HUMANITARIAN INNOVATION FUND

Development and Implementation Phase Grant Final Report

Organisation Name	Univ. of Natural Resources and Life Sciences, Vienna Dept. IFA-Tulln Institute of Environmental Biotechnology

Project Title	MicrobialSludgeQuality (MSQ) – Development of a field test kit for the microbial quality control and detection of pathogens in untreated and treated faecal sludge
Partner(s)	• **Austrian Red Cross (AutRC) – NPO** • **WASTE (Waste) – NGO** • **Waterschap Zuiderzeeland, Regional Water Authority– Knowledge partner** • **Butyl Products Ldt Group (Butyl) – Industry partner**
Problem Addressed / Thematic Focus	Aim is the development of a field lab for public health and process monitoring throughout the treatment process of faecal sludge in urban humanitarian aid settings and to conduct a pilot trial with the prototype.
Location	Austria
Start Date	Nov. 2016
End Date	Oct. 2017
Reporting Period	Final report

Total Funding	149,919 GBP
Total Spent	150,439 GBP

Innovation Stage	Development
Type of Innovation	Product – Prototype of a field lab for the public health and process monitoring of an emergency context faecal sludge treatment plant
Project Impact Summary	➢ A prototype of a field lab for the public health and process monitoring of faecal sludge treatment plants

	has been developed and subsequently tested in a one-month field trial in sub-Saharan Africa. ➢ High interest in the prototype was expressed during the whole project duration by the faecal sludge management community. ➢ Parts of the MSQ project consortium have submitted a proposal for the HIF diffusion call (Ended December 10th 2017). The FAST project (Field lab wider Applied for Sludge Treatment) plans to increase the field labs visibility (peer campaign and field school of technical experts) with humanitarian aid organisations. ➢ Currently, it is planned to include the field lab as part of an IFRC Mass Sanitation Emergency Response Unit, which will be deployed to Bangladesh.

PROJECT ACTIVITIES AND OUTPUTS

*Please go to **Appendix 1** and attach the final workplan, showing all work that was actually completed.*

1. With reference to the final workplan, what have been the key achievements of the project?

- **Expected Results 1 & 2: Development of the prototype of a field lab for the public health and process monitoring of faecal sludge treatment plants**
  During the laboratory phase of the project (both ER 1 & 2) the analytical methodology for the field lab was developed and tested. The achievements for Expected results 1 & 2 are easier described together. To establish some of the field methods, prototype equipment needed to be developed beforehand. The completed prototype alongside the analytical methodology was finished in time for the field trial in Malawi. The opportunity arose to test the prototype in Austria before the field trial at a household-level wastewater treatment system.

- **Expected Result 3: Successfully field testing the prototype field lab in Blantyre, Malawi**
  As originally proposed and planned in the workplan, a field trial of the prototype field lab was conducted in Blantyre, Malawi. For this trial, the garage of Waste's local office was adapted to be used as a lab. The prototype was set up in the first week and afterwards operated for another three weeks by Boku and Austrian Red Cross. The main aim of the field trial was to test the prototype and ensure the usability under field conditions. The analytical and the support equipment functioned well. During the field lab, five different faecal sludge and wastewater treatment plants were sampled. The operation of the full field lab for over one months also resulted in an improvement/lessons learned list, which was incorporated into the prototype after the field trial.
  A lab tech was hired by Waste to support the teams work during the field trial and to continue lab operation until the end of the project. The lab tech was trained for two and a half weeks. Training a local lab tech also allowed an important estimation into the necessary training requirements for future operators.
  Due to the high interest in the used helminth detection method a workshop was organised for the University of Malawi.

- **Expected Result 4: The prototype is being turned into a product by the industrial partner**
  The design and procurement documentation has been turned over to the consortium's industrial partner. Currently, Butyl products is including this data into their procurement processes to enable the assembly of the field lab as a product.
  Originally, it was planned to ship the prototype to the industrial partner. However, this was not possible, because the prototype of the field lab stayed in Blantyre to be continuously used with Waste, Malawi. Most of the equipment in the field lab is standard, out-of-the-box equipment and therefore, a physical transfer to Butyl Products would not have been necessary. For equipment designed and assembled by IFA-Tulln, the physical transfer would have been helpful to ease replication. This hindrance was compensated by transferred in-depth documentation on these products.

- **Highly positive feedback to the prototype from the faecal sludge management community**
  Already during the laboratory phase of the project (ER 1 & 2), the project consortium was contacted by several organisations (e.g. Sanivation and ENPHO) and projects, which expressed their interest in the project.
  To ensure acceptance with possible future operators of the field lab and to obtain additional critical feedback, a summary of the field labs composition and capabilities was distributed within the faecal sludge management community. Per example, feedback was provided by organisations such as EAWAG. In this case, addition of certain parameters were suggested. All feedback was included into the documentation of the prototype and transferred to Butyl Products Ltd..

INNOVATION OUTCOMES

Whether this innovative project was successful, not successful, or a mix of both, the HIF would like you to report as much detail as possible, so that success can be built on and failures can be learned from. By 'success' we mean that the innovation has achieved the planned positive impact/outcome, or that it has performed better than the current process, product or system.

2. Has the project demonstrated the success of the innovation? *(Please choose only one answer.)*

☐ Completely successful
☒ Significantly successful
☐ Partially successful
☐ Completely unsuccessful

2b. Please select the successes that your project have achieved:
(You may choose more than one)

☒ There is real evidence that the project achieved the planned outcome(s)
☒ There were perceived contributions or improvements to the planned outcome(s)
☐ Learning was achieved within the project cycle
☒ 'Lessons learned' were gathered and circulated to humanitarian stakeholders and actors
☐The completion of this project has led to another innovation
☐ Other *(please comment)*

2c. Please select the challenges your project has encountered:
(You may choose more than one)

☐ The project did not complete its planned activities
☐ There is no real evidence that the project achieved the planned outcome(s)
☐ There were few perceived contributions or improvements to the planned outcome(s)
☐ Learning was not achieved within the project cycle
☐ 'Lessons learned' were not circulated to humanitarian stakeholders and actors
☒ Other *(please comment)*

While the development and testing of the prototype of the field lab can be considered successful, this prototype is the first version and adaptation of the field lab. Additional feedback and experience in the operation of the field lab will definitely lead to further improvements of the lab. Further refinement of the field lab is planned in the proposed and submitted FAST-HIF diffusion project.

To allow for continuous changes and adaptations it is suggested by the project consortium, that the developed methods and equipment should be treated as open source materials. However, the final decision on the policy of keeping the methodology of the field lab up-to-date will taken by Butyl Products.

2d. If there is any evidence for the successful performance of the innovation, please describe it further:

- *Laboratory comparison and development of field methods*
  Some of the methods (e.g. bacteriological analysis, chemical oxygen demand, helminth egg detection) used in the field lab had to be adapted for field use. The development started by setting an analytical base line with several different faecal sludge, wastewater and manure samples. Afterwards, these methods were gradually adapted for field use and always compared to the base line. The newly developed methods provided similar results compared to the lab.
  For example, in helminth egg analysis a centrifuge is needed. The electrical centrifuge was switched with a manual centrifuge to adapt the method for field use. However, first tests showed, that similar revolution speeds with the manual centrifuge did not result in similar helminth egg recoveries. Through several trials, the right manual centrifugation speed was found and the field method than resulted in similar recovery rates.
  Chemical oxygen demand analysis requires a heating block for the digestion of the sample. In a fixed lab, an electrical heating block is used. There blocks are expensive, need a constant power supply and are heavy. In the field method, a sand-bath (sand filled pot on a gas stove) is used. Results from both systems were similar.

- *Successful test of the field lab during the field trial*
  The field trial proved that faecal sludge treatment plant monitoring in the field is possible with the supplied equipment. The performance of the lab during field trial can be separated into two distinct topics:
  Testing the analytical equipment
  Several different faecal sludge/wastewater treatment plants were sampled during the field trial. The results of these samples are only analytical snapshot of the plants. For a detailed assessment of each plant the duration of the field trial was too short. The field labs results should have been crosschecked by a reference lab. Due to several difficulties, the reference

lab was not operational for most parts of the field trial. While the field labs results were not crosschecked, the analytical methodology and equipment worked under field conditions.

Testing the support equipment

For the operation of the lab, the support equipment (ranging from power supply to personal protection equipment) is as important in the field lab as the analytical equipment. Proving operational effectivity of this equipment under "non-laboratory" conditions was considered an important part of the field trial. Some support equipment had to be assembled onsite, for example the power supply system, due to delays in shipping. In general, the support equipment functioned well during the field trial. In some cases, e.g. adapters for gas tubing, adaptions had to be made in the field. An improvement list was drawn up und included in the procurement information of the field lab.

3. Please show the components of the project which contributed the most to any *successes*:

(where 1 = most influence 3 = least influence)

Component	***1***	***2***	***3***	***N/A***
Design and placement of the innovation	☒	☐	☐	☐
The methodology or approach to collecting evidence	☐	☒	☐	☐
Context	☒	☐	☐	☐
The availability of resources and capacities (financial, human, technical etc.)	☒	☐	☐	☐
Success in identifying and responding to different project and innovation risks	☐	☒	☐	☐
Strength of relationships and collaborations within the team and with other stakeholders	☒	☐	☐	☐
The process was flexible and responsive to emerging results	☒	☐	☐	☐
Ability to draw on experience and expertise of existing practice, codes and standards	☒	☐	☐	☐
Other:	☐	☐	☐	☐
Other:	☐	☐	☐	☐

4. Please show the components of the project which contributed the most to any unsuccessful elements of the project

Component	***Yes- contributed to failures***
Weaknesses in the design and placement of the innovation	☐
The methodology or approach to collecting evidence	☐
Context	☐
A lack of access to resources and capacities (financial, human, technical etc.)	☐
Difficulty in identifying and responding to different risks	☐

Lack of good relationships and collaboration within the team and with other stakeholders	☐
Having a process that was not flexible or responsive to emerging results	☐
No ability to draw on experience and expertise of existing practice, codes and standards	☐
Other: *Reference lab during the field trial* To crosscheck the labs analytical performance during the field trial, it was planned to engage the local labs of the University of Malawi to act reference lab. Due to a combination of delays and several different technical difficulties, the reference lab was of limited use for the MSQ project. However, all the analytical methods used during the field trial, have been crosschecked during the laboratory development phase.	☒
Other:	☐

5. What are the top three, key lessons learnt relating to the innovation? *This should relate to the innovation or the sector in which it operates, rather than project implementation.*

1. Emergency faecal sludge treatment plants

While there are several ongoing projects in practical testing and compiling information on emergency faecal sludge management and treatment system, until now there are now standardized treatment strategies or plants.

Established faecal sludge management/treatment processes would allow easier inclusion of the field lab into humanitarian aid organisations.

2. Standard monitoring parameters for faecal sludge treatment plants are needed

The analytical parameters included in the field lab are based on a literature search performed before the laboratory phase of the project. Theses parameters were collected from and merged out of a number of different literature sources. However, currently there are no standard guidelines on the process monitoring of (field) faecal sludge treatment plants in emergencies.

Standardized guidelines would strengthen the field labs role in the treatment process and help operators in choosing the right control parameters for their process.

3. Software as important as hardware

The MSQ project focused on the development of hardware, the prototype of the field lab. The importance of the software side (training, process documentation) was discussed early on in the project. However, the focus was put on the hardware development. During the field trial, two lab techs, with different experience levels, were trained to operate a lab. Thus, some hands on experience on training was gathered. This experiences support the assumption “software is as important as hardware”.

During the project, duration descriptions were compiled for all developed and adapted analytical methods. While, they are no training materials, an experienced lab tech is enabled to operate the lab using them. For the field school of the proposed HIF-diffusion project “FAST” it is planned to develop training materials, which will afterwards be available and can be adapted to each organisation own training regime and process documentation style.

6. Do the final outcomes support the initial rationale for the innovation?

☐ Yes, completely
☒ Yes, significantly
☐ Partially
☐ No, not at all

Please describe further:

The initial rational for the MSQ project focused on the need for a mobile field lab to monitor field faecal sludge treatment plants in (mainly urban) humanitarian aid settings. The first idea for the project originated from the need for a field lab expressed by the humanitarian aid and NGO partners of the project consortium and by the IFRC as external organisation. Therefore, the rational for and subsequently the whole project was consumer driven.

The intended use of the field lab within humanitarian aid organisations implied certain boundaries and design criteria (appropriateness, applicability, affordability, mobility) in the development process.

The outcome of the project, the prototype of the field lab, supports the initial rational. The need for a field lab able to monitor faecal sludge treatment plants was still existing at the end of the project. The developed prototype was also able to fulfil the design criteria.

The Austrian Red Cross, as active humanitarian aid organisation, also put an emphasis on estimating the training requirements needed for the operation of the field lab. While training two lab techs during the field trial, it became clear that the wide range and complexity of analytical procedures required for the monitoring of faecal sludge treatment plants, requires extended training periods. To administer such training directly in the field is possible but connected to certain inhibitions.

7. How has your understanding of the innovation changed through the project period?

In the proposal, the MSQ project planned and described the development of a field test kit. Basically, the faecal sludge version of the well-known DelAgua test kit for water testing. During the duration of the project, this basic understanding changed into the development of a full field lab.

In an emergency context, a field lab needs to get operational as soon as possible after arriving in the deployment zone, thus a well-designed integrated lab solution is required. Prior experience of the Austrian Red Cross in the operation of water testing field labs and understanding of the complexity and scope of faecal sludge testing gained during the project supported this assumption. Therefore, a field test kit only comprised of analytical equipment would not function properly in the planned for humanitarian/emergency aid conditions.

It is our understanding, that through providing lab support equipment a field test kit is turned into a functional field lab. For some specific bulk materials (e.g. cleaning paper, gloves …) only a starting quantity is provided in the prototype of the field lab.

The field lab is also designed to be modular; this offers the customer a degree of flexibility in adjusting the analytical parameters to their treatment process and the lab support modules to local conditions.

8. Did the innovation lead to any unexpected outcomes or results? How were these identified and managed?

The project consortium was contacted by NGOs and social enterprises with a focus on faecal sludge management, but not involved in humanitarian aid. These organisations were also interested in the field lab, due to their desire to ensure functionality of the process and the quality of the end products.

These organisations might not need the full lab, but only parts of it, due to available and existing infrastructure. The field lab was adapted to serve their needs. The equipment of the field lab was structured in separate modules. Thus, a customer has the possibility to adapt the field lab to the given treatment process and local infrastructure.

METHODOLOGY

9. Was the methodology successful in producing credible evidence on the performance of the innovation?

☐ Yes, completely
☒ Yes, significantly
☐ Partially
☐ No, not at all

Please describe further:

The methodology chosen for the project proved to have been helpful for the development of the field lab. Splitting the overall task of the development of the prototype field lab in achievable expected results (ER) was necessary.

- *Laboratory development phase*
  In the proposal, ER 1& 2 were split for the reason, that ER 1 – "Method development" will focus on comparative lab and field lab work and that ER 2 – "Prototype development" will focus on construction of the physical lab equipment. However, in most aspects both ERs were treated as combined, due to development needs of analytical methods. Some equipment needed for the field analytical methods (ER-1) had first to be developed as part of the prototype (ER-2).
- *ER 3 - Field trial*
  Developing a prototype field lab for emergency conditions without testing it in the field outside of a laboratory would not have produced any meaningful results.
- *ER 4 - Product development*
  Granting the product development its own separated Expected Result proved to be highly necessary. During the field trial many improvements to the field lab were collected, which needed to be included. Discussions held within the project consortium and with the University of Malawi in Blantyre led to the change of the field test kit into the field lab. Further, the time in Malawi also led to adaptions of the lab to allow for modularity. Thus, opening the lab to the market for development cooperation organisations or social enterprises.

PARTNERSHIPS AND COLLABORATION

10. How and why did the partnership change during the course of the project?

During the course of the project, the partnership did positively change. The project consortium had a very good and structured working relationship, bringing the partners closer together.

- *Waste*
  Without the work of Waste in preparing and supporting the field trial, one of the most important parts of the project would not have been successful. During the laboratory development phase, Waste offered input and feedback regarding the chosen parameters of the field lab.
  Waste was also very active in dissemination efforts and gave the project access to their extensive network of contacts.
- *Austrian Red Cross*
  The Austrian Red Cross was heavily involved in supporting both field trials (Austria & Malawi). During the field trial, Austrian Red Cross started giving invaluable inputs for the product development process.
- *Butyl Products Ltd.*
  Butyl Products connection with in the emergency aid community helped boost the visibility of the project. During the duration, they supported the progress of the project.

11. Are there plans to continue your partnership, either while scaling up this innovation or on other projects?

☒ Yes, with this innovation
☐ Yes, with another project
☐ Maybe
☐ No

Please describe further:

Austrian Red Cross and Butyl Products Ltd. plan to continue their working relationship in the proposed HIF-diffusion project "FAST".

DISSEMINATION

12. Please describe any steps taken to disseminate the outcomes of the project.
Please include all completed and forthcoming, as well as all planned and unplanned products (for example, research and policy reports, journal articles, video blogs, evaluations).

- *Blog entries*
  Several blog entries were posted on the MSQ project's HIF homepage. These blogs were also shared in social media and in newsletters
- *Newsletter*
  The first newsletter was shared per e-mail within the extensive network (1,000+ recipients) of the project consortium.

- *Informal channels*
  Through informal e-mails and skype calls, the project consortium was in contact with several social enterprises, NGOs, research projects and humanitarian aid organisations.
- *Future publication in scientific journals*
  It is planned to publish an article on the development of the field lab and possibly data from the field trial in a scientific journal.
- *Bachelors thesis*
  During the laboratory phase of the project, the Boku team was supported by two bachelor students. The data generated during their internships will be the basis of their bachelor thesis.
- *HIF diffusion project "FAST"*
  The proposed "FAST" project will mainly focus on the dissemination of the field lab using a field school and peer campaign.
- *Exchange on the standard methods for faecal sludge testing*
  Currently an exchange regarding a contribution to the upcoming publication of "Standard methods for faecal sludge testing" with EAWAG, the South African Water Research Commission and the University of KwaZulu has started.

13. Has the project received any third party coverage during the project (from news media, third party blogs, researchers or academics etc.)?

The project was featured in the European Biogas Association's June Newsletter (http://european-biogas.eu/2017/06/22/boku-university-develops-microbialsludgequality-msq-project/).
A local Lower Austrian newspaper covered the participation of the University of Natural Resources and Life Sciences, Vienna in the field trial.

SCALE UP AND DIFFUSION – WHAT NEXT?

14. Is the project or innovation to be replicated or scaled up?

☒ Yes, we will scale up in the same or similar context
☐ Yes, we will scale up within our organisation (including running more pilots or trials)
☐ Yes, we will replicate the innovation/project in another context or country
☐ Yes, the innovation/project will be replicated or scaled up by another organisation or stakeholder
☐Yes, other
☐ No

If you answered *yes* to question 14, please answer 14b:

14b. What model are you pursuing to scale up or sustain your innovation?

☒ Applying for more donor funding
☒ Selling the innovation or patent
☐ Cost recovery (for example, selling your service or being paid as a consultant to implement the innovation)
☐ Innovation to be taken up by organisation or government as standard and included in standard planning and core funding by them
☒ Other: Planned (near future) deployment of the field lab within the deployment of an IFRC Mass Sanitation Module Emergency Response Unit to Bangladesh

Please describe further:

- The prototype of the field lab is currently transformed by Butyl Products into a product soon to be available for purchase
- The first deployment of the lab is planned together with the Austrian Red Cross as part of an IFRC Mass Sanitation Module Emergency Response Unit
- Austrian Red Cross and Butyl Products have submitted the HIF-diffusion project proposal "FAST" for wider dissemination of the field lab in the humanitarian aid community.

15. If the project or innovation could be replicated or scaled up, please list the three most important issues or actions that will need to be considered:
(where 1 = most important and 3 = least important)

Suggestion/issue	*1*	*2*	*3*
1. Acceptability of new technology in the community The acceptance of the field lab, as new technology, in humanitarian aid organisations is of high importance. The involvement of the Austrian Red Cross, support of IFRC and the proposed "FAST" project should partly counter the issue and boost the acceptance of the field lab.	☐	☒	☐
2. Suppling sufficient training to operators of the field lab The success of the field lab at scale will strongly depend on any organisations ability to train its operators. While each possible user-organisation follows their own recruitment and training regimes, providing open-source training materials ensures successful and efficient lab work.	☒	☐	☐
3. Continuous refinement of the field lab The developed prototype is now the first iteration of the field lab. The structure, scope and equipment will certainly have to undergo changes and adaptations over time. It is highly important that the iteration and change process is connected to the users of the product and includes a scientific review system.	☐	☒	☐

Appendix 1. Final Workplan

Below is a table that is the same as the workplan that you submitted with your original application. There are **three ways** to respond to this section.

1. If there have been no changes at all through the project you may cut and paste your original workplan here**.**

2. If there have been changes to the project but these changes **were previously reported to the HIF** in an *Agreement Amendment* form, please adjust your original workplan so that these changes are recorded in it here.

3. If there have been changes which were **not previously reported to the HIF,** please **also** fill in Table 2 (which is on the next page). In particular, please make sure to explain any budget various greater than 15% in Table 2.

Please paste your final workplan in here >

Expected Results	Main Planned Activities	Implementation Period (Months)												Responsible Party / Person	Amount 2016		Amount 2017	
		1	2	3	4	5	6	7	8	9	10	11	12		HIF	Others	HIF	Others
ER1 Stable and (laboratory) proven analytical methodology for the detection of microbial quality	**Overall time for ER1**	x	x	x	x	x	x							**Boku**	£33,585.64	£2,308.80	-	-
	Development of a reliable and statistical sound sample preparation method	x	x	x														
	Development, transferral, and laboratory testing of microbial analytical methodology for faecal sludge		x	x	x	x	x											
	Development and laboratory testing of complimentary analytical methods for the assessment of sludge quality			x	x	x	x											
ER2 Finished version and lab tested prototype of field test kit	**Overall time for ER2**			x	x	x	x	x	x	x				**Boku** / Butyl	£37,973.99	£9,097.40	-	-
	Development of sampling and pre-treatment devices for faecal sludge in an field context			x	x	x	x											
	Development and construction of a prototype of the field test kit					x	x	x	x									
	Laboratory testing of the prototype of the field test kit								x	x								
ER3 Positive operation of the field test kit in a pilot trial at a suitable location with a sludge treatment plant	**Overall time for ER3**									x	x			**AutRC**/Waste	£15,091.98	£741.45	£45,275.93	£2,224.35
	Preparations for the field trail and shipping of the field test kit									x								
	Set up of the field test kit at the pilot trial facility										x							
	Operation at the pilot trial facility										x	x	x					
ER4 Finalised field test kit prototype ready for market introduction	**Overall time for ER4**											x	x	**Butyl**/Boku	-	-	£17,990.55	£3,954.40
	Assessments of the results of the pilot trial											x						
	Incorporation of gained experience and knowledge into the prototype											x						
	Transferral of the prototype into a market ready product											x	x					

Table 2: Changes to Workplan

For every change in the final workplan that is different to your original worktable AND that has not already been reported to the HIF, please add a record in this table. Changes can include alterations to the methodology, project process or innovation design, for example.

Change (as referenced in workplan above)	Reason for change	Overall impact of change
1. Extension of field trial until end of project	During the preparations and the execution of the field trial did not consume the estimated and allotted funds. Therefore, this change in the workplan did not required any budget shifts or additional funds.	➢ Long term durability test during field use ➢ Provide more detailed performance review of sampled faecal sludge/wastewater treatment plants ➢ More reference data points ➢ Strengthen project and cooperation between City council and local partner organisation
2.		
3.		
4.		