

Emergency Sanitation Project

 International Federation
of Red Cross and Red Crescent Societies



Emergency Sanitation Project Progress Report

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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 desludging equipment, that has been deemed ready for deployment in emergency operations.

Work related to untreated faecal sludge is centered in Blantyre, Malawi. Testing of toilet hardware is underway in South Sudan and Central Africa Republic. A summary of recent progress can be found on the following page.

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.

Summary of Progress Since Previous Update

Alternative toilet and no toilet Options

- Cranfield University's 'Sit & Pull' toilet, which we 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. This makes it one of the best designs of a bag-based toilet that we are aware of. However, it would require a significant investment to manufacture the bags, so this design has been discontinued.
- We also worked with Loowatt to develop a proposal for an emergency toilet. The proposal is very promising and has been passed to the Humanitarian Innovation Fund, who have a larger amount of funding available.
- Mosan in-home toilet improved and trialled 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 its used in doesn't have a roof. Sanivation are completing their report on the toilet now and full feedback will be available shortly. Now the trial has finished the Mosans are being sent to South Sudan for use by disabled people who would otherwise have difficulty using a latrine.

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 disc and 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;

Handwashing Devices

- Solicitation of new concepts via online challenge and 3D printing of various designs.
- Design of new tap concept and prototype, seeking external funding for developing it to a production model
- Working with a local designer 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. We are now on the third design iteration of this, and forty prototypes are on their way to South Sudan for testing.
- A new design for a communal handwashing station is being converted to a prototype.

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 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 in Oslo, gathering feedback

from Oxfam's global field staff during our annual technical forum (demos from suppliers on site), and testing in the UK.

- 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.
- More raised latrines are now on their way to be used in Bangui, CAR.
- Three different types of trench linings are going to South Sudan where they are much needed to combat the collapsing black cotton soil. Eighty superstructures of two different types have also arrived there to be tested.

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. The project is expected to start in October 2014 and will amongst others benefit from ARKAYs extensive distribution network in Malawi and regional countries including Zimbabwe, Zambia and Mozambique, and may offer an injection mould that can be used on several locations in East Africa.

Multipurpose and non-stick latrine slabs

- 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 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.
- Additionally, we are investigating and intend to trial American Standards' SaTo (Safe Toilet) pans. They are unique toilet pans which cleverly combine the low-water benefits of a direct drop pit with the pleasantness and safety of a U-bend. The location of the trial is currently being determined.

Wastewater disposal

- One bioadditive for sludge reduction has been tested. The results were disappointing. Another bioadditive is being prepared for testing in conjunction with a modified septic tank.
- The market survey of worm suppliers in South Africa has been completed, with several potential suppliers capable of bulk delivery identified. Phase 2 of the vermicomposting trial is being planned.
- New alternatives are being explored such as the principle of cavitation/flotation where bacteria is ripped apart through cavitation fluid is separated from solids through flotation.
- Work has begun on upscaling of the lime, ammonia and lactic acid treatment in 13m³ bladder and IBCs with two MPhil students from the University of Malawi and continued the monitoring of the worm- and terra preta toilet installed and the Flexigester. The Flexigester is now producing its first biogas.

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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

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.

We have trialled the Mosan toilet in Kakuma refugee camp, Kenya, with partner Sanivation, and feedback from this will help understand issues around its design and implementation. Now the trial has finished the Mosans are being sent to South Sudan for use by disabled people who would otherwise have difficulty using a latrine.

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 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 will be high, however, so we are not going to proceed with this.

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'. We worked with Loowatt to

develop a concept for an emergency version of their toilet. The cost of developing it means that the Humanitarian Innovation Fund are now funding this separately.

Activities Planned

- Testing of Mosans with disabled people in South Sudan.

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 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.
- § 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**

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

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

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

We tested three different linings in Wales with the assistance of Shelter & Construction Consultants. Using a digger we tested them to destruction, which resulted in one of the linings being found inadequate and development of it was discontinued.

Testing Dunster House Raised Latrines in South Sudan

Eight cubicles of Dunster House raised latrines were used by the Oxfam cholera response in Juba. Feedback from this trial has resulted in significant design improvements.

Activities Planned

- Field trial of Dunster House and Flexxolutions raised latrines in Central African Republic
- Field trial of AMG and Dunster House superstructures in South Sudan
- Further field trial of AMF and Dunster House superstructures, location TBC.
- Field trial of three different types of latrine linings in South Sudan

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 will start the project in September 2014. Apart from market assessments the project will also link up with local builders in order to design slabs that are easy to install. The project will also have a comprehensive marketing and supply chain component.

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

Using UNICEF/DFID Challenge fund in Malawi, production and product testing will be done in 2015 and 2016..

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

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, which would cause a logistical headache, 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.

Investigating the use of the American Standards' SaTo (Safe Toilet) pan.

The SaTo is a unique toilet pan which cleverly combine the low-water benefits of a direct drop pit with the pleasantness and safety of a U-bend. We are looking for humanitarian programmes interested in trialling this.

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:



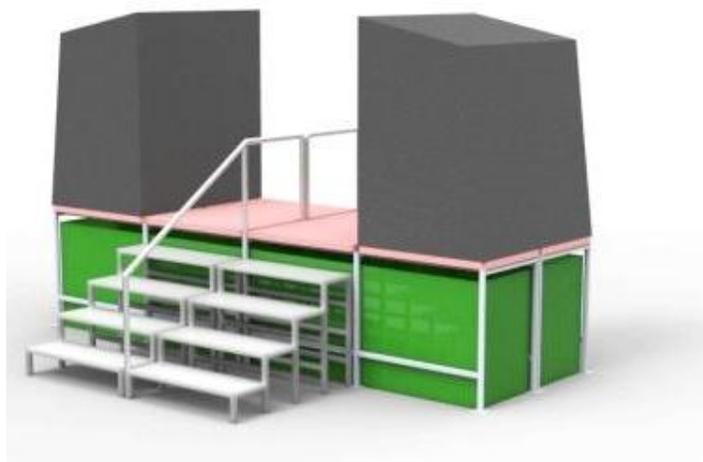
The entries have been scored and the top four entries have entered a voting on the WASTE website. Based on this voting three have been given a prize of €500.

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 around £3/unit.

Activities

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 print and test the designs in our programmes without logistics difficulties.

We received 13 entries into the challenge, of which five work. We are currently assessing them to determine if they are good enough to be used in our programmes.

Handy Wash 2 Development

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

We're now on our third iteration of it and are sending forty of them out to South Sudan for field testing. We're also exploring large-scale manufacturing options.

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 the Emergency Sanitation Project. We are therefore seeking funding for this elsewhere.

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.

§ After an unsuccessful request for proposals, IFRC has shared communal handwashing devices with identified suppliers and provided information about positive and negative aspects of their design. A new design has been developed and is currently undergoing prototype production.

Planned activities

- § Review of new prototype.
- § Development of new foot and 'one-touch' taps.



Options for desludging – Difficult Areas

Objectives:

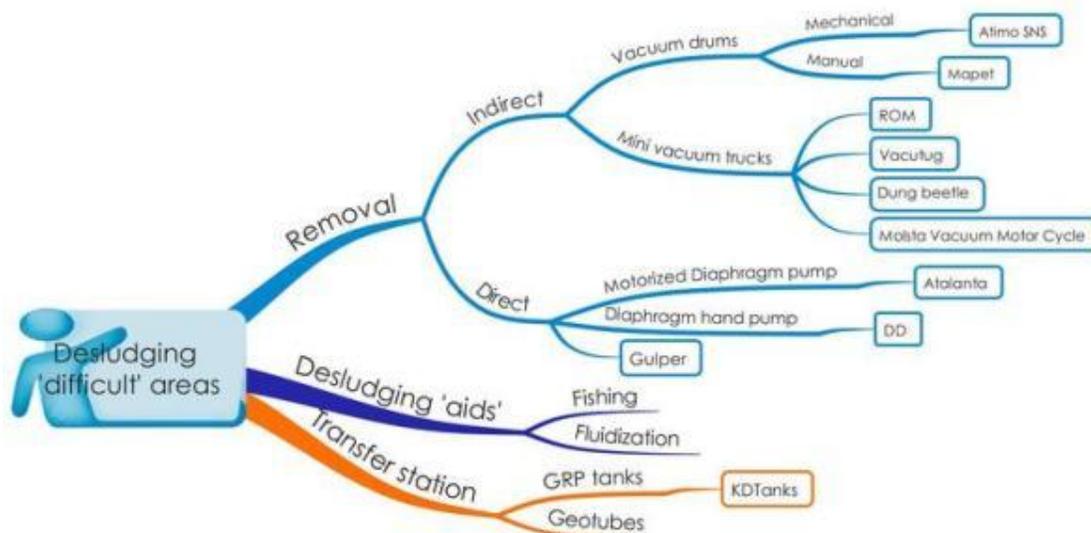
- Improved ability of field teams to rapidly mount desludging activities.
- Development and testing of single desludging kit using existing materials, including desludging pump, transport storage, and all accessories.

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 (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 one does not have a fluidizer, an off-the-shelf fluidizer was selected and . IFRC chose a membrane pump solution as comparison and purchased one. As transfer station a 13-m³ bladder and a 3-m³ sludge tank (flat pack) were purchased.

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 continued up to the end of June 2014. From the testing in the field of the ROM2 it 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 as long as the fluidizer is used and rubbish is fished out.. It has been tested on over 350 toilets, removing over 435 m³ 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.

Nozzle type	Picture of spray pattern
Standard ROM2	
Karcher standard	

Nozzle type	Picture of spray pattern
<p>ROM rotating nozzle</p>	
<p>ROM pointed nozzle ENZ</p>	

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 many 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 an IBC, and then the ROM was used to empty the IBC and transfer to a 13m³ 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.

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

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.

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

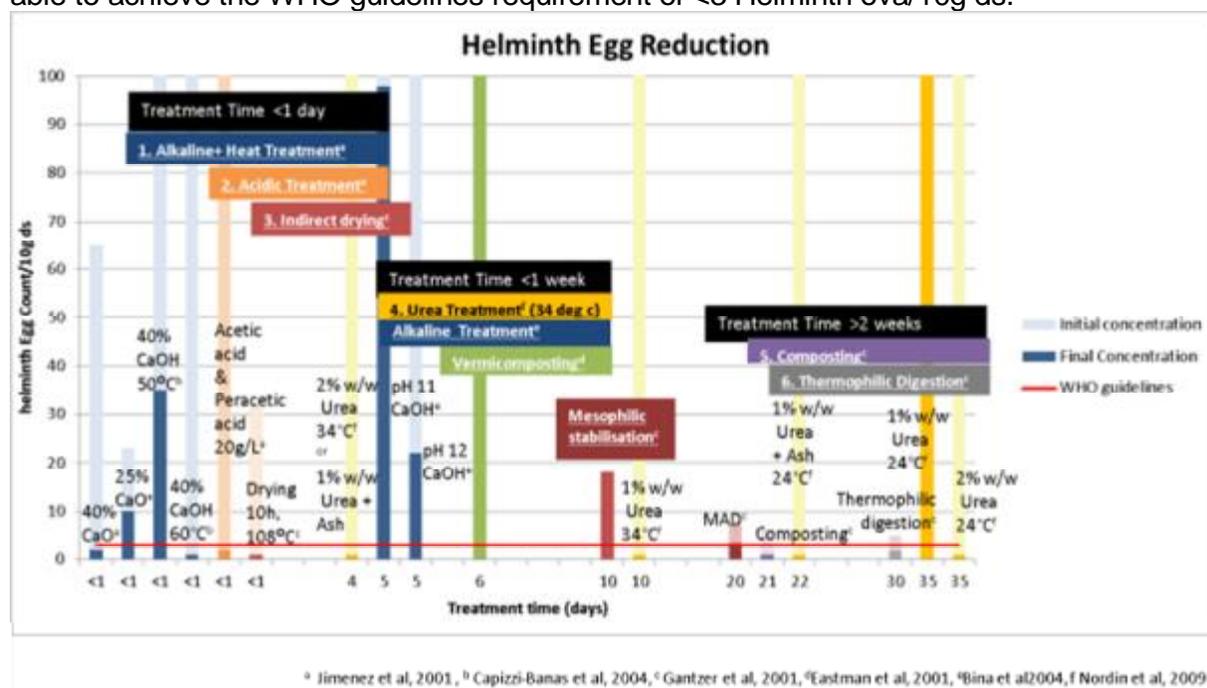
Objectives:

- 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 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.



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
<ul style="list-style-type: none"> • Treatment Time • Final Concentration of E-coli, Salmonella and Faecal Coliform 	<ul style="list-style-type: none"> • 4-8 days • <1000 cfu/100ml 	<ul style="list-style-type: none"> • 2 hours • <1000 CFU/100ml 	<ul style="list-style-type: none"> • 7-9 days • <1000 cfu/100ml
<ul style="list-style-type: none"> • pH 	<ul style="list-style-type: none"> • pH 9 	<ul style="list-style-type: none"> • pH 11 	<ul style="list-style-type: none"> • pH 4
<ul style="list-style-type: none"> • Quantities of Chemical Addition for Treatment 	<ul style="list-style-type: none"> • 2% Urea w/w (20g urea/kg Sludge =9g TAN/kg Sludge) 	<ul style="list-style-type: none"> • 12-16g Lime per kg Sludge (The buffer capacity varied considerably between sludges) 	<ul style="list-style-type: none"> • 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.



Flexigester

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.

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. 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 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 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 which began in July 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.

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 worm research will assess the limits of large scale vermin-composting. Field trials are expected to begin in September.

Two bioadditives, 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.



Testing bio-additives in Malawi

Activities Planned

Trialling of the Flexigester will continue and results from the two bioadditive trails will be analysed and disseminated. 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, including a small scale package treatment unit, 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, lactic acid and urea (see summary next page), 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