VUNA - Valorisation of Urine Nutrients in Africa (EAWAG, Switzerland, and South Africa)

Posted by dorothee.spuhler - 28 Jan 2013 15:22

Dear all,

In my role as one of the moderators of this forum, I would like to introduce the work performed by the Swiss Federal Institute of Aquatic Science and Technology (Eawag), eThekwini Water and Sanitation (EWS) in Durban, the University of KwaZulu-Natal (UKZN), and the Swiss Institutes of Technology Zurich and Lausanne (ETHZ and EPFL). This work is funded by the Bill & Melinda Gates Foundation (BMGF):

VUNA - Valorisation of Urine Nutrients in Africa

By recovering nutrients from urine in small decentralised reactors, VUNA wants to develop a dry sanitation system, which is affordable for the poor, produces a valuable fertilizer, promotes entrepreneurship and reduces pollution of water resources.

In this collaborative project, the Swiss Federal Institute of Aquatic Science and Technology (Eawag), eThekwini Water and Sanitation (EWS) in Durban, the University of KwaZulu-Natal (UKZN), and the Swiss Institutes of Technology Zurich and Lausanne (ETHZ and EPFL) work together to focus on three important aspects:

1. reactor technology

2. network management

3. socio-economic boundaries

Please visit the project website for more details: www.vuna.ch

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Nitrification reactor

Posted by kudert - 13 Nov 2011 16:02

Dear all

This is a short note that we successfully started a reactor for urine stabilization via nitrification at Eawag.

More information about our project on nutrient recovery from urine can be found at www.eawag.ch/vuna .

Kai

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Re: VUNA - Valorisation of Urine Nutrients in Africa

Posted by dorothee.spuhler - 30 Jan 2013 18:17

I would like to complete the description in my previous post (**which had been prepared by Eawag**) with a few more interesting informations and ask some questions.

As mentioned in the short description above, partners are the University of KwaZulu-Natal (UKZN) and the eThekwini Water and Sanitation (EWS) Services based in Durban.

Together they are applying a "**feedback loop approach**" (I picked that up from an old presentation from the Fecal Sludge Management Conference in Durban 2012):

- First, in depth research is done at Eawag (Switzerland);
- Then applied research is conducted at the University of KwaZulu-Natal;
- And finally the role out and application is done in partnership with the eThekwini Municipality.
- Then, the experiences are "looped" back to the lab.

From the homepage, I could not find out what activities are carried out when and where (maybe I just didn't see it). From what I have heard through personal communication of project members, not all of the components are equally researched in all of the 3 locations.

However, it seems that there is quite a lot of work done in the field of **"reactor technology and network management"**
covering following aspects:

- Nitrification
- Evaporation
- Electrolysis
- Hygiene
- Reactor Operation
- Urine Collection
- Performance Modelling

Research looking at “socio-economic” boundaries is done for the “economic feasibility” and social acceptance.

The “**economic feasibility**” is focussing on:

Understanding how a urine market could operate in Durban

Developing a model which could be adapted for, and implemented in the rest of sub-Saharan Africa, and ideally, laying a foundation for the rapid spread of nutrient-incentivised sanitation plans.

In terms of “**social acceptance**” the VUNA novel environmental technologies will be accompanied by studies, which investigate the socio-cultural perceptions and factors influencing users’ acceptance. In addition the project plant to investigate and monitor the use of urine diverting toilets and urine-derived fertiliser products as well as to develop appropriate educational activities and awareness material. But no results are available yet.

I have a few further questions, which I would like to ask to the project responsibles:

General:

- When did the project start and when will it end?
- You say you “want to develop a dry sanitation system”: does that cover only the three mentioned components or also additional aspects like toilet design etc. looked at?

Reactor technology:

- In what form do you “harvest” or “valorise” the fertiliser from the urine and what would be the end-product to be marketed in Durban? Is it different for the different technologies (e.g. in terms of nutrient content)?
- What of the reactor technology research aspects (i.e. nitrification, evaporation, electrolysis) is currently researched and where (at what stage)? Can you already say, which technology is the most promising or for the roll out and application in Durban/Sub-saharan Africa and why?
- Can you share already some results in terms of health and ecotoxicology according the end-product?
- What other hygiene aspects do you look at?
- In an old presentation from Durban I also read about “Distillation” – have you done research in this field - and if yes – why did you stop it?

Urine collection and performance modelling:

- What kind of collecting system have been researched and how? And which ones will (or have been?) be tested in application in Durban?

Thank you!

Best Dorothee

By the way: did you know that VUNA in isiZulu (language of project area) means harvest!
www.eawag.ch/forschung/eng/gruppen/vuna/organization/index_EN

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Re: VUNA - Valorisation of Urine Nutrients in Africa

Posted by bastian.etter - 05 Feb 2013 08:59

Hi Dorothee,

Thanks for your interest in our project! To reply to your questions:

Duration of the VUNA project: October 2010 to September 2014

Components: All project components are described on the website www.vuna.ch. With regards to toilet design: the VUNA acceptance studies do address some design issues, although designing new toilet interfaces is not part of our project.

Reactor technology

The **nutrient products** vary depending on the treatment technology:

1. precipitation: the product (struvite) is a powder that contains mainly phosphorus (12.5 % of mass)

2. nitrification & evaporation: the product is a liquid solution, concentrating all nutrients contained in urine in about 3 % of the initial volume. Nitrogen is present as ammonium and nitrate.

3. electrolysis: the resulting products depend on process parameters, such as electrode material, voltage etc. electrolysis can be used at various stages of the processes.

The **location and application** of the various processes:

1. precipitation: is researched in Durban only. Struvite precipitation is a very robust process. However, it

recovers mainly phosphorus and only a very low fraction of nitrogen (5 %). The drainage liquid of the process still contains high nitrogen and potassium loads.

2. nitrification & evaporation: are researched in Durban and Zurich in parallel. The process has been working well at pilot scale, though needs some refinement for full-scale application.

3. electrolysis: is at a very initial stage. Research is at lab scale on specific components of the process.

Health & Ecotoxicology:

The nitrification & evaporation product is hygienically safe, given that during the process it is heated. Experiments on the fate of micro-pollutants (e.g. pharmaceuticals residues) are currently carried out at the Eawag labs and first results will be available shortly.

Distillation: is a specific form of evaporation. Concerning our process, distillation is currently used in the nitrification & evaporation pilot plant in Zurich and will also be used in Durban soon. In parallel, we are also researching alternative methods (humidification) to evaporate the liquid contained in urine.

Urine collection

Some news on the tested collection systems are to be posted on our website soon. Stay tuned: www.vuna.ch

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Re: VUNA - Valorisation of Urine Nutrients in Africa

Posted by stefy - 12 Feb 2013 13:17

Dear Bastian

As this is my first post on the forum, I introduce myself: I recently finished my studies in Sustainable Development in Switzerland with focus on social aspects and water issues (water governance, organisational development, social-ecological systems). Now I'm doing an internship at seecon international GmbH in Switzerland, assisting in the SSWM Toolbox (www.sswm.info) and other sanitation related projects. That's how I came into touch with SuSanA and why I'm getting more and more interested in technical and non-technical aspects of sanitation issues.

I really like your approach of combining large-scale nutrient recovery with a business model for economically poor people. I have some less technical questions:

1. I asked myself, why do you make large-scale nutrient recovery that complicated? Why didn't you chose the easy option of direct application of (stored and dilluted) urine to the fields? Or in other words: what is the background of the VUNA project? And where do you see its biggest niche or application area?

2.What happens to the faeces?

3.Are there already any results from the research components "economic feasibility" and "social/ user acceptance"?

And by the way: are there any videos available?

Looking forward to your responses and thanks!

Stefy

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Note by moderators: This post was made by a former user with the login name stefy who is no longer a member of this discussion forum.

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Re: VUNA - Valorisation of Urine Nutrients in Africa

Posted by bastian.etter - 15 Feb 2013 09:06

Dear Stefy,

Thanks for the interest in our project! Here some answers to your questions:

1. Of course, direct urine application is the simplest and most efficient way of urine fertilisation. However, there are several challenges to a large scale application, which we try to tackle in the VUNA project:

a) concentrating the nutrients in about 3 % of their initial urine volume and weight saves storage space and transportation costs.

b) processing the urine into a fertiliser product that does not smell bad improves user-friendliness.

c) processing the urine at higher temperatures kills pathogens and makes it safe to handle.

d) processing removes part of the organic pollutants and can be extended to remove all of them.

2. Faeces treatment is not part of the VUNA project. The eThekwini is running an interesting project to pelletise faecal sludge (www.parsep.co.za/pages/Malaysia-Poster1.pdf).

3. The economic and social acceptance studies are currently carried out in the field and the first results are being processed. We will publish any interesting intermediate and final results on our website www.vuna.ch.
Stay tuned!

For videos, check out the "News" box on the left side of our website!

Best regards,

Bastian

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Re: VUNA - Valorisation of Urine Nutrients in Africa

Posted by corine - 27 Feb 2013 09:34

Dear all,

I would like to point out the following news on the VUNA homepage:

Complete nutrient recovery

The paper „Udert, K.M., Wächter, M. (2012) [pdf] Complete nutrient recovery from source-separated urine by nitrification and distillation. Water Research 46(2), 453-464.“ is now available as pdf.

Documentation

In this register you find a lot of additional reading material. Now there are also the links to the following

videos:

- SRF1 - Einstein: Urin gegen Dünger Engpass (German)
- Smart Studio featuring the VUNA nitrification reactor at Eawag (English)
- SABC -50|50: Excellence in eThekwini (English) (about the infrastructure projects in eThekwini)

Agriculture

Results from struvite crop trials at University of KwaZulu-Natal in South Africa

Fact-sheet: Odindo, A., Bame, I., Buckley, C. (2013) [pdf] Struvite crop trials. Crop and Soil Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa

Results from a plant growth study at ETH Zurich

Poster: Nutrient (re)cycling from human urine [pdf]. Christophe Bonvin, MSc candidate, ETH Zürich, Institute of Agriculture Sciences, Group of Plant Nutrition,

The homepage is updated constantly with new findings. I'll keep you informed.

About me: I am studying Environmental Engineering at ETH Zurich. Since January I am working alongside my studies at Eawag on the VUNA project. I am mainly involved in the communication and the documentation of the project.

I appreciate your interest!

Best regards

Corine

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VUNA project

Posted by eliro - 28 Nov 2013 11:32

Dear all,

Please see below a paper our team at UKZN has produced, as part of the VUNA project described above. If you have any questions, please don't hesitate to ask here on the forum. I am sorry but the paper has a copyright with IWA Publishing. If you would like to have a copy, you can e-mail me (simply use the contact button on the left of this post) or email me at

Assessing perceptions and willingness to use urine in agriculture: a case study from rural areas of eThekwini municipality, South Africa.

Authors: A. E. Okem, S. Xulu, E. Tilley, C. Buckley and E. Roma

In Journal of Water, Sanitation and Hygiene for Development Vol 3 No 4 pp 582–591 © IWA Publishing 2013

doi:10.2166/washdev.2013.036

www.iwaponline.com/washdev/up/washdev2013036.htm

ABSTRACT

In recent years there has been a growing body of knowledge exploring the benefits of using sanitation-derived nutrients. Such studies aim to uncover strategies that facilitate nutrient recovery from urine and faecal sludge for agricultural use. This paper presents the findings of a study which assessed the willingness to handle and use urine in agriculture among people living in rural areas of eThekwini Municipality, South Africa. Results show that less than 5% of participants are using urine as a fertiliser. This could be attributed to limited awareness of the value of urine in agriculture since only 9.7% are aware that urine contains essential nutrients that can support plant growth. Furthermore, health concerns, smell and the opinions of others are identified as barriers to the handling of urine. The study therefore recommends that participatory field trials and promotional activities are conducted to improve users' awareness and acceptance. The outcome of this research is of importance to help inform low- and middle-income countries' governments as they address urban and environmental challenges such as access to adequate sanitation, poverty and food security.

CONCLUSIONS

Our research provided an overview of current perceptions of UDDT users in eThekwini Municipality on the re-use of urine for agricultural purposes, highlighting some of the hurdles encountered. Managing the re-use of urine as a resource requires a radical shift in perceptions and practices, which involves all stakeholders in the value chain, from local authorities to end users and consumers. Yet this study provides only an overview of existing perceptions on the re-use of urine. Further research is recommended to assess the impact of suggested interventions (i.e. participatory field

demonstrations, training and promotion activities) to increase users' awareness of the value of urine-based fertiliser and acceptance of the practice.

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Re: VUNA - Valorisation of Urine Nutrients in Africa (EAWAG, Switzerland, and South Africa)

Posted by corine - 06 Dec 2013 11:11

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Dear all,

Finally, our new brochures are online!

Each brochure is a compact and easy to understand summary of one research topic within the VUNA project.

The VUNA brochure collection:

Urine collection networks:

- Urine collection - Setting up a system
- Performance model - Optimising collection
- Optimise collection - Minimising costs

Urine treatment processes:

- Nitrification - Stabilising urine
- Distillation - Concentrating urine
- Electrolysis - Compact reactor

- Complete recovery - All nutrient solution
- Struvite production - Phosphorus fertiliser

Risks of urine use:

- Pathogens - Inactivation
- Pharmaceuticals - Degradation

Agricultural use

- Urine fertiliser - Greenhouse trials

Socio-economic aspects:

- Incentives - Encouraging collection
- Hygiene education - Improving health
- Social acceptance - Feedback from users

Check out the brochures !

Best regards,

Corine

www.vuna.ch

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Re: VUNA - Valorisation of Urine Nutrients in Africa (EAWAG, Switzerland, and South Africa)

Posted by KimAndersson - 13 Dec 2013 18:22

Dear Corine and VUNA research team,

It is excellent to see all your factsheets sharing your project progress. Your work is really showing great potential to contribute to rethinking the sanitation development in the future.

Still, I have some questions that I hope you can answer:

Urine processing technologies: From what I can see in your factsheets most technologies that you apply seems fairly high tech. What are the main challenges that you encountered in search for affordable and technically accessible methods? In the case of nitrification and distillation, are you planning to go beyond the laboratory level and set up a pilot plant for testing in a real setting? For the struvite production that you now also tested in field, what are your strategies for management of the remaining liquid sub-product (considering that 80% of the volume remain, and also the main content of nitrogen and other nutrients).

Urine collection system: From the lessons in your project, what would you say are key components that can create a sustainable collection system for urine (including economic, social, and environmental dimensions)?

Thanks and keep up the nice work!!

All the best,

Kim

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Re: VUNA - Valorisation of Urine Nutrients in Africa (EAWAG, Switzerland, and South Africa)

Posted by kudert - 16 Dec 2013 11:33

Dear Kim

We aim to produce a valuable product (i.e. a fertilizer), prevent environmental pollution, ensure high hygienic standards and minimize the direct contact of the toilet users with urine. We think that these four goals can be achieved in the best way by bringing the urine to a collection point, where it can be treated with more complex technologies. I am not aware of any onsite technology, which can achieve the same results. However, with so many researchers working in this field right now, it is well possible that we will have highly efficient and easy-to-maintain urine treatment technologies for on-site reactors soon.

Two of our technologies, nitification/distillation and struvite precipitation, were first tested in the laboratory and later in pilot-scale reactors. Our main focus is on nitrification/distillation. One pilot plant has been running at Eawag's office building for than two years, another one is currently being installed at a horticultural center in Durban. For the next year, we are planning a third pilot plant.

As you pointed out, the effluent of the struvite precipitation process contains most of the nutrients, by the way by mass and by financial value (see the following paper for more details: Etter, B., Tilley, E., Khadka, R. and Udert, K.M. (2011) Low-cost struvite production using source-separated urine in Nepal. Water Research 45(2), 852-862.) Stuvite production has received a lot of attention, because it is a comparatively simple process and because it produces a phosphorus fertilizer. There is definitely a market for struvite, but in order to achieve all four goals that I mentioned above, struvite precipitation has to be combined with another process. One possibility is to treat the struvite effluent in the nitrification/distillation process. By this, we can produce two fertilizers, first a phosphorus fertilizer (struvite) and second an ammonium/potassium fertilizer. Furthermore, we produce distilled water.

A urine collection system has to be sustainable in various ways:

- as much urine as possible has to be collected to prevent environmental pollution and to recover most of the nutrients as fertilizer

- the collection system has to be financially viable

- urine collection must not be a burden for the local community

- urine pick-up has to be reliable

- urine collection should be a source of income for the local community

In VUNA, we investigate different approaches. In one approach, financial incentives are used to engage the local community in urine collection. In another approach, urine collection is organized and provided by the water and sanitation utility alone (institutionalized collection). Both approaches have their advantages and drawbacks. In the end of the project, we will be able to give you a more detailed answer about the key components.

Best regards, Kai

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Re: VUNA - Valorisation of Urine Nutrients in Africa (EAWAG, Switzerland, and South Africa)

Posted by kudert - 16 Jan 2014 09:57

Dear Susana forum users, if you interested in more news about the VUNA project, please join us for the webinar "Innovation in resource recovery and reuse" next week:

Tuesday 21 January 2014, 16:30 - 17:15

(CET - Central European Time; use this time converter if you are unsure of the time difference to your location: www.timeanddate.com/worldclock/converter.html)

Agenda:

16:30 Recording starts

(1)

VUNA - Valorisation of Urine Nutrients in Africa

By Kai Udert, EAWAG, Switzerland

see discussion above and www.vuna.ch

(2)

Structuring of the fecal sludge market for the benefit of poor households in Dakar, Senegal

By Mbaye Mbeguere, Senegal National Sanitation Utility, ONAS, Senegal

forum.susana.org/forum/categories/97-enabling-environment/5057-structuring-of-the-fecal-sludge-market-for-the-benefit-of-poor-households-in-dakar-senegal-onas#6845

(3)

Modeling the next generation of sanitation systems

By Luiza Campos, University College London, UK

forum.susana.org/forum/categories/97-enabling-environment-and-others/4741-modelling-the-next-generation-of-sanitation-systems-university-college-london-uk

17:15 End of webinar

For more information on how to participate, see in this posting here on the forum:

forum.susana.org/forum/categories/139-general-information-and-announcements/5624-5th-webinar-on-2

1-january-2014-sanitation-webinars-with-bmgf-grantees-organised-by-stockholm-environment-institute?limit=12&start=12#6746

Kind regards, Kai

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