on preliminary work is the main reason why this area of the ESP will need to be carried on beyond the existing funding.

Anaerobic Digestion has been explored and following numerous proposals from commercial firms. IFRC chosen to trial the Flexigester from SOWTech which combines anaerobic digestion with a pasteurisation system. This system involves an innovative "Orca agitation valve", which opens automatically causing release of gas and a flow of material in the digester agitating the material and improving the digestion efficiency. Trials of this in Malawi are ongoing. Given the detention time required it is unlikely that anaerobic digestion will be a complete solution for large scale sludge disposal. However, it may be appropriate for smaller scale situations or constitute a piece of larger solution.

Sludge Treatment: Flexigester Trials - Malawi. February 2013

Tigerworm vermi-compost processing has shown promising results for single toilets. However, large scale worm treatment has not been explored and current estimates indicate that a human waste load of 10 people per square meter can be achieved. A trial beginning in April will assess the feasibility of importing large quantities of worms (live and eggs) and how to maximize the efficiency of vermin-compost processing. The results of this trial will inform the feasibility and practicality of future proposed vermi-composting in emergency settings.

Two bioadditives, which are biological catalysts for promoting sludge reduction and pathogen removal, have been identified for trialing. These are Consortium Prebio Lice SM produced by Natura Viva of France and is transported in powder form, and Indian Ministry of Defence Research Laboratory (DRDO) anaerobic microbial cocktail, which is now being commercially developed and marketed by NVH Technology and is transportable as a aqueous solution. IFRC is planning to trial both products towards the end of April 2014 in Malawi. Both products will be trialed in very simple experiments with minimal variation of factors which could influence efficiency of the process primarily to focus on proving the process works. Following this it is hoped that further experiments can be undertaken to establish key factors which govern the process.

A design contest for Bachelor, Master and PhD students was advertised via universities worldwide, with submissions received at the start of March 2014. Seven detailed high-quality submissions are currently under review.

Activities Planned

The work ongoing and planned between March 2014 and August 2014 (the end of the current OFDA funding) includes trialling of the two bioadditives, and tiger worms at scale, and further trialling of the Flexigester. Although work in this area will be significantly progressed it is unlikely that this significant work stream will be fully explored by the end of the current OFDA funding. New treatment methodologies are currently under consideration.

Pipeline analysis

Taking into account work planned for the coming months, workstreams have been divided into the four categories.

Closed Research Streams:

(Includes work expected to close in the next few months, items ready for deployment, and results that may be made use of by external programmes)

- ROM2 and desludging kit haVe been trialed in Malawi and is ready for deployment in emergency settings.
- Raised Latrine developed by WASTE in the framework of S(P)EEDKITS are ready for deployment.
- Biodegradable bags: follow and contribute wherever possible in the development of 'Pacto' and 'Loowatt' toilets: knowledge on bio-degradability and treatment of bags filled with urine and faeces;
- Locally produced Latrine slabs: follow and contribute wherever possible in the development of the ARKAY plastic slab in the framework of UNICEF/DFID Malawi: add emergency context specific criteria and develop a mutual market;
- Non stick / 'shit-phobic' material: follow and contribute wherever possible in the development of coatings: testing of KK Nag and other coatings in the field;

Continued streams

(includes technologies still under development, in trial stage, or being considered for expansion):

- Handwashing devices.
- Sludge treatment, including lime treatment, polymer flocculants, algae, freeze-dried activated sludge. and other recently identified technologies.
- Urinals as add on to raised latrine
- Multipurpose Latrine Slabs: add-ons to the KK Nag slab: seat, urinal, UDDT.
- Latrine kits: raised latrine, latrine superstructure and trench lining
- Bucket toilets and systems surrounding their use

New streams being considered by ESP partners

- Development of reduced odour transfer stations and use of transfer station as treatment of faecal sludge;
- Disc pumps for desludging and sludge drying and investigation of smaller desludging pumps
- Use of bacterial/enzyme cocktails aimed at a 'magic' pit / Perpetuloo: a toilet that never fills. We expect this can be done in close collaboration with the HIF, The Humanitarian Innovation Fund;
- Testing of different technologies in the field such developed in the framework of the BMGF 'Reinvent the toilet challenge': being the intermediary between the inventor and the emergency market. Examples include:
    - American Standards 'Sato ® Latrine Pan' and 'Sato ® Latrine seat';

- Aerosan: use of ‘chimney’ effect to dry faeces;
- RTI system: solid/liquid separation by means of an inclined screw, sludge drying via convection, electrochemical disinfection of the effluent, combustion of the dried faecal sludge.

- Investigate Fuel cells powered by faecal sludge for latrine lighting
- Evidence and improvements on UDDTs for emergencies
- Investigate solid waste compaction equipment
- Investigation of squatting ‘no latrine’ options