Emergency Sanitation Project

International Federation of Red Cross and Red Crescent Societies

OXFAM

WASTE advisers on urban environment and development

Emergency Sanitation Project
Final Report

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

USAID FROM THE AMERICAN PEOPLE

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 presents the first phase of the ESP's work, which was funded by the US Office for Foreign Disaster Assistance (OFDA) from October 2012 to 31st March 2015. The ESP in this phase consisted of 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, with a collection/disposal system
- 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 treatment and disposal

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

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

Work related to untreated faecal sludge was centred in Blantyre, Malawi. Testing of toilet hardware has been undertaken in South Sudan, Central African Republic, and the UK. Other trials were carried out in Cote d'Ivoire and India.

The ESP sought not only to discover new designs for sanitation in emergency response, but also to change the way that humanitarian agencies and suppliers solve issues with equipment and bring them to market. The ESP attempted a number of different methods of innovation under this grant. Some, such as accelerated innovation events, were successful in sourcingl a wide spectrum of input in improving sanitation and led to new partnerships and bringing concepts to fruition. Student design contests were less successful due to the challenge of generating publicity and interest in them. Several ESP workstreams were based on designs from the developmental context, pushing existing processes to their limits of effectiveness to simulate disaster response conditions. Direct partnership with known suppliers was avoided as much as possible in order to foster new ideas from heretofore untapped sources of innovation. Although this was a challenge, as humanitarian equipment suppliers already understand the context and client, the ESP identified and built relationships with a number of new suppliers and product developers..

The strength of the ESP was the consortium approach. No one humanitarian agency or academic institution could have brought the array of perspective, expertise, and roll-out capacity that the ESP consortium applied to the problem of sanitation in challenging settings. A larger consortium would bring greater resources to bear on the problem, and the ESP is actively seeking additional partnership.

If it is to be worthwhile, the work of the ESP, both successes and failures, must be shared. The ESP has kept professional networks abreast of progress through presentations at meetings and conferences, the ESP website, and published research.

A pipeline analysis has been performed to determine which work streams of the original work plan 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 work streams can be streamlined, combined, or closed down to ensure that the most promising are allowed to receive the necessary time and resources to succeed in phase 2.

A new concept note with a limited number of research areas is currently being developed by the ESP. Workstreams will be reduced and the focus of the second phase will be onsite excreta storage and treatment, safe excreta removal and storage, and combined process excreta disposal. Further work to deploy proven technology will also be carried out by consortium partners.

Summary of Progress since Previous Update

Alternative toilet and no toilet options

- Cranfield University's 'Sit & Pull' toilet, which Oxfam commissioned, has a cunningly designed seat and special bag which would allow the bag to be closed and disposed of simply by pulling a cord on the outside of the toilet. However, it would require a significant investment to manufacture the bags, so this design has been discontinued. However, the concept is similar to the Loowatt design which is already significantly advanced. Through our coordination and discussions at the Humanitarian Innovation Fund meetings, the Reinvent the Toilet Exhibition and internal meetings in Oxfam, Loowatt has been identified as a promising team that could develop a proposal for a household emergency toilet, building on their concepts and learning's from Madagascar. ESP has supported Loowatt in developing a proposal which has been granted funding from the Humanitarian Innovation Fund to carry out a detailed analysis of the 'alternative/no toilet options', and thus present some options.
- The Mosan in-home toilet improved and trialed it in Kakuma refugee camp, Kenya, with partner Sanivation. Feedback has been generally positive but some issues have been identified, such as the toilet overheating if the cubicle isn't used, the lack of a roof, no means of carrying out anal cleansing and menstrual management.
- Oxfam, through their own sources of funds (WaSH innovation fund) have also progressed with development of a bucket latrine prototype initially with the supplier Nag Magic (which supplies the emergency squatting slabs). This has taken place in slum areas of Nairobi. This concept had some pit falls: the person's toilet behaviour can be seen by the subsequent person; there were issues with the sealing of the lid; complaint of splash back when using, and households needed to empty at the local communal sanitation centres. Oxfam have since then collaborated with the sanitation social enterprise organisation, Sanergy to produce a urine diversion bucket concept, which links well with their existing urine diversion latrines at household, communal and school level.

Desludging

- While membrane pumps have proven useful in desludging of septic tanks, they quickly become clogged when used with simple pits. Desludging pump alternatives are being explored including macerator pumps.
- Fluidization of sludge by a separate high-water pressure device was tested using a variety of nozzles. This allows for a flexible set-up apart from the ROM 800 liters vacuum device, where the fluidizer is part of the machine.
- The Vacutug was tested extensively and its performance compared to the ROM and membrane pump.
- Extensive dissemination efforts are underway to ensure that the WASH response community is aware of the new desludging equipment options available.

Handwashing Devices

<u>Household handwashing devices:</u>

- Solicitation of new concepts via online challenge and 3D printing of various designs. Our original intention was to send the concepts which had potential to the 3D printer Oxfam had in Lebanon. However, the concepts governed by the online challenge did not bring any appropriate ideas.
- Oxfam have been collaborating both with a local designer and Nag Magic to improve on our existing Handy Wash device. The Handy Wash 2 uses an improved valve which doesn't require a spring, making it easier to use, and is also more robust. 40 prototypes have been sent to South Sudan for testing, with positive feedback, and 100 prototypes are about to be sent to DRC (June 2015) to be part of a wider level of

hand washing research with CDC, and Buffalo University examining the appropriateness of the hardware, and enablers/barriers to hand washing. Our suppliers are examining options for making a mould for the hand washing taps, which should aim to keep the unit cost at approx £3-5.

Communal handwashing devices

- A new design for a communal handwashing station was tested in the IFRC's Ebola response operation. The unit shows promise and a second version (modified based on feedback from its use in Sierra Leone) is expected to be trialed in Nepal.

Latrine Kits: Superstructures, Raised Latrines and Trench Linings

- At the time of the last report we were still working with many different suppliers creating a range of different products. Since then we have chosen the best products, cutting down the number of suppliers we are working with, and are now focussing on the two or three most promising products in each category.
- The process of choosing which products to retain included taking twelve prototypes to the Global WASH Cluster meeting is Oslo, gathering feedback from Oxfam's global field staff during our annual technical forum (demos from suppliers on site), and testing in the UK, including with British Red Cross sanitation response personnel.
- Raised latrines have been used as part of our South Sudan programme's cholera response in Juba and the feedback has resulted in a number of design changes. These include making the instruction manual clearer, changing the locks to make them less easy to steal, changing the way the steps attach, improving some brackets, improving the packaging, lengthening the roof, making the door reversible and various other changes.
- Thereafter, the raised latrines were sent to Bangui, CAR where the communities acknowledged that they felt the structures were 'bouncy and not stable', and required 'a shorter height between the steps' to the latrine. Since both the trials in South Sudan and CAR, all our raised latrine concepts/designers have incorporated this feedback.
- In addition to the field trials, the Global WASH Cluster and Oxfam's annual technical meeting, a team of two (engineer and logistician) have visited all the suppliers to see the most up to date prototype, assembled them to gauge how intuitive it is, and see the specifications first hand.
- Three different types of trench linings have gone to South Sudan where they are much needed to combat the collapsing black cotton soil. Due to logistical and security constraints these trials have not taken place yet, however the teams have them prepositioned and ready for assembly.

Locally produced latrine slabs

- The findings of the ESP project were used by WASTE in cooperation with Arkay plastics to solicit funds from the Unicef/DFID Challenge fund in Malawi to produce latrine slabs in East Africa adapted to the specific needs of the population. Unfortunately, funding has not yet been secured.

Multipurpose and non-stick latrine slabs

- We are working in collaboration with KK Nag and Unicef to develop a toilet seat, which fits the Nag Magic latrine slab for people with mobility disabilities and for pregnant women. The first moulded prototype has been produced and may be tested in field programmes.
- Additional work is underway with KK Nag on an add-on to make the slab more child-friendly instead of creating a whole new slab for children. Once it's been refined it will also be tested in the South Sudan programme.
- It has been determined that it is preferable to use a specifically designed urine diversion slab than the KK Nag's urine diversion insert for the existing Nag Magic slab.

Wastewater disposal

- The field trial of vermicomposting of human sludge was completed in India. The study found that worms can survive exposure to (and even hatch from cocoons in) human sludge, that pathogen removal is largely due to the presence of a vermifilter rather than the worms, and that worms can produce significant sludge volume reduction.
- Preliminary trials of a heat treatment unit for sludge treatment were carried out in Cote d'Ivoire. The first field trials used water to determine operational issues with the unit. Consultations are underway with the supplier to address those issues before the unit is used with human waste.

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Innovation Methods and Dissemination

The ESP sought not only to discover new designs for sanitation in emergency response, but also to change the way that humanitarian agencies and suppliers solve issues with equipment and bring them to market. The ESP attempted a number of different methods of innovation under this grant.

Accelerated innovation events
The Design a Bog Day was an attempt to get a wide spectrum of people interested in improving sanitation under one roof for a day. This targeted and focussed day resulted in many different stakeholders discussing a pressing subject, which brought new partnerships and concepts to fruition, and thus further development.

Student design contests
Contests aimed at students were launched for two research streams. The hope for these contests was that they would not only produce useful innovations but also act as an advocacy tool for future designers and engineers. The main challenge with launching these contests was generating publicity and interest in them. The number of submissions received was disappointingly low.

Modification of existing equipment
A number of the pieces of equipment developed and trialed in the ESP were based on designs from the developmental context. While acknowledging the critical differences in the two, the ESP has always sought experience and inspiration from the much more advanced area of sanitation work in the long term developmental context to inform solutions to emergency response. Much of this work involved pushing existing processes to their limits of effectiveness in more extreme conditions.

Working directly with known suppliers
Although the ESP explicitly wanted to avoid this method as much as possible, this is perhaps the most straightforward method of equipment development available to humanitarian agencies. Attempts to find new suppliers have been mixed. The “usual suspect suppliers” are simply easier to work with as they understand the humanitarian context and the systems of humanitarian agencies. However, the ESP has also developed new relationships with new suppliers since either meeting them via the Design a Bog Day, the Reinvent the Toilet fair, and or have been exposed to our website.

Dissemination
The work of the ESP will come to little if the humanitarian WASH sector is unaware of its successes and failures. We have kept the Global WASH Cluster, the WatSan Interagency Group, and our own agency networks abreast of the work of the ESP. In 2014 we presented to capacity crowd at the Stockholm Water Week. The summary of desludging research was submitted and approved by the WEDC conference in early 2015. We will continue dissemination work in 2015 at the Global WASH Cluster meeting and the Emergency Environmental Health Forum. Our initial call of solving the apparent problem statements in emergency sanitation were communicated on our ESP website. This will be updated to reflect our conclusions of this phase of our research and development of equipment. Furthermore, the procurement systems of Oxfam and IFRC (which handles a large volume of equipment purchase for their own networks and other partners) will be updated with the newly available equipment. Further work will be conducted with suppliers and other large volume purchasers (e.g. UNICEF and UNHCR) to make them aware of the new range of equipment now available for sanitation in difficult settings.

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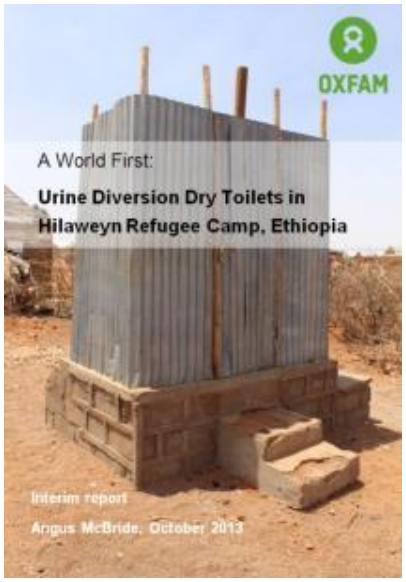
Progress and Results by Work Stream

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 has been written to disseminate lessons learnt, plus CDC have funding via R2HC to examine the performance of the UDDT vaults by examining the temperature, and die off of Ascaris eggs in the vaults – which is ongoing.

Field visit to tiger worms latrines
Field visits to Dire Dawa in Ethiopia and Monrovia in Liberia to see the progress of the tiger worm latrines has communicated some positive conclusions ranging from positive acceptance by the community, and the worms are effective in digesting the faecal waste at an optimum level – little fresh faeces seen inside the pits.

Liberia tiger worm toilets – seeding of worms

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, and black soldier fly larvae.

Sanergy facility

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'
All three partners from ESP attended the Reinvent The Toilet Fair in Delhi in March, 2014 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, and Aerosan – desiccation of faecal waste , could be useful far sooner.

SanCoP Emergency Sanitation Event
Oxfam hosted t a UK Sanitation Community of Practice event in February 2015 to discuss the latest sanitation ideas that may be applicable in emergencies and to 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

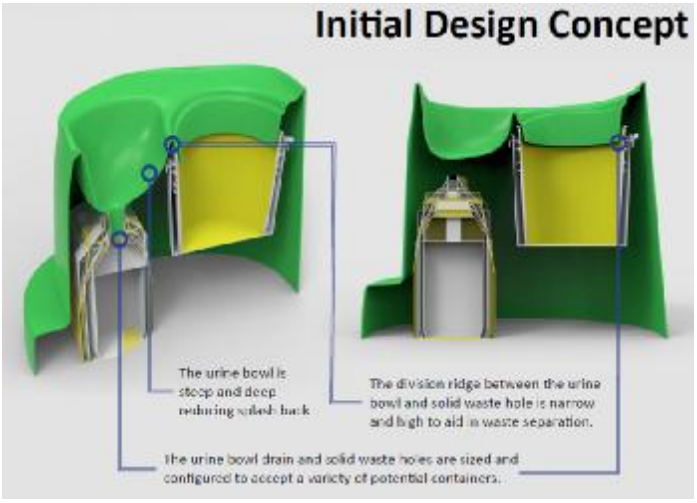
regulations preventing the infiltration of any grey or blackwater into the ground, portable sanitation options seemed like a good solution.

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
The Mosan is a urine-diverting in-home toilet. It separates the urine into a container which is relatively easy to dispose of and the faeces into a bucket which, when covered with sawdust or ash, is fairly inoffensive to handle.

Oxfam have trialed the Mosan toilet in Kakuma refugee camp, Kenya, with partner Sanivation, and feedback from this will help understand issues around its design and implementation.

Jitegemee Phase II Development
The Oxfam Kenya programme has been working 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. This is in joint collaboration with Sanergy. The following images showcase the concept and model.



Cranfield University Project: Development of improved bucket toilet
Oxfam sponsored a project at Cranfield University to develop an improved bucket toilet that will allow waste to be safely separated from the user. Six postgraduate students developed the ‘Sit & Pull’ toilet. Using no water it collects faeces in bags and, uniquely, allows for the closing and disposal of the bags simply by pulling a cord on the outside of the toilet. The set up cost for manufacturing the bags is high, therefore we shall not pursue this further given there are other options via Loowatt and Sanergy/Oxfam.

Loowatt Emergency Toilet
Loowatt have developed an innovative toilet which uses a long, biodegradable bag which is fed gradually through the toilet on each ‘flush’. Oxfam have met on several occasions to

discuss Loowatt developing a concept for an emergency version of their toilet. The desk top study, and development of prototypes is now funded separately via the Humanitarian Innovation Fund, and the ESP and other sanitation colleagues are part of their consultation process, and discovery of new and/or improved ideas.

Biodegradable bags.

Objectives:

- Promotion of the diversification of the number of producers of biodegradable bags for pee and poo given that there are currently a small number of options available.
- 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 out 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.

§ Additional research was started with more focus on the 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.

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.

Conclusions:

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 assessment of 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 and therefore sensitive to damage and lastly they are not repairable in the field.

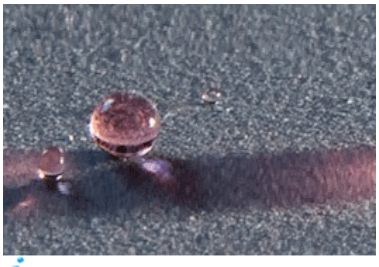
A non-sticky coating would be a good alternative since coatings can be applied later on, even when the latrine slab is at location in the field. Besides, a coating can also apply on other relevant parts, not only for the slab. These coatings are promising according to the suppliers (easy to apply, durable, etc.) however this should be tested since these are subjective sources. Testing is an elaborate and costly affair and currently 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 look into this issue is the 'pressure cooker' toilet of Loughborough University. The research will take one 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

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

Latrine Pit Linings, Superstructures, and Raised Latrines

Objective

Develop, test and have ready for production at least two different emergency pit linings, two different new emergency latrine superstructures and two emergency raised latrine models. They will be suitable for air freight, affordable, durable and be easy to install.

Activities

Test of nCircle latrines in Maban, South Sudan
nCircle latrine superstructures were sent to Maban to be used in the refugee camps accommodating refugees from Sudan. Valuable feedback has fed into improvements to the nCircle latrine itself, making it more collapsible for more efficient shipping, as well as guiding the development of other latrine superstructures.

Design a Bog Day
Design a Bog day was organised as a networking and design event. It gathered together a mixed group of NGO workers, representatives from suppliers, academics and product designers to come up with solutions for the latrine kits 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.

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

Grants to support the development of kits.
After a selection process grants of £5,000-10,000 were given to Dunster House, Compact Shelters, Flexxolutions, Coventry University and Econoplas to develop their kit designs.

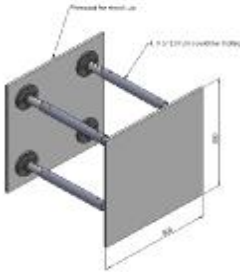
Test of Evenwaste and nCircle latrines in Bundibugyo, Uganda
Three Evenwaste raised latrines and fourteen nCircle superstructures were sent to the refugee transit centre in Bundibugyo, Uganda, where Oxfam has been responding to an influx of refugees from the Democratic Republic of Congo. This resulted in a lot of learnings which have been applied to the development of the kits.

Global WASH Cluster Meeting
http://washcluster.net/wp-content/uploads/sites/5/2014/06/19th-Global-WASH-Cluster-Meeting-Minutes-Final-Draft-Oslo-2nd-and-3rd-of-April-2014.doc
Twelve different kit models were taken to the Global WASH Cluster meeting in Oslo. Feedback was sought from the attendees and they were instrumental in narrowing down the products to continue to work with only a handful.

Humanitarian Learning Forum

Oxfam holds an annual event, the Humanitarian Learning Forum, where many field staff gather together to exchange learnings. We brought in all of the kit suppliers to present their products, gather feedback and advertise their existence.

Testing of Trench Linings in the UK
Oxfam tested three different linings in Wales with the assistance of Shelter & Construction Consultants. Using a digger Oxfam tested them to destruction, which resulted in one of the linings being found inadequate and development of it was discontinued (circular pit linings by Newcastle University). The Dunster, Oxford Plastics and Even Product latrine lining kits are awaiting trial in South Sudan (delayed due to logistic and security constraints).Their concepts are presented in the images below.


Dunster *Oxford Plastics* *Even Products*

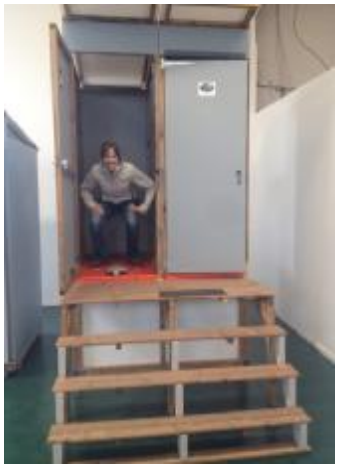
Testing Dunster House Raised Latrines in South Sudan & Central African Republic
Raised latrines from the suppliers Dunster House and Flexxolutions were used by the Oxfam cholera response in Juba, and the Oxfam IDP response in Bangui. Feedback from this trial has resulted in significant design improvements ranging from changing the locks to make them less easy to steal, changing the way the steps attach, and the step height, making the instructions for assembly clearer (pictorial) and strengthening the slab floor span over the raised tanks.

Tendering rapid latrine superstructure, durable latrines superstructure and raised latrine
Oxfam are able to present two options for the superstructure; one which is a rapid superstructure, which can be assembled in a matter of minutes and replaces the likes of plastic sheeting and wooden pole and a second one which is a more durable latrine. The following images present the concepts of the 'rapid superstructure' for the immediate scale up latrines in an emergency.


Even Products *AMG - Vango*


Aircell *Dunster House*

The following images present the concepts being developed both by Dunster, Even Products, Aircell and Flexxolutions for the raised latrine concept, and the durable superstructure.

Aircell *Dunster House*



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Even Products

Flexxolutions

A Public Health Engineering Advisor, and the Logistics Equipment Quality Officer have together visited all the above suppliers and assembled their rapid, durable superstrucutres and raised latrines to gauge how intuitive they are to assemble, and appraise which of the specifications one likes and dislikes. Next steps are now, a tender has been launched by the logistics team with a closing date of the end of June 2015, to bring these 3 concepts to a conclusion based on their price, weight, volume, specifications, and the appropriateness in solving the original problem statement. Oxfam intend to include these successful items in the Equipment Supply Catalogue, which can be ordered both by Oxfam field staff and external agencies through our recently launched Humanitarian Procurement Centre. In the meantime, Flexxolutions, supported by WASTE, has been able penetrate the market. To date 116 toilets have been sold to MSF to be used in Iraq. A second order consisting of 82 toilets is going to be sent to Nigeria via MSF France.

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 interactions 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 its slab design. So the issue was left aside, as agencies responding to emergencies are unlikely to buy it.

Discussions were also held with 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. However, the funding did not materialize.

Inventory feasibility recycled plastic.
Our study on the feasibility of recycled plastic for squatting slab use revealed that it 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
The overall conclusion of the ESP is that this topic could be taken up by the market and there are many alternatives. There is little additional value to put extra ESP resources in this topic.

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

Working with KK Nag and Unicef on the development of a toilet seat.
A toilet seat add-on for the existing Nag Magic slab will allow it to be used by different culture and make it easier to use for some disabled people and pregnant women.
The seat has been through several computer based and polystyrene iterations, guided by feedback from ourselves and Unicef. The resulting design has now been moulded and will be received shortly.

Working with KK Nag on the development of a child-friendly add-on for the slab
Rather than create a separate slab for children, we are working with KK Nag to create an add-on which secures to the existing slab. This will be useful in schools and in child-friendly spaces. Once this has been refined it will be tested in South Sudan, along with the sitting add on toilet seat.

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 organized 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 website. 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.

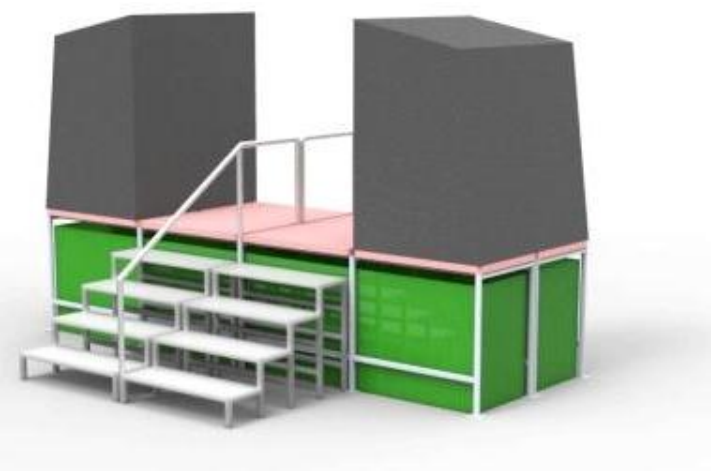
The design contest resulted in 14 applications from 11 different countries. See map below:

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.

Further work
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 refugee 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 an ESP meeting in London decided to discontinue the contest. One important reason is the doubt of IFRC and Oxfam GB that a separate urinal 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..



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 around £3/unit.

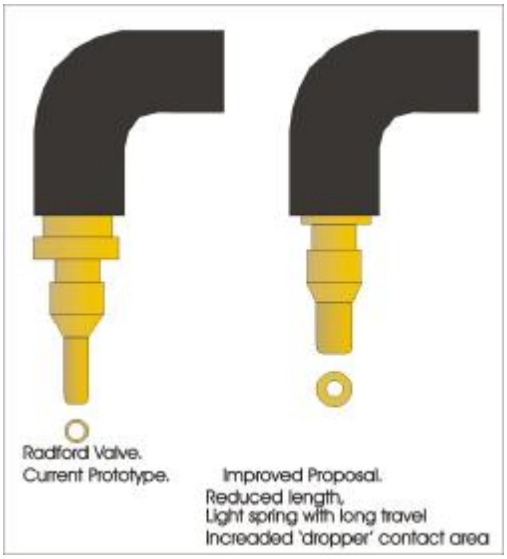
Activities
Product Designers
Oxfam commissioned Alex Bone & Steve Matthews, a pair of product designers, to conduct a review of existing handwashing devices and produce sketch prototypes and concepts of potential new handwashing products.

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
Oxfam collaborated with Makr, a 3D printing company, to crowd source designs for handwashing devices on their 'MyMiniFactory' website. Oxfam had intended on printing these concepts through a 3D printer in Lebanon which will allow us to print and test the designs in our programmes without logistics difficulties. 13 entries were received from the challenge, of which a few had potential. Collectively Oxfam had to discount this exercise and to rather continue with the Handy WaSH concept, as the crowd source designs did not provide us anything credibly different, or appropriate.

Handy Wash 2 Development
The Handy Wash handwashing tap was developed over a number of years by Oxfam in collaboration with Nag Magic and has been field proven as being effective. There's always room for improvement though and Oxfam have been working on a new version which uses an improved valve which is easier to use, and should also be more robust.

Based on the improved concept a local UK product developer and Nag Magic are jointly developing an advanced concept. Initial prototypes were sent to South Sudan for testing, with positive feedback. An improved model is being made, and shall inform and be part of some trials in DRC together with CDC and Buffalo University which will examine both the hardware and the software – enablers and barriers to hand washing.



The above image illustrates the current concept of the hand washing device – with the right hand side being the improved version.

Native Design
Our partnership with design firm Native has resulted in a very compelling handwashing tap concept and prototype, but the cost of developing it to a production model exceeds the budget available under ESP at this stage, thus has been stopped.

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 was developed in consultation with WatSan practitioners in Red Cross national societies. This built upon work by IFRC in 2012 which looked into all handwashing products available on the market.

§ After an unsuccessful request for proposals, IFRC shared communal handwashing devices with identified suppliers and provided information about positive and negative aspects of their design. A new design was developed by KK Nag. This involved a Styrofoam prototype followed by the production of plastic molds.

§ The handwashing units (pictured left) are foot operated, have 2 handwashing stations and holders for bar and liquid soap.

§ The units were first tested in the IFRC's Ebola response operation. Feedback from this initial test was provided to the supplier and improvements that did not require the production of new molds were made.

§ The IFRC has deployed sanitation response teams to Nepal following April's earthquake. After the failure of locally produced handwashing units, the British Red Cross team based in Chautara, Nepal made a request for more robust hand washing units to be installed at existing communal latrines. Ten units are being deployed to Nepal and based on this experience and that of upcoming technical trainings more modifications to the units will be made.

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:

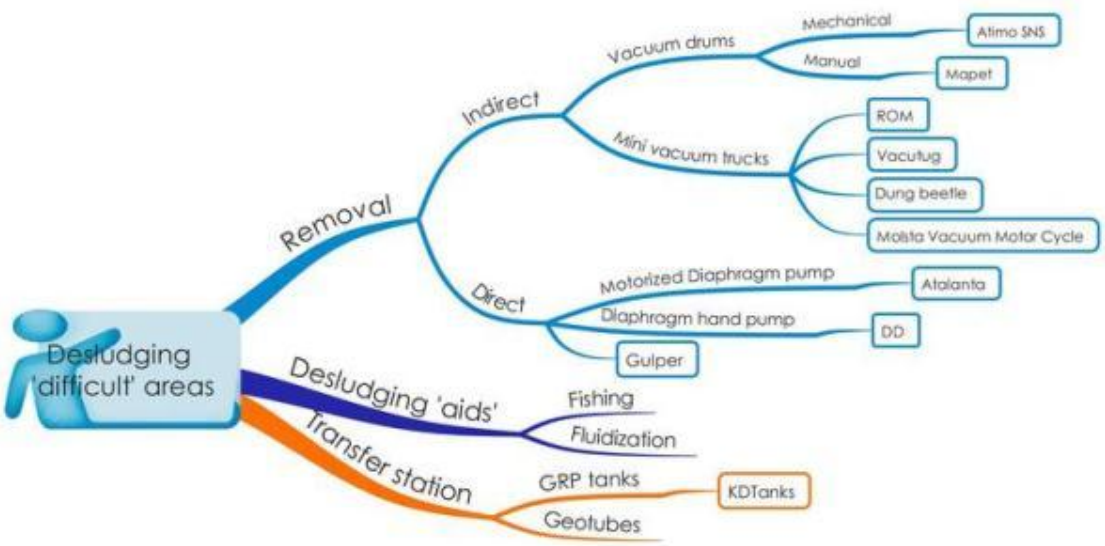
Activities were executed (see mindmap below):

§ Review desludging difficult areas;

§ Design and produce prototypes;

§ Testing in the field.

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



Design and produce prototypes.
Three desludging units and a transfer station were chosen for further development and testing.

- WASTE opted for the ROM2 vehicle, a vacuum-operated machine with 800 litres holding tank, and had it tailored for emergency situations and 'difficult' sludge: in-built fluidizer, larger (3" instead of 2" hose), etc.


ROM2

- The Netherlands Red Cross (NLRC) and the Malawian Red Cross partnered in this part of the project and donated some of the equipment so that the Vacutug and the fluidizer could be included in the tests. NLRC wanted to have a fair comparison with the current standard at the market, the Vacutug. As this unit does not have a fluidizer, an off-the-shelf fluidizer was selected.


Vacutug Mk2

- IFRC chose a flat pack desludging kit with 3 m3 tank, membrane pump, and valve and hose manifold which allows the unit to be filled and emptied without disconnecting hoses.



Left to right: Flat pack desludging kit, Membrane pump, Kit mounted on truck

- For the transfer station a 13-m^3 bladder was purchased.

The setup of the field trials included:

- § 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, began in November 2013 and continued up to the end of June 2014.

From the testing in the field of the ROM2 it became 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 as long as the fluidizer is used and rubbish is fished out. It has been tested on over 350 toilets, removing over 435 m^3 of difficult sludge including emptying of toilets abandoned as full for several years. It 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 that the item be added to the catalogue of relief agencies once the changes recommended by the project.

A separate high-pressure device, Karcher, was purchased and tested with different nozzles to find out what set-up is best to fluidize sludge and what would be the best pressure. It was concluded that the pointed nozzle works best. Using the pressure washer we had initially planned to fluidise 25 pits with each of the Vacutug and the diaphragm sludge pump. This target was not possible for two reasons:

- The diaphragm pump proved suitable for relatively 'clean' septic tank sludge and unsuitable for use in pits with significant amounts of rubbish as this interferes with the sealing of the port valves. While the pump is perfectly adequate for septic tanks with little or no rubbish, its use in pit toilets was abandoned;
- The team experienced many problems with the reliability of the Vacutug – broken drive systems, starting system, etc. Although the Vacutug is designed to be self-propelled, due to its lack of manoeuvrability it was not able to access may toilets even though we used

a 30m suction pipe. Part of the limitation was that once the tank was full, the Vacutug was difficult to move to the disposal site. Therefore the sludge from the Vacutug had to be transferred to a storage tank, and then the ROM was used to empty the tank and transfer to a 13m^3 bladder which was on site about 100 m away. However, the lower cost of the Vacutug in comparison the ROM should be considered in equipment selection.

It is unlikely that one desludging unit would be suitable for all contexts. More likely is that different equipment would be used in a 'hub and spoke' configuration, with smaller units collecting sludge from less passible areas and bringing it to a collection point for transport o the final disposal site. This collection point needs to be able to store waste safely and with minimal nuisance.

The use of the bladder is successful as it reduces transport movements – in conjunction with the ROM 800 the team was able to empty 8 pits in a working day. It was slightly damaged and a repair kit on-site is needed. However as the bladder has an inner and an outer bag, repairs are not easy. The bladder is recommended in cases where it is not meant to be relocated frequently as it is easily damaged during transport. In order to avoid environmental accidents in the case of punctures, the bladder should be positioned in a depression at least 30cm deep. Even after leaving sludge in a bladder for 4 weeks it was still possible to empty the bladder. The bladder is also effective in containing unpleasant smells.

Emptying bladder/ Transfer station

After extensive modifications we found that it is possible to empty difficult accessible pit latrines with thick sludge in an effective and efficient way with a mobile pit-emptying machine. These machines are capable of handling most sludge in lined and unlined pit latrines and in septic tanks and able to access a high percentage of toilets. The key components of such a mobile desludging unit" should include:

- A fluidizer that can spray high-pressure water at around 60-100 bar;
- Fishing equipment such a hooks to remove rubbish;
- A vacuum pump capable of creating a vacuum of 0.5 bar, with a capacity of at least 2000 litres per minute. Membrane pumps are effective with septic tanks. Other pumps may also be effective in desludging a variety of pits;
- Three-inch flexible suction and outlet hoses in order to avoid frequent blockages by un-fished rubbish;

- A holding tank of 1000 litres to store and transport sludge. The inside of the tank should be easily accessible in case the discharge port becomes blocked;
- The unit should be mounted on a small truck or trailer and the lengths of the suction pipe and fluidizing hose should be increased to 30 metres to increase accessibility;
- Improvements in the logistics of operating the unit, including access to localized disposal (or a transfer station), make it possible to desludge up to eight pits in one working day.

The final full report of the desludging trials is available at www.emergencysanitationproject.org and http://www.waste.nl/en/product/testing-desludging-units-for-emptying-pit-latrines-and-septic-tanks

Dissemination of awareness of equipment developed is an important part of this project and the work was presented at the Global WASH Forum 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. Two reports have been produced to disseminate the findings: one short summary for the general public and one elaborate report with more details. The reports have been promoted intensively through mailings, SuSanA website and the results will be presented in the WEDC conference July 2015.

Further research needs

This work stream of the ESP is significantly developed, and the equipment has been received positively by practitioners aware of the equipment. MSF Amsterdam is considering purchasing equipment for rapid deployment. A real emergency is the next further trial needed for this equipment. In the meantime, ignited by the ESP efforts, ROM equipment is being purchased by several development projects in Malawi (sponsored by EU and BMGF).

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.

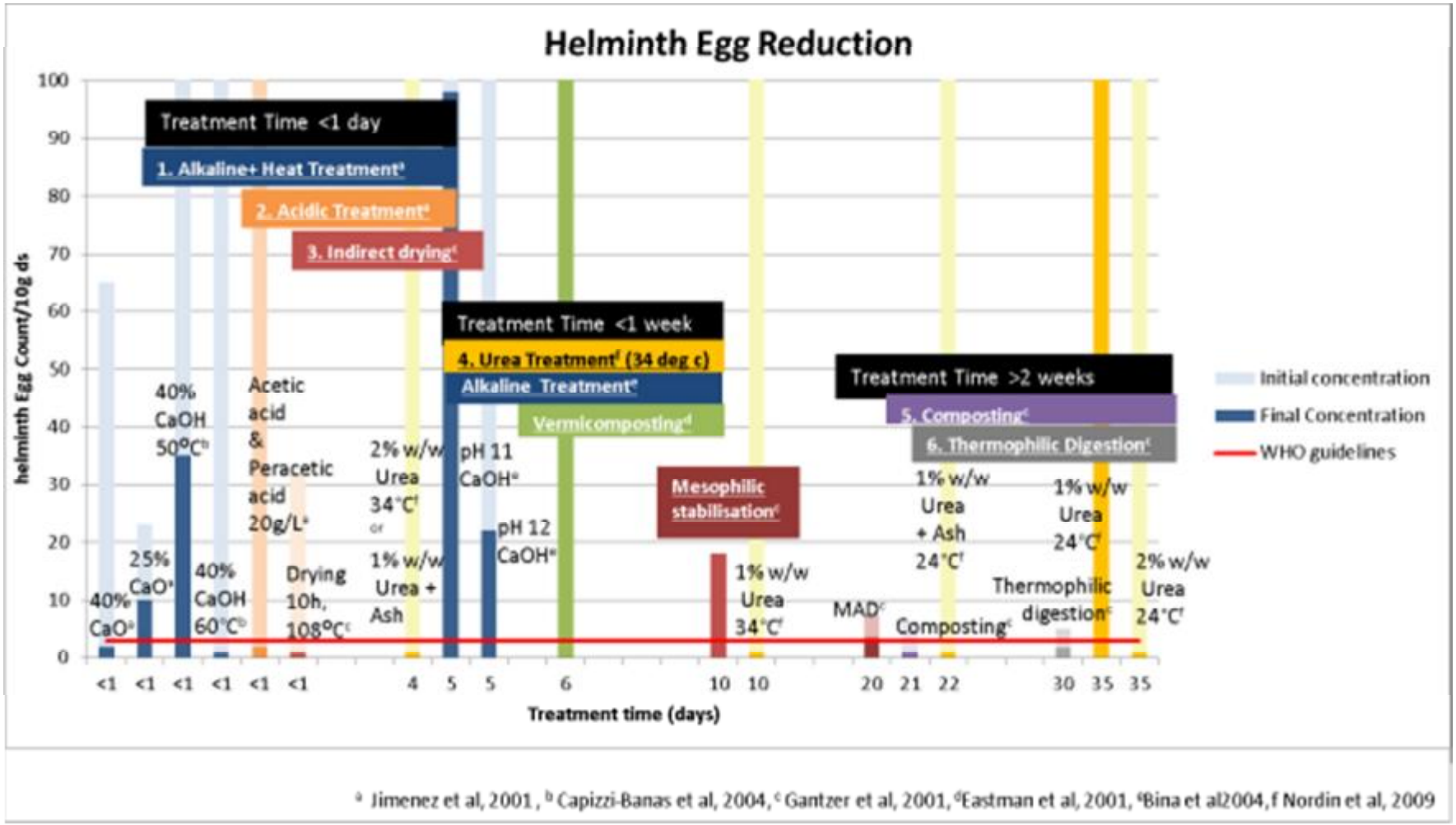
Sludge Treatment – Ammonia, Lime, Lactic Acid

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 and 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.



[a] Jimenez et al, 2001, [b] Capizzi-Banas et al, 2004, [c] Gantzer et al, 2001, [d]Eastman et al, 2001, [e]Bina et al2004, f Nordin et al, 2009

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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 – Bio additives, Worms, Anaerobic Digestion, and Heat Treatment

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.

The ESP wanted to identify a process or system that would be simple and inexpensive to operate, rapidly operational and be transportable by cargo aircraft. As this would be a system for the acute emergency phase, the final effluent quality did need to be high. Anything which reduces the harmful impact of the sludge (including odor, destruction of aquatic life, algae blooms, disease outbreaks, etc.), even a small amount, was considered welcome. Sludge volume reduction was, obviously, desirable but not a necessity. Batch or continuous flow treatment and the use of chemical consumables were deemed acceptable. Modular designs (i.e. equipment working in parallel in order to be scalable) were prioritized.

To enable trialing and development in this work stream 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 work stream 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 chose 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. The system also involves an innovative way of killing pathogens in the effluent and a 'donut' to capture the nutrients from the effluent. 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 a larger solution.

Flexigester 'Donut' for effluent disposal and gasholder full of biogas, June 2014

Flexigester trials June 2014, temperature will be increased by plastic 'greenhouses' on top of the effluent pipes (white boxes)

Testing effectiveness worm and terra preta toilet, June 2014

Tigerworm vermicompost processing has shown promising results for single toilets. However, large scale worm treatment has not been previously explored and current estimates indicate that a human waste load of 10 people per square meter can be achieved. Large scale vermicomposting research work began in July 2014 to assess the feasibility of importing large quantities of worms (live and eggs) and to study how to maximize the efficiency of vermin-compost processing. However, it was impossible to import the worms into Malawi and the trial was relocated to India.

The results of the first phase of the worm research trial, a questionnaire sent to various worm suppliers in South Africa, indicate that the South African worm industry has the capacity to supply over 3,000 kg per month or over 36,000 kg of live worms per year. Allowing for the number of non-responses to the questionnaire it is thought that this figure could be significantly higher and potentially double these figures.

The current monthly supply of worms has the potential to process the faecal sludge from an average sized humanitarian camp (population of 11,400). Three thousand kg of worms have the ability to process the faecal waste from 15,000 people daily, around 4 tonnes per day. Through the companies' projections it can be seen that there is the potential to increase production to over 11,000 kg of worms per month or over 132,000 kg per year. This could support processing of around 15 tonnes of faecal waste per day. Furthermore the worms processing the waste would multiply, in ideal condition their mass could double approximately every 60 days; these worms could be harvested and used in other camps. Another option would be to establish an independent worm farm for these systems. From these results it can be concluded that the South African worm industry currently has the capacity to supply worms for humanitarian settings and this capacity could be quickly increased to meet larger demands.

The second phase of the trials tested the effects of worms and vermifilters on faecal sludge. The vermifilters and sludge were housed at Rajiv Gandhi Infotech Park Sewage Treatment Plant in Hinjawadi, 20km outside the city of Pune in India. The vermifilters took approximately three days to set up and were run for a period of 52 days (7/3/15 to 27/4/15). When the 11 day feeding phase is accounted for, there were only 38 days for sludge digestion and vermicompost production. This is a relatively short period to run such an experiment as we have noted in our previous work that it takes approximately six weeks for the worms to acclimatize to a new food source

Vermifilters in-situ

The full report of the worm trials is available at www.emergencysanitationproject.org

Although this study was not completely definitive it has shown clearly that:

- worms are capable of digesting faecal sludge and converting it into compost
- cocoons can hatch into worms in the presence of faecal sludge
- vermifilters are efficient at removing solids and also faecal pathogens

This is therefore a promising avenue for sludge treatment, which merits further examination, particularly over a longer period of time with more feed cycles. Refugee camps could be ideal locations for vermicomposting.

Testing bio-additives in Malawi

Two bio additives, which are biological catalysts for promoting sludge reduction and pathogen removal, were identified for trialing. These are Consortium Prebio Lice (Co-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.

Unfortunately, preliminary results of the Co-Lice have not shown any impact of sludge volume. Trials for the NVH cocktail began in late August 2014. Results on solids and pathogen removal were not as high as expected. It is probably that tampering with the materials during transport and customs clearance may have resulted in reduced performance. The IFRC is currently planning new trials of the NVH septic tank and 'cocktail' in 2015.

Field trial of heat treatment unit

The IFRC has utilized small scale water treatment units for decades. While the units are often expensive and complicated to operate, they are able to produce water of high quality and can be dispatched and set up very quickly. Package wastewater treatment plants like those used in military outposts are far less common and much higher in price and complex than considered feasible for the humanitarian context. Furthermore, it was assumed that package units would receive more research and development interest and funding from other sources and that the ESP's resources were better spent on mass scale, simple designs. However, when a known supplier of water treatment plants approached the IFRC with a design for a package heat treatment unit for faecal sludge which was designed and priced for the humanitarian context it was hoped that it might be possible to serve both mass and specialized contexts.

The development of the Hygienizer was much slower than previously hoped. Expectations that it might be used to treat human waste in Ebola treatment centres were unmet due to severe production delays.

Preliminary testing in Norway indicated that the unit could remove pathogens from faecal sludge, thus rendering it safe for other uses. The device was finally sent to Cote d'Ivoire in 2015. Early trials using only water have indicated operational issues with the unit in field conditions. These issues are being addressed with the supplier prior to further trials with human waste.

Conclusions and Next Steps

The Emergency Sanitation Project was born out of a common complaint of WASH personnel. "I get inundated with "new" equipment for water supply that I don't need. Why doesn't anyone ever call me about a new idea for a toilet?" Water supply equipment designed for the humanitarian context has been available for at least 35 years. No one thinks it's perfect, but most of it is good enough. And yet the offers keep flooding in while the sanitation side of our work is neglected.

Things have changed somewhat in recent years. Bill Gates launched the 'Reinvent the Toilet' initiative and Matt Damon wore a toilet seat around his neck to highlight this critical issue. Even outside the WASH community, sanitation is no longer the taboo it once was. And inventors and suppliers have started to take notice.

However, some of the same problems remain. What does it actually mean when a humanitarian agency says "we need sanitation equipment"? What aspect of the broad topic of sanitation are we talking about? What kind of equipment and what should it do? How much are you willing to pay for this?

The predecessor to the ESP attempted to answer some of these questions by drafting requirements for three aspects of sanitation in humanitarian response. More importantly, the Haiti earthquake and cholera outbreak of 2010 brought our shortcomings in sanitation into plain view. When the ESP began we had a better idea of what sanitation solutions we needed than ever before.

The problem for the ESP to solve was how to find those solutions.

When discussing innovation, two schools of thought often develop: the incremental versus the radical approach. For the ESP, innovation was largely, but not exclusively, a matter of increments. During this phase of the ESP, known technology has been adapted to the humanitarian context or adjusted based on additional field trials. Ideas which were transferred from paper to prototype have had more mixed success. We also conducted some fundamental research to broaden the evidence base of a little studied area. As so little was known about the areas of research, the objective of much of the research was to establish the limits of a process previously used in smaller scale or less extreme conditions.

Challenges, which we needed to overcome, included the delays with customs in getting equipment to places such as Malawi, South Sudan, and CAR for equipment trials. Specific to South Sudan challenges also included the rains and security. Finally, documenting results and receiving feedback has been easier in some locations than others.

The consortium is proud of what it has developed but would agree that no single design could be classified as a game changer. We remain open to technology that is several steps ahead of the status quo but wary of bold promises from entrepreneurs.

There are a number of ways in which the consortium would like to proceed with the ESP. We knew from the start that certain areas being explored during this phase were more advanced and therefore more likely to produce usable results by the end than others. More research and proof of concept work is needed in certain areas. Furthermore, the consortium wishes to go beyond a 3 member group and expand the partnership. As experience has shown that the best form of awareness raising of new equipment is to use it in the field in full view of colleagues, there is also a desire to seek more funding for deployment of equipment. The continued work of the ESP will require broadening the sources of funding.

Pipeline analysis

Taking into account the progress made in the first phase of the ESP, work streams have been divided into the three categories.

Closed Research Streams:

- 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 is merged with the Flexxolutions toilet and is now sold on the market. The main buyer is MSF 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. Intense discussions with Pacto did not result in new development.
- Locally produced Latrine slabs: restart of discussions with UNICEF Malawi and contribute wherever possible in the development of the ARKAY plastic slab: 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 – both household and communal.
- Sludge treatment, including lime treatment, lactic acid and urea, 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 – simply requires the conclusion of the tendering process by Oxfam in July / August 2015, and trials pending in South Sudan pertaining to the trench lining.
- Bucket toilets and systems surrounding their use
- Combination of multiple sludge treatment methodologies.

New streams being considered by ESP partners

(includes research work being proposed to different donors)

- Disc pumps for desludging and sludge drying and investigation of smaller desludging pumps
- Use of bacterial/enzyme cocktails aimed at fast sanitization and stabilization and reducing fillup rate. This is currently being 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;

- 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

The ESP will seek to grow its partnership and work with more organizations interested in improving sanitation in humanitarian response. At the same time, it acknowledges the need to better focus on what is likely to produce tangible results. A new concept note for an ESP Phase II is currently being developed with fewer work streams, some of which continue or combine previous initiatives while adding a few new areas of research and development.