1st International Conference on Terra Preta Sanitation

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Conference Brochure

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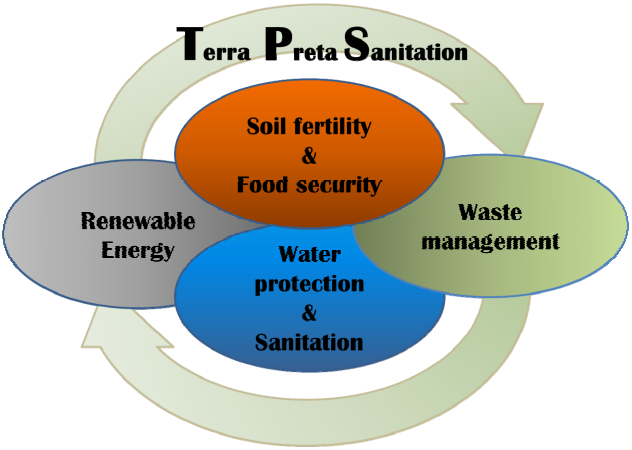

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IWA International Water Association

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DBU Deutsche Bundesstiftung Umwelt

TUHH Technische Universität Hamburg Harburg

WECF

Ralf Otterpohl

Professor Ralf Otterpohl is head of the Institute of Wastewater Management and Water Protection at TU Hamburg and one of the pioneers in TPS as well as initiator of the TPS-IC.

Integration of Sanitation, Bio-Waste-Management, local Energy production and Agriculture

Ralf Otterpohl

www.tuhh.de/aww

Imagine:

- Sanitation is designed for full reuse of water and nutrients, zero emissions to our precious waters. There are solutions for dense inner cities and comfortable low-cost aproaches for rural areas. Biowaste is integrated into the same system to be composted together with charcoal.
- Energy supply is partly based on an organicly growing forest the is cut of at a resonable hight to supply wood for woodgas technology. At the same time this forest is restoring degraded eroding land and can upgrade it over 20 years for organic food production. In the tropics and subtropics Moringa trees are feeding people and supply a water treatment agent, their wood can become fuel after other utilisation
- Electricity is produced while there is no wind power, heating the storage tanks for warmwater supply. The woodgas unit is producing charcoal needed for sanitation and biowaste management to produce rich soils.
- Organic agriculture farms finally realizes that vegetable production can be tripled as compared to organic or mineral/toxics based production today. Science has shown that plants can and do feed on macromolecules and even living microorganisms. Feeding the soil accordingly is possible. Cities and villages are producing a huge flow of highly fertile black soils that is used to feed the soil. Biochar-compost from human excreta is used non food over the first ten years until micropollutants and pathogens are gone.

How do we get there? All elements exist on small scale already! Creativity is needed to bring these systems to hundreds of millions of users in many different forms. It seems to be ideal to create regional franchising operations with small local partners, working in co-operation with authorities.

Our highly sectorial science and society leads to a lack of synergistic solutions. On top of that key players are often part of their own peer's mainstream thinking and/or miss-defining importance of issues with high media coverage. We lost our footing, forgot about our 100% dependency on living soil. Not only food production but water renewal, avoidance of flooding/drought, supportive regional climates, green areas and forests, local economy depends on living soil. Humus rich soil makes water; sanitation, in turn, can make soil. Bio-Waste can be an ideal feeding material for keeping soil healthy. Energy production can be done with woodgas technology, co-generating power, heat and charcoal as a technology for the larger scale. On a on-site level it is ideal to supply woodgas stoves and a sustainable supply of fuel, what can be based on local materials like coconut shells. The charcoal should not be burnt but used for carbon-composting in order to create long term fertile soils. Wood gas stoves instead of wasteful and toxic open fireplaces offer great cooking even with woody waste materials and the charcoal for composting the remaining bio-waste and excreta. This can be a pathway for the integration of Sanitation, bio-waste-management, local energy production and agriculture. Terra Preta Sanitation offers a clear pathway towards highly cost efficient solutions from low cost to luxury solutions. Lactic acid fermentation allows easy waterless collection and efficient sanitization of excreta. Composting with clean charcoal can mimic the probably most sustainable society that lived on earth in large numbers for thousands of years: the Indio's of the Amazon. All they left after their ruthless destrucion around 500 years back is beautiful ceramics and huge areas of the most fertile black soil entirely man made mainly from bio waste, excreta and charcoal: Terra Preta do Indio, the Black Soil of the Indios (Factura et al., 2010). In contrast to this our 'modern' societies have managed to destroy or deplete around one third of all arable land around the world between 1950 and 1990 (UN Millenium Report). Those cilvilisations that did not keep their soils healthy have vanished again and again troughout human history (David Montgomery: Dirt – The erosion of cilvilisations)

With this wider picture of the nexus between efficient local energy supply, agriculture and biowaste management, dry sanitation can become a major cornerstone of future food and water security, prevention of flooding and draught. The global relevance is larger in regions with high population density because of the relative amounts of human excreta to land area. On the other hand excreta of animals can be used the same way. The challenge with human excreta management is collection and transportation with no or very little dilution, useable for humification. From the development of ecological sanitation we see some hundred thousand installations of urine diverting dry toilets (UDDT) around the wold. Compared to demand this is still a very low number and it is not yet spreading by itself. Lactic acid fermentatation is a great tool to make any type of dry toilet much more reliable, helps with thorough sanitisation as it was found not only at University of Leipzig, Germany. Double vault systems become unneccesary and containers can and should be completely airtight exept when used. This is a major advantage in itself as there is no smell whan idle and with the lactic acis fermentation the can be very little smell when the toilet is used. One big advantage is that the smell is slightly sour but not feacal like any more. In our experiments we had phases with too much smell, lactic acid fermentation requires a good dose of micro organisms and a carbon source to feed them. TUHH is now doing targeted research on those lactic acid bacteria that are not producing gas but living well in feacal matter and urine. It seem that the process works better in separate feaces and urine; our goal is however to also find ways to get away from the restrictive ad somewhat difficult urine diversion. This can be combined with waterless urinals to keep volumes of mixed material smaller. On the other hand research is also aiming at composting both urine and faeces together with fine woody wastes and charcoal from woodgas units. Organic compost is preferable to mineral urine based fertilisers to supply organic agriculture.

Terra Preta Sanitation is not restricted to low-tech approaches. It is also possible to collect the solids from blackwater loop systems (Intaqua AG, Hamburg) or Hamburg Water Cycle (Hamburg Water) and treat it with lactic acid bacteria and biochar.

The process of lactic acid fermentation and addition of biochar opens many new ways for dry toilets and will probably open the door for large scale applications form many different regions of the world. Let us work together from different sectors to go to scale together!

Organisation Committee

Torsten Bettendorf, TUHH

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T.B is scientific employee at the Institute of wastewater management and water protection at TUHH. His research focuses on the production of fertiliser and soil enhancer within new sanitation approaches.

„Wastewater is still a hardly used resource of plant nutrients and soil improving organic and its treatment mostly aims at an environmental friendly disposal. TPS can be seen as great opportunity to exploit this potential. The coordination of the energy, waste and (waste) water management towards the production of durably fertile soils is challenging as it requires overcoming the barriers between this sectors and traditional claims. The TPS-IC will bring together scientist and practitioners, offers a stage for exchange, and identifies the state of knowledge as well as further need for research.

The aim is clear, let us have a look on possible ways!”

Claudia Wendland, WECF

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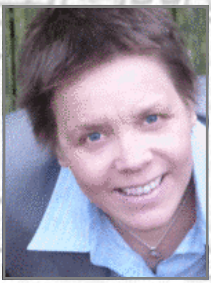

WECF as an international environment and women network strongly supports the Terra Preta Sanitation approach because TPS reflects the important nexus between water, energy and agriculture. It is the key challenge not to think in terms of technologies or sectors but rather to use a holistic nexus approach in order to meet the sustainable development goals for all. Sanitation is a neglected area which was thought to be soon and easily solved but for many people worldwide it is not. And it is unfeasible, unaffordable and discriminating to apply conventional sanitation solutions to all regions in the world. The benefit of Terra preta made of human excreta is - independent from the toilet technology – the product: safe rich organic soil.

Organisation Committee

Kerstin Kuchta

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Professor Kerstin Kuchta is head of the Waste Resources Management Group at TU Hamburg. Her research is focused on utilization of organic wastes, energy recovery from waste, particularly focusing at hydrogen and biomethan production, as well as metal recovery by urban mining.

Her personal statement reads as followes:

"One of the most exciting aspects of the conference is the chance to network with others who share your research interest."

Robert Gensch

robert.gensch@germantoilet.org

Robert Gensch is working at German Toilet Organization in Berlin. Since 2007 he has been involved in promoting reuse-oriented and sustainable sanitation concepts worldwide. He started his sanitation related work at the GIZ sustainable sanitation program in Eschborn, Germany, followed by an assignment in Cagayan de Oro, Philippines. He was the founder and director of the Sustainable Sanitation Center (SUSAN Center) of Xavier University, Philippines and initiated first pilot projects on terra preta sanitation in the Philippines. As a proponent of the Sustainable Sanitation Alliance (SuSanA) he is also leading the SuSanA working group on “Productive Sanitation and Food Security”

Organisation Committee

Mariska Ronteltap

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As a lecturer at UNESCO-IHE I highly support this conference, as it seeks to bring back together all current knowledge regarding terra preta sanitation, and to define research questions that are still left unanswered. In these times of searching for possible sanitation solutions that work under many different and challenging circumstances I feel this conference can bring a strong contribution. There are a lot of interesting debates going on regarding terra preta sanitation; I look forward to meet other colleagues from the field and together bring this technology to the next level of knowledge and experience

Martin Kaltschmitt

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Professor Martin Kaltschmitt is head of the Institute of environmental technology and energy economics at TU Hamburg. His main researches are focused on the field of renewable energies.

His message towards the TPS-IC reads as follows:

"It is important to show and assess what is known and what is unknown in this exciting field. Only then convincing strategies can be developed how to integrate this option into our society in a sustainable way."

Scientific committee

Ralf Otterpohl (Germany)
Piet Lens (the Netherlands)
Håkan Jönsson (Sweden)
Martin Kaltschmitt (Germany)
Kerstin Kuchta (Germany)
Gina Ichton (Philippines)
Massimiliano Fabbricino (Italy)
Jutta Kerpen (Germany)
Boris Boinceau (Republic of Moldova)
Vishwanath Srikantaih (India)
Srikanth Mutnuri (India)
Linus Dagerskog (Sweden)
Oliver Christ (Germany)
Günter Langergraber (Austria)
Ina Körner (Germany)
Bruno Glaser (Germany)
Zifu Li (China)

German Ministry of Environment, Nature Protection and Nuclear Safety

Peter Altmaier
Federal Environment Minister

Haiko Pieplow
Speaker

Welcome Speech

Resource conservation and climate action are two core areas of the German government's environmental policy that will become even more important in the context of growing globalisation. Germany is well prepared for both the expansion of renewable energies and further strengthening of the recycling of wastes, particularly bio wastes. Our success speaks for itself and we are pleased to see that experts from all over are seeking to exchange experience with us.

Our achievements to date in the context of the Energiewende particularly stand out. Already, more than 20 per cent of our electricity comes from renewable energies. The share of renewable energies in total gross electricity consumption will be increased to at least 35% by 2020. After that date, a continuous increase is prescribed. By 2020, the share of renewable energies in heat supply is to reach at least 14%. Bioenergy has an important role to play here as its generation can be targeted, controlled and also stored, for example in the case of biogas.

Over the past few years we have continuously worked hard to further develop the Renewable Energy Sources Act so as to improve its effects and thus create incentives for using bio wastes in anaerobic digestion plants.
However, change is also underway with other resources. In early 2012, the Federal Government asserted its will for a sustainable resources conservation policy with the adoption of the German Resource Efficiency Programme (ProgRess) - the first national resource efficiency programme to be adopted by a government in Europe.

In addition to material efficiency in production and sustainable consumption of goods, closed-cycle management makes a substantial contribution to conserving natural resources. The use of various recyclable materials extracted from waste will in future play a decisive role. The use of agricultural residues and organic waste must also be further increased as a standstill in this case would be a step backwards.
The Closed Cycle Management Act, which entered into force on 1 June 2012, reinforces waste prevention, re-use and recycling and promotes the conservation of natural resources through closed-cycle management. Further progress is to be made to in substituting primary raw materials with secondary raw materials and fuel extracted from wastes in particular by means of separating and upholding demanding recycling quotas.

This is also the subject of the *Terra Preta Sanitation Initiative* which is concerned with current issues relating to the production and recycling of waste materials when manufacturing soils with high carbon content from which Terra Preta can be produced. In spite of research progress made and meetings held over the past few years, interest in this area remains as high as ever. I therefore think it would be a good idea to tackle these issues at international level and to discuss them in detail with representatives from various scientific fields.

The spectrum of relevant fields is very broad. Such fields include the use of organic wastes in the production of biochar, the use of information acquired through Terra-Preta research with a view to climate policy and also the impacts of carbon accumulation in soils on yields and micro-organisms. In addition risks such as the possible accumulation of pollutants and methods for the production of soils with high carbon content will be discussed.

To facilitate a final evaluation there are several other issues which will require further examination.
An interesting meeting with lively discussions is therefore on the cards. I wish this meeting, which I have gladly agreed to sponsor, every success.

Bruno Glaser

Prof. Dr. Bruno Glaser is currently professor for soilbiogeochemistry at der Martin-Luther-Universität Halle-Wittenberg. He is furthermore executive director of the Biochar Europe UG in Halle.

Potential and constraints of Terra Preta products for soil amelioration and climate change mitigation

Terra Preta is man-made black soil left behind by pre-Columbian people in Amazonia, occurring in a region dominated by highly weathered infertile soils and being still sustainably fertile today. Therefore, knowing how Terra Preta was made and how it works could help us to solve our problems of soil degradation while increasing soil productivity. The existence of Terra Preta in Amazonia today proves that it is principally possible to convert infertile soils into sustainably fertile soils even under intensive agriculture. Therefore, Terra Preta is a general model for sustainably improving soil fertility and ecosystem services while storing large amounts of C in soil for a long time. Key factors for maintaining sustainable soil fertility are increased levels of soil organic matter (SOM) and nutrients stocks by using a circular economy using biogenic “wastes” as sources of natural resources. Biochar is a key factor of the Terra Preta concept together with input of tremendous amounts of nutrients and microbial processes and this scheme can be transfered to modern society. From this concept it is clear that it makes no sense to work with pure biochar to mimic Terra Preta effects. It is like working with pure flour while studying the principle of making a cake. Therefore, for ecological studies it is important to include nutrients and microorganisms to study biochar (Terra Preta) effects.

In order to understand biochar-related processes, studies on pure biochar should only be undertaken when extracted from nutrient- and microorganism-containing environments either from laboratory or field incubations.

Biochar amendments offer potential for carbon-neutral or carbon-negative food production and concomitant development of brand value and an income stream from acquisition of carbon certificates traded on the voluntary carbon market. The eco region Kaindorf (Austria) has successfully implemented such a system. In addition, when combined with plant nutrients from waste materials such as from green wastes or slurries, additional benefit arises from saving money for buying mineral fertilizers such as NPK and by reducing resources allocation for water purification e.g. when nitrate is leached into groundwater after improper slurry application to agricultural fields. The latter is supposed to increase in the near future due to rapid growth in biogas production followed by the disposal of huge amounts of biogas slurry.

Theresa Theuretzbacher

Theresa Theuretzbacher is a graduate student in Water Management and Environmental Engineering at the University of Natural Resources and Life Sciences (BOKU), Vienna. In her bachelor's thesis she investigated Terra Preta like products and Terra Preta Sanitation. In several projects in rural Ghana, Alaska and DR Kongo she gained experience in solving problems of specific local water, waste and sanitation challenges. In Ghana she proposed a sustainable village development plan based on a closed life cycle. The Project was awarded with the Bauhaus Solar Award. Theresa Theuretzbacher is maintaining a long term network of knowledge with interested villagers in order to exchange water, waste and sanitation related information.

Investigation on Terra Preta like products on the German– Austrian Market

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Positive characteristics and stability of Terra Preta have led to a lot of research and experiments to create new Terra Preta like products. "Terra Preta" and Terra Preta like products are sold in Austria's and Germany's markets. In this work we aimed at comparing the ingredients and quality of a variety of commercial products with conventional compost.

As a first step, we sent a questionnaire to all the companies with questions regarding the ingredients and treatments of their products. We conducted basic physicochemical analysis to determine the ingredients and to compare the substrate quality to composts. Ten samples of four companies and one private person were analysed to provide an overview on the range of Terra Preta like products and products sold as "Terra Preta".

We performed quality determination and comparison by means of standard parameters, humic acid determination, simultaneous thermal analysis and FTIR-spectroscopy.

These parameters are appropriate methods to characterize compost quality and stability. The results of the water content, the loss of ignition (LOI) and the respiration activity over 4 days (RA_4) showed a wide range of values. The highest value of humic acids of all samples is 11% organic dry matter (oDM). As benchmark, well humified composts have more than 30 % oDM humic acids. Compared to these values all samples show rather poor results.

Most present “Terra Preta” products do not include faeces and generally they do not yet completely fulfil the expectations of high quality compost. Some products are still in the phase of development.

It is questionable, which ingredients or processes will make a product Terra Preta like. Further research on the right ingredients, quality improvement as well as long term experiments is necessary. As Terra Preta is a product of an ancient culture, produced in the Amazon basin a discussion regarding the appropriate term is warranted. It is debatable if names like Terra Preta Nuova and Terra Preta Sanitation are proper names for products or concepts from outside the Amazon basin.

Nadejda Andreev

Nadejda Andreev is a sandwich PhD fellow at Unesco-IHE Institute for Water Education. Nadejda has completed her MSc degree in 1998 at Central European University in Environmental Sciences and Policy and also has gained a second MSc degree in Biodiversity at Swedish University of Agricultural Sciences in 2004. PhD research topic deals with terra preta sanitation and its applications in sustainable management of human excreta from separately collecting toilets. In Moldova, Nadejda leads an NGO which implements projects related to decentralized sustainable technologies.

The effect of terra preta like substrate on germination and shoot growth of radish and parsley

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Lactic acid fermentation (ensiling) is a relatively new approach in treating human faeces from separately collecting facilities. The advantage of lactic acid fermentation is the prevention of nutrient loss via leaching, precipitation or volatilization and requires a relatively short time for faeces treatment: 2-4 months versus 1-2 years of storage (Buzie-Fru, 2010; Factura et al., 2010; Scheinemann & Krüger, 2010; WHO, 2006). Addition of charcoal increases the stability of the end product and its potential fertilizing value (Elad et al., 2012); the concept on which terra preta soils were based (Smith, 1980). The objective of this study was to evaluate the effect of lacto fermented human faeces, wood charcoal and a mix of lacto fermented material and charcoal addition (terra preta-like substrate) on the germination and shoot growth of radish and parsley.

The mixture of wastes which was exposed to the lactofermentation process in this study had the following composition: human faeces (40% wet weight), cattle manure (30%), fruit residues (17%), sugar beet molasses (8%) and activated microbial innoculum (5%) from sauerkraut brine. The human excreta were obtained from three separately collected school toilets of Nisporeni district, Moldova. The charcoal was a residue from an enterprise producing wood charcoal for grilling. In order to carry out germination tests, a "paper towel" method was used (Garcia et al., 1992), the radish seeds were treated with a liquid obtained from a suspension of lacto fermented material, charcoal, and terra preta-like substrate at 0.5%, 1%, 2%, 4% and 6% mass fraction to water. The control was performed with dechlorinated water. The germination index was obtained by multiplying germination and relative root length, both expressed as a percentage (%) of the control values (Gopinathan & Thirumurthy, 2012). The parsley seeds were sawn directly in the soil (control) and a 3:1 mixture of soil and terra preta-like substrate.

Main results

In parsley, the germination in the control started 5 days earlier than in terra preta-like substrate, however, after one month the mean shoot length of the latter reached 4.95 cm, compared to 3.78 cm for the control. In addition, in terra preta-like substrates 92 % out of total 60 seedlings survived, while in control - only 70 %.

In radish the germination index for charcoal was increasing (127%, 116% and 109%) at 0.5%, 1% and 2 % mass fraction , and decreased (84% and 87%) at 4 % and 6 %, for lactofermented material - the germination index did not differ at different mass fractions, ranging between 101% and 103% and for terra preta-like substrate - the germination index was the highest, increasing from 123 % at 0.5 % to 155 % at 6 % of mass fraction.

Preliminary conclusions

The results from this study on radish and parsley demonstrated the lack of toxicity and usability of terra preta-like substrate for soil enrichment and its potential beneficial effects on crops. The effect on germination and shoot growth in radish in terra preta-like substrate was superior to charcoal and lacto-fermented material alone.

Horazio Factura

Horazio Factura is Bachelor of Science in Agriculture and worked as Agronomist in the Periurban Vegetable Project - Xavier University Ateneo de Cagayan as a technical person in Allotment Garden Projects
He did his Masters in International Horticulture, Leibniz University of Hannover, Germany and furthemore worked as an Intern for Deutsche Gesellschaft fuer Internationale Zusammenarbeit as an expert in Reuse of Urine and Faeces back to Agriculture.
He is currently PhD student at Institute of Wastewater Management and Water Protection, Hamburg University of Technology. Furthermore he is an expert on Terra Preta Sanitation in Low-cost Implementation and Application for tropical region.

Addressing Poor Sanitation and Generating Added Values through Terra Preta Sanitation – The Experiences from Xavier University Ateneo de Cagayan, Philippines

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This paper presents experiences of Terra Preta Sanitation (TPS) as a result of scientific investigation and as well as observations based from actual field usage specifically in Lumbia, Cagayan de Oro City (CDO), Philippines. Xavier University (XU) played the major role in conducting scientific experiments on TPS and in working with the district administration of Lumbia through a convergence project in addressing issues on poor sanitation. Lumbia is a periurban district of CDO where agriculture is the most common livelihood. Open defecation is very rampant in many villages due to absence of sanitation facilities i.e. toilets and access to water.

Through a convergence project XU provided ecological sanitation (ecosan) urine diverting dehydration toilets (UDDT) to some identified families. TPS was used in the toilet by pouring a small amount of microbial solution containing lactofermenters in the faecal container after each toilet usage. Feedback from users revealed that no faecal odour was observed from the toilet. A new odour was commonly observed which was a result of bacterial action in faeces which caused the fermentation process.

Lactic acid fermentation and vermicomposting are the main faecal treatment used in TPS. The goal is to produce hygienically safe compost product that can be used in improving unfavorable soil condition while at the same time providing nutrients for plant growth. To achieve this, faecal storage and vermicomposting facilities were established. Scientific experiments were conducted to find out the effectiveness of the treatment processes in eradicating feacal pathogens. Results showed that after 3 months of storage, faeces was virtually free of parasite eggs particularly Ascaris lumbricoides which proved to be very difficult to eradicate as observed in earlier studies. Chemical analysis showed that TPS compost product contained 1.79, 0.89 and 1.41% for Nitrogen, Phosphorus and Potassium respectively.

Management of human excreta through the TPS process is a promising example of a reliable system for sustainable sanitation that also provides added values in the form of economic benefits helping low income farmers. Protection of drinking water source from faecal contamination can be assured including the spread of waterborne diseases among humans. All these are easily achieved even in low cost means therefore TPS is highly recommended especially in water-critical areas particularly in tropical countries.

Srikanth Mutnuri

Dr. Mutnuri was a recipient of DAAD-UGC Scholarship to complete his Doctoral Research at UFZ – Centre for Environmental Research, Germany and obtained his degree from Anna University Chennai in the year 2004. He joined BITS Pilani K.K Birla Goa Campus as a full time faculty in 2005. He is a Recipient of American Society for Microbiology & Indo US Science and Technology Forum (ASM IUSSTF) Indo US Research Professorship for October 2010. He is part of the expert committee for solid waste management for the state of Goa, India. He is a consultant for GIZ "waste to Energy" project for Nashik, India. He had completed four research projects funded by various Indian funding agencies. Currently he has three projects funded by CSIR, DSTE and DBT. He has published 13 research papers in International Journals and written two Book Chapters. He received Helmholtz association's Junior Scientist Award and FEMS Young Scientist Award to participate in International conference on Environmental Biotechnology, Leipzig, Germany. 2006 and 14th International Biodeterioration and Biodegradation symposium Sicily, Italy, 2008 respectively. He had attended National and International Conferences to present his research work as Oral and Poster presentations. He was the convener for two International Conferences in Environmental Biotechnology held in the year 2009 and 2011 at BITS Pilani K.K Birla Goa Campus.

Terra Preta as an Alternative for the Management of Sludge from Waste Water Treatment Plant

Meghanath Prabhu[1] Malte Horvat[2], Linus Lorenz[3] Ralf Otterpohl[3], Torsten Bettendorf[3], Srikanth Mutnuri[1]

Terra preta (Black soil) is a composting method which involves charcoal addition and lactic acid fermentation. It acts as terrestrial carbon sequestration technique helping to alleviate global warming and has potential for great social benefits in enhancing agricultural production by increasing soil fertility without fertilizer addition (Kurth Kleiner, 2009).

Our institute has a waste water treatment plant of 300m^3 capacity of fluidized bed reactor (FBR) type generating 20m^3 of wet sludge every day. To reduce the expenditure and the load on centrifuge, the sludge is dried in the drying bed during the non-monsoon period.

There is objection for this from certain quarters due to smell. Local community raised an issue regarding this. Therefore an alternate solution for the sludge management is essential. A functional horizontal plug flow anaerobic digester of working capacity 60m3 with food waste as the substrate already exists in the institute. Biomethanation potential (BMP) for the co-digestion of food waste and sludge at different mixing ratios were carried out in order to manage sewage sludge generated and 1:2 mixing ratio of food waste to sludge gave maximum biogas production of 486 ml/gm VS with methane content of 63%. As the anaerobic digester is already running on food waste, it could accommodate further $3m^3$ of sludge. The remaining $17m^3$ of sludge after centrifugation (corresponding to 1360 kg/d) could be used to increase the soil fertility and productivity by making *Terra preta*. Lab scale studies of *Terra preta* of sludge (after centrifugation) were tried with following different ways, (I) sludge (control 1), (II) sludge + charcoal (control 2), (III) sludge + charcoal + EM (Effective Microorganisms for lactic acid production), (IV) sludge + charcoal + EM + Soil and (V) sludge + charcoal + EM + Soil + CaCO3. Lactofermentation was carried out for 28 days to improve the sludge characteristics. No faecal odour was present after lactofermentation in samples having EM. C/N ratio in above five samples decreased from 26, 61, 65, 72 and 61 to 13, 44, 40, 49 and 47. This was followed by vermicomposting for further refining of the sludge. Currently the effect of the terra preta compost on plant growth is under investigation. The detailed results will be presented during the conference.

Stefan Böttger

Due to his work as a scientific assistant, industrial engineer Mr. Stefan Böttger already dealt with the topic of adaptation of wastewater infrastructures to demographic change during his studies. As a project manager for the Leipzig-based company Tilia Umwelt GmbH he was significantly involved in the realization of the R&D-project "Terra Preta and the operator model.

Terra Preta—production from sewage sludges of decentralised wastewater systems

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The mixture of primary and excess sludge of decentralized wastewater treatment units contains a high concentration of nutrients and lower quantities of undesirable substances. Today this sludge has to be transported to a central sewage treatment plant and is treated in an entire cleaning process, using a lot of energy.

A sustainable regional development requires closing cycles of materials on a regional level. The production and use of a fertilizer made of sewage sludge could improve the local energy and resource efficiency and will strengthen the regional economic development and produce regional added value.

Taking into account the ecological, economical, technical, social and legal aspects, the necessary base for a concept to production and marketing of Terra Preta has been developed in a research and development project, funded by the Saxon State Ministry for Environment and Agriculture (SMUL). Tilia Umwelt GmbH has the role of the applicant. Cooperating partners are:

- Training and Demonstration Centre for Decentralised Sewage Treatment (BDZ)
- Veterinary faculty of the University of Leipzig, Institute for bacteriology and mycology
- Abwasserzweckverband Leisnig

- PETERSEN HARDRAHT lawyers, financial advisers
- Institute for testing and development of waste water technology (PIA)
- alles klar GmbH

Within the project, requirements for production and implementation of such an approach in Germany were identified. The examination of legal requirements on production and use of Terra Preta as fertilizer show, that the existing restrictions will be no obstacle, as long as the produced fertilizer complies with the requirements of the 'Sewage and Sludge Ordinance' and the 'Fertilizers Ordinance'

Another goal of the project was the comparison of a large-scale industrial production and a small-scale production. It was determined that the technological and economical advantages of the small variant outweigh the industrial production.

On the basis of the first laboratory tests, statements on microbiological and material characteristics of the product could be made as well, as the qualitative requirements of the input substrates (i.a. coals) could be defined. The research shows among other things, that the examined pharmaceuticals have been degraded, the relevant heavy metals were below the requirement values and the product contains a sufficient amount of nutrients. Therefore, the results demonstrate that Terra Preta from sewage sludge of decentralized units can be used directly as a fertilizer in agriculture.

In addition to the production of Terra Preta, the project is aimed to develop an operator model for building, commissioning, maintenance and other services related to decentralized sewage treatment plants and disposal of sludge. The developed economic analysis demonstrates that central operation of decentralized systems offers a clear cost advantage.

Further specific investigation for improving plant growth and soil quality, the construction of a pilot plant for an industrial-scale production of fertilizer and detailed analysis of various operator models are still unresolved. However, our initial findings already show, that Terra Preta produced of sewage sludge of decentralized wastewater systems is a sustainable, intelligent innovation for region development and the environment. The combination with the developed operating model could even increase the benefits.

Daniel Meyer–Kohlstock

Daniel Meyer–Kohlstock holds a degree in Forestry since 2002 and got his Masters in Environmental Engineering from the Bauhaus-Universität Weimar in 2009. There, he works in national and European projects on biological waste management and follows his PhD-studies on nutrient cycling in Urban Farming. In his free time he tends the soil of an allotment garden which grows some tasty heirloom vegetables and fruits.

The integration of Terra Preta Sanitation in European nutrient cycles – Options for alternative policies and economies

D. Meyer-Kohlstock[1], E. Kraft[1]

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The current nutrient flows towards and within the European Union are shortly depicted. Most of these flows are unsustainable and action is required to avert collapse. Therefore, several policy changes at the European level were made, respectively are in planning, to enable a transition to a sustainable nutrient balance. But while some policies do promote nutrient recycling and preservation, that cannot be said for all. And certain regulations have even the potential to undermine this goal. For all policy changes the same is the time-consuming process to find a mutual consent among all 27 member states. Along the way, stands the risk to agree to the least ambitious regulation and with that to miss the intended goal. With this situation it is worthwhile to examine decentralised solutions, which could be implemented within the existing European and national policy framework, or at least require only minor changes on these levels.

Terra Preta Sanitation (TPS) is one such solution. The possible integration within other decentralised structures, like urban farming and regional currencies is outlined in the presentation paper. TPS would not only be supported by these structures, but they would also profit from this solution in return. This can have a multitude of positive political and economic implications on local levels. The paper closes with a short look at the TPS potential to recycle nutrients compared with current strategies at EU level, including some centralised end-of-pipe technologies.

Bojan Pelivanoski

Bojan Pelivanoskihas a background as civil engineer and recently he finished his studies at TUHH in environmental engineering and master in business and administration. Terra Pellet is a start up of the TUHH and aiming at the production of organic fertiliser based on 100% resource recycling.

Terra Pellet – an organic fertiliser inspired by Terra Preta

Bettendorf, T., Voss, T., Di Fraia, S., Pelivanoski, B., Kuchta, K., Otterpohl, R.

Throughout the last decade the number of biogasplants in Germany increased rapidly. At the same time the amount of digestate, which is are considered as soil enhancer or liquid organic fertilizer. Due to high water content of digestate transportation expenses make a direct application often economically unattractive. The potential of domestic or municipal wastewater to substitute mineral fertilisers is widely unexploited. Agricultural usage of sewage sludge is declining and replaced by incineration. Increasing demand on agricultural soil in terms of food and energy production requires improved management of soil and organic waste likewise.

Based on digestate utilization the Terra Pellet concept is an opportunity for need based fertilizer and soil improvement according to the idea of Terra Preta. Terra Pellet follows the paradigm of hundred percent resources recycling for creating fertile and healthy soil. Prototypes of Terra Pellet were already produced and the fertilizing effect is proven in plant experiments. The compacted shape of Terra Pellet increases transportability over regional scale and is adapted to conventional fertilizer spreader. Hence Terra Pellet is attractive for organic- as well as conventional agriculture.

Thorsten Schütze

Thorsten Schuetze studied Architecture in Hamburg, Germany. Since 1998 he is working as freelancing architect, consultant, researcher and lecturer in the field of sustainable architecture and urbanism in Europe and Asia. He received scholarships and worked as author and editor for numerous international scientific publications about his researches, amongst others for the United Nations Environment Programme (UNEP). In 2005 he received his PhD at the Faculty for Architecture and Landscape at the Leibniz University Hanover and became partner of the architectural office ³hwp - hullmann willkomm & partner - research, planning and development in architecture² in Hamburg/ Germany, for whom he worked as executive in 2006. From 2006 he was Assistant Professor at the Faculty of Architecture at Delft University of Technology in the Netherlands. He is active member of the International Forum on Urbanism (IFoU) scientific committees and editorial boards. Since March 2012 he works as Professor for Architectural Design at the Sungkyunkwan University in Korea. The focus of his research is on sustainable architecture and urbanism.

Building integrated Terra-Preta-Saniation systems – key components of urban infrastructure systems for sustainable resource management

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The sustainable management and provision of vital resources such as water, energy and food is only possible by means of integrated solutions and based on interdisciplinary strategies. This is particular the case in urban environments where population densities and inter-relation between different infrastructure sectors are more complex and challenging than in rural areas. Generally intensive land use for buildings and infrastructures combined with high population densities in cities result in a physical disconnection of areas where resources are consumed and metabolites are produced, and areas where resources, which are consumed in the cities are produced and resulting metabolites are managed.

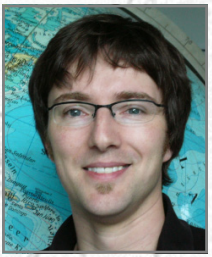
Metabolites from urban resource consumption are generally regarded as wastes but according to the principles of integrated urban resource management they are regarded as resources.

Buildings and people play a key role in overall layout and function of urban infrastructure systems for resource management. In buildings, the biggest part of the urban social activity and resource consumption takes place. The building design, the kind and layout of the installed building services engineering - and infrastructure systems determine both the performance and the resource consumption over the entire lifecycle of the building itself as well as of the required connecting urban infrastructure systems, particularly for the management of energy, water and organic wastes.

Conventional sanitation systems in buildings, centralized infrastructures and resource management systems have system immanent disadvantages regarding ecological, economical and social criteria. In contrast, Terra-Preta Sanitation can play a key role in sustainable sanitation, resource management (including water, energy carriers, food, as well as liquid and solid organic waste streams) as well as the development of sustainable urban environments and infrastructure systems. This paper discusses findings from best practice case studies in Germany and their implementation in current concepts for so called 'Zero-Emission-Buildings', which can produce energy, water and resources, in Europe and Asia. Such building concepts are exemplary for new flexible and decentralized approaches towards sustainable resource management and the remodelling of urban infrastructures and urban environments in future cities. Using the example of on-going applied research projects in Europe an Korea, this paper discusses the establishment of a general framework of "Zero Emission Buildings", which will allow the inclusion of future technical development and societal insights.

The discussed projects foster exchange of newest developments and compilation of best practice examples in order to accelerate the development of decentralized and building integrated services engineering technologies and infrastructure systems by innovative system configuration of single technologies, with Terra-Preta-Sanitation as a key element in the overall building and urban infrastructure concept. The specific objectives are to reduce the direct water footprint by up to 100%, to design and operate up to 100% organic waste free buildings, to attain net zero energy consumption, to foster no additional building and service costs, to integrate food production into buildings, and to generate benefits through integration and creation of synergies between social (didactical and social), environmental (resource efficiency and productivity) and economical aspects (cost efficiency and local economy).

Robert Wagner



Dr. Robert Wagner is a research associate in the working group Geoecology at the Free University Berlin, Department of Earth Sciences. Since 2009 he coordinates the TerraBoGa project in the Botanical Garden Berlin-Dahlem. His main researches are focused on the field of sustainable soil protection.

New challenges of resource management in the Botanic Garden Berlin by producing and applying biochar substrates

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In the Botanic Garden Berlin more than 20 000 different plant species from all over the world are cultivated on an area of approximately 430 000 m². These plants produce approximately 2 000 m³ organic waste and residues (stem wood, pruning, general green waste, leaves, grass clippings) each year, which in the past had been mostly unused and disposed of in a way that is both energy and cost intensive. Apart from the waste production, the Botanic Garden has a great demand on compost and peat respectively on peat substrates for potting plants and in total this demand is around 250 m³ each year. The Botanic Garden currently has to buy all of its compost, peat and substrates that are required. In addition to the organic waste and green waste, the high amount of human faeces that are left in the Botanic Garden by visitors and employees and which have been disposed of as wastewater so far, are also seen as important and valuable nutrient resources. The most important objectives of the research and development project are the efficient use of the produced organic waste and the closing of small scale material cycles in the Botanic Garden by producing and applying high quality biochar substrates. TerraBoGa wants to make a significant contribution to sustainable soil management in terms of avoiding the loss of soil carbon and nutrients.

The environmental impact of the produced biochar substrates like the leaching of nutrients is investigated. Of further interest are quality aspects as well as the investigation of a possible peat substitution. A very important task is the sanitation aspect of the produced biochar substrates. The project finally intends to publish a guidance in order to share valuable experiences.

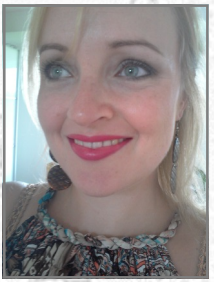
In the beginning of the project two ways of the production of biochar substrates are applied - conventional composting with biochar and fermentation of organic wastes with biochar. Currently both processes are combined, depending on the feedstock.

Regarding first characterizations of the produced biochar substrates, all of the examined parameters are in the range of the German compost association and are usual values for garden composts. Further investigations concerning the leaching behaviour show a reduction of the nutrient leaching in biochar substrates compared to substrates without biochar. Starting with the monitoring of greenhouse plants an increase of biomass, plant height and amount of leaves in substrates with added biochar compared to those without biochar was found. Several other pot trials show a significant impact of biochar.

In regard of the few effects seen in the field trials as well as many positive effects of the pot trials, long term test seem to be essential to evaluate the full potential of biochar substrates.

The effects which can be expected by the achievement of the named objectives, particularly by closing the internal material cycle are evident: Reduction of costs, waste disposal, water consumption, discharged nutrients and emitted greenhouse gases and as a consequence the increased health of soil, plants and atmosphere

Rosa Kuipers



Rosa Kuipers has been always fascinated about our basic needs, including sanitation, and their influences to our daily life. It drives her to attend meetings and visit local research institutes and companies around the world to stay up-dated about the latest trends and the current economic and political situation. She is fascinated by challenges and problems and has respect to different opinions and interest to find out what really drives all different stakeholders in their decisions and actions. And this without being prejudiced about a picture of the future.
She had her master degree in 'Technology and Policy' with the specialization on 'Development Economics' at the Eindhoven University of Technology, including a certificate 'Technology, Globalisation, and Development'. Nowadays, she is employed voluntary as PR and Marketing Manager and Personal Assistant of the CEO at ' DoGoodFeelGood'. Also, for two years she is conducting research related to poverty alleviation and supply chain mechanisms in the field of sanitation in several development countries in Africa and Asia, including to investigate the success factors for the logistics of human nutrients in the urban area and therefore interviewed many different .

A Socio– economic assessment of urine seperation, with a reflection on the possibilities for terra preta sanitation, for the recycling of nutrients to rural agriculture in the Philippines.

Kuipers R, Balkema A.J.*, Flapper S.D***

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To make ecological sanitation (EcoSan) and the use of human nutrients in agriculture successful, the whole chain from toilet user, logistics server provider up to the farmer should be organised in a beneficial way. A field study in the Philippines revealed that overall challenges are the social acceptance of innovative sanitation systems, the handling of excreta, and convincing farmers to change their habits for safe and optimal application of biofertilisers.

For these reverse logistics, the main challenges are bringing together the different actors and organise the logistics in a financial feasible way. Through interviews with the different actors and a cost benefit analysis we found that the above closed-loop system can be profitable. The main bottle-neck is the lack of demand for bio-fertiliser. Therefore, participation of farmers is needed in EcoSan and Terra Preta projects to gain knowledge on application and yield improvements. Market regulation and quality control can also help in creating a market-pull.

Mammo Bulbo

Mammo Beriso Bulbo is masters in Environmental Science and Engineering from Indian Institute of Technology Bombay in India. He is a lecturer in Water Supply and Environmental Engineering at Arba Minch University in Ethiopia. Currently, he is pursuing his PhD in Terra Preta sanitation technologies at Hamburg University of Technology, Germany. His main interests include: alternative water and sanitation technologies, decision support systems, rural community development projects, and international development cooperations.

Terra Preta application in Ethiopia

*Mammo Bulbo**

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The fact that the processes of Terra Preta Sanitation (TPS) are build on simple processes of fermentation and composting makes TPS an attractive sanitation concept to many parts of the world, especially low-income countries. However, one of the factors determining large-scale implementation of TPS is the availability of precursors of Terra Preta as: human urine, faeces, biomass waste, manure, bones, biochar, & process organisms. Moreover, a well-organized scheme for sanitation supply chain management is crucial. This paper addresses the question of availability of such precursors and organizational capacity in terms of sanitation supply chain management in Arba Minch - Ethiopia for large scale implementation of TPS.

Roland Wolf

Roland Wolf started early Terra-Preta Experiments in 2005 together with Harald Wedig, in whose forest garden in the Netherlands they investigated the improvement of very poor sandy soil through biologically activated biochar. Basing on the analysis of the components of indigenous Terra Preta by Prof. Bruno Glaser et alii, they very soon focussed on the creation of Terra Preta as result of an actively steered fermentation process. Both were inspired through their activities in the Permaculture-movement, that focusses on designing agricultural eco-systems, recycling of biomass and build up of soil fertility.

Roland Wolf carried out Terra-Preta experiments in Prof. Declan Kennedy's Permaculture Park in Lebensgarten Steyerberg from 2010 to 2012. Together with Robert Strauch he managed the installation and operation of Terra-Preta-dry-separation-toilets during the European Permaculture Conference 2012 in Escherode near Kassel for the „Permakultur Institut Deutschland e.V. “.

He gives workshops and produces Terra Preta in several projects near Duisburg.

Application of Fermented Urine for build up of Terra Preta Humus in a Permaculture Park and Social Impact on the Community Involved

Initial situation: The community gardenland at Lebensgarten Steyerberg has very poor sandy soil with no more than 20-25 ground points. Need of soil improvement was indicated.

Strategy: Humus build up through Terra Preta technology. Chaff rich in lignite was used as main source material. The chaff originated from forestry work within the park and was spread in a 25 meter long, 1,5-2 m wide and 60 cm high wall.

Challenge: The limiting resources, in order to start the composting process was lack of humidity (755 ml annual rainfall), nitrogen and humus building microbial soil life.

Solution: The remedy of choice for all three afore mentioned limiting factors was urine fermented with facultative anaerob soil microbes. Spread and fixation of nitrogen and phosphorus Inoculation with humus building soil microbes.

Effects on humification and nutrient fixation: The application of fermented urine on dry stacks consisting of lignin, biochar, loam and clay had the following beneficial effects:

Irrigation

Alltogether this enhanced the humification process. The build up of microbe population in the stack prevented climate damaging gas emissions. The lowest layer of chaff stayed dry and did not compost for several months after the application of fermented urine. This proved that neither water nor nutrients were leaking into ground water, while the upper layers were already in full humification process. After one year the terra preta heap had lost half its volume due to compaction and humification.

Implementation: Four members of the community were collecting their urine for the experiment. All were instructed in the technique of fermentation with lacto-fermentation and soil microbes.

The urine was collected and transported in closeable plastic buckets. Altogether 2m³ of fermented urine were applied to a stack of 25 m³.

Social impacts: The urine donators were motivated by saving flush water and getting ecological insights on the project. One couple's annual water bill went down 50 Euros.

The application of fermented urine for humus and terra preta production resulted in controversial feelings among the community members, ranging from enthousiasm to fear of being poisoned by human excrements, especially the negative reactions endangering the project as a whole.

Conclusion: Fermented urine is an effective agent enhancing microbial digestion of chaff stacks leading to build up of terra preta humus.

The application of fermented urine provokes strong emotions both pro and contra within the community envolved. In order not to jeopardize the project, public explanation and discussion before and during the project are indispensible.

All terra preta sanitation projects need good cultural and emotional design before technical implementation starts.

Providing 300 persons during a one-week open air conference with dry Terra Preta humus toilets

The European Permaculture Conference 2012 was held on a community site in Escherode, near Kassel in Germany. This open air convergence of about 300 participants had to be provided with sanitation for the duration of one week. The conference was run on the garden area of the community „gAstwerke“ that only provides sanitation systems with running water for a maximum of 30 people. A waterless, easy to construct solution for the remaining 270 people had to be found.

Ten dry humus toilets were built as a modular system from cheap building timber. One-hundred-and-twenty litre plastic waste bins on wheels were used as containers to receive the faeces. A mixture of pulverized charcoal from local fireplaces, local loam, wood chaff and bentonit was used for coverage and smell absorption. Lacto-fermentation microbes were added for hygienic purification.

Instructions on how to use the toilet and the litter for coverage of the faeces were displayed in every humus-toilet. Every bin was emptied twice during the two-week conference. A three-shift team of three people each to maintain and clean the toilets three times a day was organized.

The container bins were inoculated with purifying lacto fermentation microbes, in order to prevent the smell of ammonium. The content of the bins was used for Terra Preta production during and after the conference, in order to produce fertilizer for the garden site on which the conference took place.

In order to reduce the urine input into the dry humus toilet, urinals for men and seperate urinals for women were constructed, using old plastic canisters as material. A special female construction team was formed, using their gender specific experience for the design needs of women.

The urine was stored in a 1m3 container. Sugar and lacto-fermentation microbes were added for purification, in order to prevent the emergence of ammonium. The liquid was used as fertilizer on the fields later.

The feedback by participants was very positive, for they were used to much poorer sanitation standards during other comparable self organized open air conferences. Smell only occurred, when users failed to cover their feaces with the organic-mineral chaff mixture. Lacto-fermentation liquid proved to be very useful to improve hygiene. Due to a bottle neck in this aspect, the microbes were not always available sufficiently at peak times. Still, smell and unconveniance was very limited. The well organized maintenance team was the key to success.

Zifu Li

Dr. Zifu Li is a professor at the University of Science & Technology Beijing (USTB) since 2004. He is founder of Centre of Sustainable Environmental Sanitation and Director of China Node for Sustainable Sanitation, supported by SEI (Stockholm Environmental Institute). He studied for his Ph. D. at Hamburg University of Technology, Germany. After graduation he worked as Scientific Researcher at Institute of Urban Water Management, University of Duisburg-Essen, Germany. In last five years Prof. Dr. Li has also been involved in many international projects in the fields of sustainable sanitation, bio-energy (Biomass and Biogas), wastewater treatment with international organizations such as GIZ, SEI, ACF, ADB, BMGF, KfW, UNICEF, BORDA, etc. He is author of more than 80 research papers in refereed journals, book contributions and international conferences. He is an associate editor of Water Science and Technology and also a regular manuscript reviewer for more than 10 national and international journals such as Bio-resource Technology, Journal of Water, Sanitation and Hygiene for Development, International Journal of Green Energy, Frontiers of Environmental Science & Engineering, Journal of Environmental Science, etc.

Energy balance analysis on the pyrolysis process of animal manure

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Animal manure is inevitable by-products from the modern world, billions tons of manure were produced every year. The conventional processing for manure treatment is composting or anaerobic digestion, these processes almost always with a long processing time and uncontrollable problems, like odors and some health risks. Thermal chemical methods (e.g. pyrolysis and incineration) dealing with bio-waste are being developed in recent years. Pyrolysis is a thermochemical decomposition of organic material at elevated temperatures without the participation of oxygen, or with very limited air. Pyrolysis of biomass could recover bio-char, bio-oil, and non-condensable gases. A review of the literatures shows that, the land application of bio-char could enhance the carbon sequestration, and the pyrolysis process is a kind of technology of energy conversion, which makes the pyrolysis

technology attract growing research rapidly. A typical pyrolysis process chart for manure processing is shown, as the fresh manure normally has high moisture, a pre-treatment process to dry the raw material is needed. In this part, the bioenergy and /or solar energy could be the first choice of energy sources due to its low cost. As the energy flows of the pre-treatment part have great differences in different areas and the energy cost is very little compared with the followed pyrolysis process, therefore the energy consumption of the pre-treatment part is not considered in the energy analysis.

This paper gives an analysis on the energy balance of the animal manure pyrolysis process, which is based on the results from related references. The calculating results showed that, for pyrolysis process of water-free manure, the recovered energy value from all products (~15.3 MJ/kg) is much more than the process energy consumption (~1.2MJ/kg), which may also be used for fecal sludge treatment. In this mode, the heat value of the non-condensable gases is around 3 mega joule from 1 kilogram dry manure, which means the pyrolysis process could be run by burning the non-condensable gases without any need of additional fuel. Meanwhile, the bio-char and bio-oil could be collected as the by-product. Assuming that, the moisture of feedstock does not affect the pyrolysis process and characteristics of the products, the energy change with feedstock moisture. Q_{in} is the energy consumption of animal manure pyrolysis, Q_{out} is the recovered energy value from all products, Q_{raw} is the heat value of raw material, η is the unit energy yield, which equal to the net energy export from 1 MJ input heat value,

$$\eta = \frac{Q_{out} - Q_{in}}{Q_{raw}} \times 100\%$$

As can be seen, Q_{in} is positively correlated with increasing moisture (M), which can be described by linear function as: Q_{in}=7.7089M+1.1986. When the moisture of feedstock is 61.3%, the recovered energy value from all products is approximately equal to the process energy consumption. As the heat capacity of water is about three times as much dry matters, and extra energy demand is necessary by heating steam from 100℃ to 500~600℃. If the steam could be separated in the beginning phase of pyrolysis process, the thermal efficiency will be greatly improved. The calculating results show that, if all the steam is separated from the system at 150℃, the linear function is: Q_{in}=4.3369M+1.2023. When the recovered energy value from all products is approximately equal to the process energy consumption, the feedstock moisture could be 71.8%, which is 10.5% higher than the mentioned process without steam separation handling.

Edward Soméus

Edward Soméus is a Swedish environmental engineer and senior biochar scientist with core competence of organic waste added value recycling and valorization by pyrolysis, biochar S&T, and biochar industrial engineering with economical and ecological commercial applications. He is graduated in Natural and Environmental Sciences from the University of Lund in Sweden in 1978. Biochar S&T coordinator and key technology designer for the EU FP5, FP6, FP7 and CIP Ecoinnovation programmes since 2002. Combining high level of scientific knowledge with industrial engineering and field applications, specializing in the RTD, engineering, GVT legal permitting, industrial applications and implementation of biochar zero emission carbon refinery for recycling and reuse of carboniferous waste materials by integrated thermal/ biotechnological means. Specializing in the indirectly heated rotary kiln technique and auxiliary installations, such as bio-fuel refinery. Inventor of the 3R zero emission carbon refinery pyrolysis technology and biotech formulated biochar applications for soil improvements, biochar solid state fermentation and formulation.

Reducing mineral fertilisers and chemicals use in agriculture by recycling treated organic waste as compost and bio-char products Improvement of comprehensive bio-waste transformation and nutrient recovery treatment processes for production of combined natural products

Edward Someus / Terra Humana Ltd.

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Intensive farming practice and human activities have disturbed the natural cycles of nitrogen and phosphorus. Industrial agriculture relies on continual inputs of mined and non-renewable phosphorus and energy-intensive nitrogen supply. It is estimated that human activity has doubled the global amount of reactive nitrogen in circulation; while tripled the amount of phosphorus since the industrial revolution. There is a strong need for increased sustainability and closing the nutrient loop in agriculture with the creation of a virtuous cycle between urban and rural areas.

In this context, reducing the use of mineral fertilisers and chemicals in agriculture are key priority objectives that can be achieved by recycling and reusing treated organic waste as compost and biochar products.REFERTIL has the mission to contribute to the transformation of urban organic waste, food industrial by-products and farm organic residues from a costly disposal process into an income generating activity. This includes an EU-27 standardized, advanced, and comprehensive bio-waste treatment and nutrient recovery process towards zero emission performance. The REFERTIL project is about EU Commission science and technology support work for EU27 standardization and law harmonization of COMPOST and BIOCHAR technology and product, including advisory support to amendment of Waste framework Directive /End of Waste and the new fertilizer legislation under development.

The compost and biochar input feed materials may not compete with human food, animal feed or plant nutrition supply. The improved output products will be safe, economical and standardized compost and biochar products containing phosphorous and nitrogen that can be economically and beneficially used by farmers. As a result, both food and environmental safety is improved, while a new economy is generated. REFERTIL is an economical application and market oriented science, technology and policy development project.

Brian von Herzen

Carbon biowaste and excreta/synthesis gas technology for energy and char *production/Pyrolysis vs. hydrothermal carbonization*

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Two and a half billion people lack access to adequate sanitation today. The Climate Foundation is developing a scaled prototype biochar reactor for conversion of high-moisture human solid waste (HSW) to biochar without grid power or water. This scaled reactor is designed to serve communities of thousands of people each day. A Phase 1 reactor was designed, built and tested in 2012 to serve 100 users per day (100upd). It consisted of three nested shells and a carefully designed gas flow for efficient operation, and was capable of operation approaching 60% moisture content. A two-stage counterflow heat exchanger provided thermal recuperation of the incoming air while cooling the exhaust gases.

The report describes the 100upd biochar reactor design, report on the results, and plans to scale the reactor to >1000upd.

The Phase 1 reactor was tested and demonstrated at the US Biochar International (USBI) Conference in July, 2012 in Napa, California, and at the Reinvent the Toilet Fair at the Gates Foundation in August, 2012, with our partners Sanergy from Nairobi, Kenya. Sanergy is developing a waste processing pipeline in Nairobi, transforming urban HSW to fertilizer products, including sanitation collection units, processing centers and associated conveyance infrastructure, composting facilities, distribution pipeline for ready fertilizer products throughout Kenya. To this infrastructure our biochar reactor will add a biochar fertilizer substrate that dramatically reduces nutrient runoff, multiplying the efficacy of Sanergy's fertilizer amendment and facilitating long-lasting improvements to soils utilizing Sanergy's amendments.

Our biochar reactor is designed with flexibility in mind, including using a range of startup fuels. It can be started with waste biogas from Sanergy's existing digester system, and can transition to syngas from the biochar pyrolyzer after startup. Alternatively, biochar can provide kindling to reach operating temperature.

The biochar produced comprises a high-quality form of charcoal that can function as a fertilizer substrate.

Thomas Voss

Thomas Voss, born on April, 4th, 1984 in Meppen, Germany, is a scientific engineer for research and development at the Institute for Environmental Technology and Energy Economics, Hamburg University of Technology.

Wood gasification in parallel flow fixed bed gasifieres for combined energie and charcoal production
Experiences from six years of operation

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Gasification is a widely used, efficient and sustainable technology for energetic and material utilization of solid biomass. Based on six years of working experience coupled with a comprehensive analysis of input and output streams, the following study presents the operation of a 500 kW_{el} wood gasification plant. The gasification realized in two parallel flow fixed bed reactors is located in Landegge (Lower Saxony, Germany). The gasifiers generate an output of 250 kW_{el} and aprox. 100 Mg_{Coal} a^{-1} each by conversion of sustainably produced woodchips from surrounding forests. process with an output of. Beside a full plant description the following study gives an impression of efforts for operation and optimization executed since 2007.

Claudia vom Eyser

Claudia vom Eyser, M.Sc. was graduated in Water Science (University Duisburg-Essen, Germany) in 2011. Thereafter she started her Ph.D. thesis at the Institut für Energie- und Umwelttechnik e.V., Duisburg, Germany. Her research is focused on the behavior of pharmaceuticals and personal care products in the environment. In fact, behavior of these compounds during Hydrothermal Carbonization, a new treatment technology of wet wastes like sewage sludge, is investigated by LC-MS/ MS.

Product quality of hydrochar from sewage sludge in terms of micropollutants

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In times of growing population and climate change the application of hydrochar in agriculture has gained in importance as promising to reduce CO_2 emissions and enhance crop yields. Waste source material is profitable in the production of hydrochar because it is easily accessible and comparably cheap. In Hydrothermal Carbonization (HTC) the source material is converted to hydrochar in the presence of water at a temperature of 180-300 °C under saturated pressure within a few hours. The requirement of water makes it suitable for the application of sewage sludge, which is poorly dewaterable. Another advantage is the high load of nutrients like nitrogen and phosphor. However, there is growing concern about micropollutants in sewage sludge which are not removed during waste water treatment. As the detailed reaction mechanisms during HTC are largely unknown, the fate and behavior of micropollutants deserve investigation to assess the product quality of hydrochar from sewage sludge as a potential fertilizer .

In this study HPLC-MS/MS methods were built up to estimate selected pharmaceuticals, personal care products and perfluorinated compounds in sewage sludge and hydrochar.

The high content of various organic compounds makes analysis challenging, so a systematic sample preparation was deserved.

Matrix effects were investigated showing that absolute recoveries did not exceed 36 and 16% for sewage sludge and hydrochar, respectively, because of adsorption effects and ion suppression by co-eluting substances in the MS. A standard addition over the whole procedure was effective to compensate these effects.

Concentrations of pharmaceuticals could be reduced during hydrothermal carbonization. Diclofenac, phenazone and metoprolol were partly removed, while carbamazepine was not degraded at all. Propranolol and erythromycin were only detectable in sewage sludge.

HTC of sewage sludge seems to improve the product quality considering the concentrations of pharmaceuticals. However, complete removal is rarely achievable. Other substance classes like perfluorinated compounds are not affected by the HTC.

Therefore threshold values are needed to assure riskless application in agriculture. In future studies elution of micropollutants after agricultural application should be investigated. Also other compound classes like polyaromatic hydrocarbons (PAK) and polychlorinated dibenzodioxins and furans (PCDD/F) should be considered.

Gina Itchon

Gina S. Itchon is a medical doctor who strayed from the usual clinical career path physicians in the Philippines follow. She sees sanitation (and the lack of it) as the most important challenge in public health for her country. Her academic background includes degrees in Biology, Medicine, and Epidemiology. She currently holds the rank of Associate Professor at Xavier University in Cagayan de Oro City, Philippines. For the medical school, she chairs the Department of Preventive and Community Medicine and is the Director for Research. Since June 2013, she has also been appointed as the director of the Xavier University Sustainable Sanitation Center. She is a teacher of research to medical students and medical residents and a scientist whose diverse research interest is mostly focused on sustainable sanitation and water safety, but also includes other public health problems such as cervical cancer, tuberculosis, children's health, and disaster

The Effectivity of the Terra Preta Sanitation (TPS) Process in the Elimination of Parasite Eggs in Fecal Matter: A Field Trial of Terra Preta Sanitation in Mindanao, Philippines

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Earlier studies have shown that Ascaris lumbricoides ova persist in dried human feces from urine diverting dehydration toilets (UDDT) vaults even up to 10 months without secondary treatment. To address gaps in the knowledge for effective secondary treatment methods, this study aimed to determine the effects of a bacterial mix (obtained from Dr Jurgen Reckin) as a fermenting medium, in combination with charcoal (Terra Preta Sanitation process) on parasite egg reduction.

The study was conducted using twenty (20) UDDTs in Lumbia, Cagayan de Oro City, in Mindanao, Philippines. The users of 10 UDDT toilets were told to add powdered charcoal and 20 ml of the bacterial mix after using their toilets for defecation, while owners of 10 different toilets were told to just add charcoal after defecation. The study was conducted for three (3) months after which the collected feces from all the UDDT toilets were collected, stored for another 3 months, and were then vermicomposted separately for six (6) weeks.

Results showed that after 3 months of undergoing the TPS process (addition of powdered charcoal and bacterial fermenting mix), fecal material was virtually free of parasite eggs, especially that of Ascaris lumbricoides which proved to be very difficult to eradicate in earlier studies, when compared to fecal material to which only charcoal was added. Nitrogen, Phosphorus and Potassium (NPK) values for both experimental groups were also comparable after undergoing vermicomposting.

Therefore, the TPS process is an effective secondary treatment method for eliminating pathogenic bacteria and parasite eggs in a country with a tropical climate like the Philippines. It is capable of rendering feces safe for reuse in a shorter time compared to just drying or using no secondary treatment. This is of particular importance in developing countries like the Philippines where the parasite load in the population is extremely high. Furthermore, NPK values after vermicomposting showed that there is no significant difference between the two experimental groups.

It is therefore recommended that the TPS process be used as a secondary treatment method for faeces collected from UDDT toilets particularly in countries like the Philippines, with a tropical climate and where re-use of faeces poses a risk to health and hygiene because of a high parasite load in the population.

Hendrick Scheinemann

PhD student, University of Leipzig, veterinarian faculty, institute of bacteriology and mycology. Topic: „Untersuchung zur Hygienisierung von Kuhdung und Klärschlamm mittels anaerober Fermentation für die Herstellung einer anthropogenen „Schwarzerde“. – Hygienisation and nutrient conservation of sewage sludge and cattle manure by fermentation. 2009:Biologist diploma thesis at the University of Potsdam Topic: „Abbau von Antibiotika der Penicillinfamilie durch Bodenbakterien“ – Degradation of penicillin-antibiotics by bacteria isolated from soil.

Hygienisation and nutrient conservation of sewage sludge or cattle manure by fermentation.

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Due to the current review process by a scientific journal this short abstract cannot provide any printed specific data. This much can be said: Lactic acid fermentation of faecal matrices does have a high influence on the native microorganism flora. It shifts highly significant from health threatening to a much less critical one. Bacterial, viral and parasitic pathogens were degraded within a few days to a few weeks under lab conditions. This could be a very interesting technique for sewage sludge or manure treatment not only for hygienic reasons but also because of the matter loss is drastically reduced compared to composting. The gained fertilizer can help to improve a closed loop recycling management while destroying cycles of infection.

Asrat Yemaneh

Asrat Yemaneh did his BSc. in Civil Engineering and his MSc. in Environmental Engineering. Currently he is doing PhD research at Hamburg University of Technology, Institute of Wastewater Management and Water Protection.

Investigation of Low-Cost Sugar Supplement for Lactic Acid Fermentation of Human Excreta in Terra Preta Sanitation System

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Terra Preta Sanitation (TPS) is a sanitation system which combines biological treatment processes, lactic acid fermentation (LAF) and vermicomposting, for transforming human excreta to pathogen free humus which is rich in nutrients and organic matter. LAF has been widely applied for preservation of foods and disinfection of various organic wastes. In TPS LAF is used during collection of human excreta in toilets for suppressing odour, pathogen reduction and conservation of nutrients and organic matter. For LAF process the sugar content of the substrate is particularly crucial, as sugars constitute the growth limiting substrate for lactic acid bacteria (LAB). Although, the composition of human excreta varies strongly with diet, climate and state of health of the persons, the amount of simple sugar excreted is negligible to support the growth of LAB for the fermentation process. Prior study also indicated that addition of simple sugar supplement is necessary to establish good LAF process in human faecal matter. It is very important to find easily accessible low-cost sugar sources for the LAF phase of TPS for sustainable application of the system. Kitchen biowaste can be one alternative sugar sources for the LAF process in TPS. It is a nutrient rich resource which is available in every household. In this study the suitability of kitchen biowaste as low-cost sugar supplement for LAF of human faecal matter is studied. For comparison molasses in varying quantities is also used as sugar supplement.

Batch laboratoryscale experiments are conducted with the addition of grinded, raw and pre-treated, kitchen biowaste to faecal matter.

As per the findings of a prior study mixed culture of three LAB strains, Lactobacillus Plantarum, Lactobacillus Casei and Pediococcus Acidilactici, is used as inoculum for the fermentation experiments. The fermentation process is monitored by measuring rate of pH and lactic acid concentration. Microbial analysis on E-Coli and total coliform, as sanitation indicator bacteria, is conducted to evaluate the hygienization effect of the LAF process. Parameters for nutrient and organic matter are analyzed to investigate the conservation effects. Also sensory evaluation of odour is made during the fermentation period. For experimental studies with addition of LAB inoculant and molasses in quantities of 0%, 2%, 5%, 10%, 15% and 20% (by weight), proper LAF process is established in variants where there is more than 5% molasses added. There is more organic matter degradation in 5% molasses supplement compared to higher molasses addition. With respect to the nutrients there is no significant variation for treatments above 5% molasses addition, although reactor with 5% molasses showed relatively higher ammonium concentration compared to the reactors with higher molasses additions. There are no detectable E-Coli and total coliform bacteria after three weeks fermentation period for treatments with 5% and more molasses addition with LAB inoculant. For experiment with 10% molasses addition fast rate of reduction of the sanitation indicator bacteria is observed. From fermentation studies on other organic wastes, it is established that the hygienization effect of LAF process is related to the lowering of the pH in the system, production of lactic acid which is sterilizing compound and also production of bacteriocins, which are antimicrobial compounds that are toxic to other microorganisms. In the experiments with 10% molasses the pH of the system is lowered to below 4 and final lactic acid concentration of more than 2.5% (by weight) is measured after the third day of fermentation, both of which is believed to have contributed to the fast reduction of sanitation indicator bacteria. For experiments on LAF of faecal matter with addition of LAB inoculant and 50% kitchen biowaste (by weight) as sugar supplement, final pH of less than 4 and lactic acid concentration of more than 2.5% (by weight) was measured at the end of three weeks fermentation period. Analytical measurements of nutrient and organic matter parameters indicated conservation effects of the LAF process. There is reduction in pathogen indicator bacteria during fermentation for both treatments with raw and pre-treated kitchen waste.

However, pre-treatment of kitchen waste by fermenting it with the addition of LAB inoculant prior to addition to faecal matter is found to be more efficient in lowering the pH at fast rate and resulted in fast rate of reduction of sanitation indicator bacteria. Sensory evaluation of the fermentation process has indicated that for all treatments with 5% and higher molasses addition, and also with 50% kitchen biowaste addition, objectionable odour of the faecal matter is suppressed and is replaced by acidic smell. The reduction in smell is associated with the destruction of microorganisms responsible for decompositions which may produce offensive odour. Also, formation of volatile fatty acids (VFAs), which constitute most of the objectionable odour in faecal matter, is inhibited by the LAF process. The results of this experimental study indicate that LAF process plays very useful role in dry toilet sanitation with respect to odour suppression, pathogen reduction and conserving nutrients and organic matter. It is demonstrated that kitchen biowaste can be low cost sugar supplement for the fermentation process. Combining collection of human excreta with organic kitchen biowaste will have further advantage of enabling the planning of more integrated and efficient waste management system with ultimate goal of sustainably improving soils. Future research will focus on experimental studies to establish the kinetic behavior of the LAF process.

Markus Stöckl

Markus Stöckl studied Water-Science (B.Sc. & M.Sc.) at the University of Duisburg-Essen. He made his Master thesis at the TUHH, with the focus on both, hygienisation and nutrient balances of the TPS process.
Research focus is on environmental protection and renewable energy sources.

Assessment of hygienisation of faecal matter during terra preta inspired vermicomposting by qualitative identification of *Salmonella* spec.

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Conserved faecal matter was combined with organic waste of different origins and biochar. 5 piles were filled in different ratios and *Eisena foetida* was added. 4 samples were taken analysed for *Salmonella*. Temperature inside the piles was monitored. After 88 days of composting, *Salmonella enterica* subsp. *enterica* serotype London (*S.* London) were found in every sample of 4 of 5 piles. In one pile, with a maximum temperature of 58.4 °C in the initial thermal phase of the composting process, *Salmonella* were absent. Thermal hygienisation was more effective to eliminate *Salmonella* than the digestion by the worms.

As additional experiment, the tolerance of the isolated *S.* London to low pH was observed. In a short-term (24 h) experiment *S.* London was found to grow in media with a pH below 5. At a pH of 4 or lower no growth was observed. However, with longer incubation time (5 d) in a medium with pH 4, the *Salmonella* strain was found to pick up growth after 48 hours. It was concluded, that for a successful elimination of *Salmonella* in liquid growth medium, pH has to be kept lower than 4.

Both Salmonella and Enterobacteriaceae were analysed to indicate hygienisation of the material during vermicomposting. Product assessment was conducted after 88 days of vermicomposting under environmental conditions. Mass balances for total solids (TS), total volatile solids (VS), nitrogen and phosphorus were conducted, as well as a heavy metal screen and the determination of the degree of rotting (AT_4). Both Salmonella and Enterobacteriaceae were analysed to indicate hygienisation of the material during vermicomposting.

The average losses for TS were 25 % and 40 % for the VS. Neither the percentage of biochar nor the inoculation of microorganisms showed a significant effect on the mass balances TS and oTS. Same applied for nitrogen and phosphorus. According to the degree of rotting, products can be declared as mature compost. Enterobacteriaceae were found in all products with a concentration around 10^5 cfu per g fresh material. Salmonella spp. was found in 4 of 5 products. A temperature of 58 °C within the thermal phase of the composting process was evaluated as reason for the absence of Salmonella in this product.

By the vermicomposting of faecal matter and organic waste with the addition of biochar, a soil enhancing product was achieved. However, hygienisation of the material was not complete after 88 days of vermicomposting.

Andreas Walter

Microbial communities in charcoal and microbe amended composts

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Increasing population and economic growth have lead to an expanding amount of organic waste and a decreasing availability of resources. The recycling and processing of biodegradable materials to produce efficient fertilisers for agriculture is an excellent example of an effective approach to organic waste management. Former civilisations used a mixture of charcoal, organic matter and clay or clay fragments to produce a black soil (Terra Preta), which kept productive for thousands of years. Compost mixes with charcoal should mimic this formation of Terra Preta. The aim of this project was to study the bacterial community of composts that were prepared with 10% charcoal amendment and were either pro essed without inoculum, or with an inoculum of Effective Microorganisms® (EM) and an in-house mix of microorganisms (RM) (Table 1). The sampling was done on days 33 and 88 of the composting process, and the analyses with the COMPOCHIP microarray were done in triplicate.

Prayatni Soewondo

Prayatni Soewondo is a professor of environmental engineering at the Faculty of Civil and Environmental Engineering, Bandung Institut of Technology (ITB) in Indonesia. She has been Head of the Water and Wastewater Research Group. She won her doctorate in environmental engineering at TU Berlin for research on aerobic and anaerobic treatment of textile wastewater.
Prof.Dr-Ing.Prayatni Soewondo focus her research on domestic wastewater treatment including wastewater from small scale industry (home industry) that common in Indonesia. Her commitment make her become one of expert in domestic wastewater treatment , especially in Indonesia Public Works Ministry that coordinate and responsible for developing and making policy about infrastructure including sanitation system in Indonesia.

Feces Treatment By Lactofermentation Process and Future Perspectives of Terra Preta Sanitation Concept in Indonesia

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Beside wasteful water and energy use, disposal system which is commonly used nowadays is expensive in construction and infrastructure. In Indonesia, centralised wastewater treatment only cover about 3 % of population. Feces treatment mainly rely on onsite treatment with septic tank. It has pushed hygienic risk when disposal and transport the feces through sludge (feces) treatment plant. Besides that, the odor problem arising in connection with feces cause handling of it always ignored. Most of the sludge treatment plants in Indonesia do not work properly. This is due to the influent flows discontinued in addition to the existing treatment has not yet optimal. Then, it is important to look for another methodology of treatment like TPS concept. Lactofermentation process for feces treatment that is introduced by Terra Preta Sanitation (TPS) system brings a new direction for hygienization of feces before treatment.

Lactofermentation process produces several kinds of acid which will lower the pH value in feces and produce compounds that can inhibit pathogenic microorganisms' growth .

This study was conducted in four 2,5 L capacity reactors to find out the feasibility of lactofermentation process in feces sample. The study was consist of three parts, the first stage is conducted using sample in slurry phase with fresh feces sample and mixing water ratio of 35 gram : 1000 mL, second stage using sample in slurry phase with fresh feces sample and mixing water ratio of 35 gram : 350 mL, and the third stage is conducted using fresh feces sample without addition of mixing water. In the first and second stages, fresh feces sample is converted into slurry form with moisture content that represents flushing water use in Indonesia. In the second stage,the fresh sample were collected separately from urine and not converted into a slurry phase to represent the conditions on dry toilet where the amount of flushing water is minimum. Each of stage is conducted in 3 weeks in room temperature. Test performed to determined sample characterization parameters such as pH, moisture content, volatile solid, organic carbon, NTK, and P total. After characterization process completed, the next stage is the primary research. In each stage, fecal samples will be processed by varying the concentration of glucose that used as carbon source. Variations of glucose concentration are 0%, 5% and 10%. A reactor consist of sample without addition of glucose and innoculant was used as control for each stage. Effective Microorganism (EM4) that commonly used in Indonesia are used as innoculant source and glucose was used as soluble carbon source.

First stage experiment results shown that lactofermentation process can be used as method for feces treatment without causing odor problems and also reducing patogenic bacteria. EM4 addition help decreasing pH value and provide suitable condition for lactofermentation process. Lower pH resulted in the reduction of NTK (33,33%), organic carbon (50%), H_2S (37,5%), and increasing of NH_4^+-N (82,1%). Combination of soluble carbon source and EM_4 also resulted in the reduction of three patogenic bacteria indicator, E.coli, Salmonella sp., and Shigella sp. by 9,36%, 9,99%, and 9,96% respectively

E .M.Abd El Lateef

Dr. Ezzat Mohamed Abd El-Lateef graduated with Ph.D. in Agricultural Science (Agronomy) and is currently head of the field crops research department. His general field is Sludge & Wastewater Reuse in field crop production ,Agronomy.

Plant and Soil interactions under Long term Sewage Irrigated Soils A Case Study

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As part of a four year study evaluating the practicability and value of sewage sludge use in Egypt, soil and plant surveys were carried out on a citrus plantation, irrigated with Cairo sewage since the 1920s, in order to evaluate the long-term accumulation of trace elements and heavy metals and their bioavailability. While total and DTPA soil concentrations correlated well, no relationship could be found between soil and plant tissue concentrations, despite elevated levels of heavy metals in the soil. study of long-term contamination of soil with PTEs has not demonstrated a potential risk to crop quality and yield or human health from the slow accumulation of potentially toxic elements (PTEs) in sludge-treated agricultural soil. PTE concentrations in plant tissues remained low and within normal ranges despite significant increases in soil content after long-term irrigation with sewage effluent. Concentrations of PTEs in plant tissues were not related to total or DTPA extractable metals in contaminated soil. DTPA may not be a sufficiently reliable indicator of actual phytoavailability of trace elements in sludge-treated soil, although it is accepted that DTPA is widely used in nutrient diagnosis assessment. These data provide assurance about the minimal risk to the environment from trace elements and PTEs in sludge-treated agricultural soil, but a more detailed dietary analysis of Cd intakes under Egyptian conditions is recommended, following the approaches adopted in the UK and US for setting Cd soil limits or loading rates for this element.

Torsten Bettendorf

Conversion of fecal matter and organic waste – *a comparison of thermal- and vermicomposting*

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Separated faecal matter (FM) can contribute to produce a highly fertile soil amender. In a public toilet at Hamburg central station a wet Terra Preta Sanitation System was installed recently: Under usage of low flush toilets faecal matter is separed by an interceptor with mesh and a screw. During collection the sludge is charged with fine charcoal. In three month of operation faecal matter was collected and pre-fermented by the addition of liquid Effective Microorganisms®.

This paper presents two experimental set ups for the conversion into soil enhancer by vermi- and thermal composting, results regarding temperature development and characteristics of raw material and products. After three month of storage and pre-fermentation the FM was analysed and co-composted in a mixture of biochar, sliced wood, lawn grass cutting and overlaid fruits and vegetables. The analysis of raw materials showed a wide variation in physical-chemical parameter. By mixing the raw materials the C to N ratio and water content were improved and efficient composting could be conducted. During thermal composting a temperature maximum of 66°C was achieved, whereas heat development was widely suppressed within vermicomposting. At the same time it was shown that in the vermicomposting set up nutrients were widely preserved, whereas in thermal composting remarkable nitrogen emissions via the gas phase were observed.

Amon Lukhele

Amon Lukhele is the Executive Director of Outreach Scout Foundation a local Malawian non profit making Registered Organisation. He is a graduate from Bunda College of Agriculture with Masters Degree majoring Community Development, Irrigation Engineering and many others.
He has experience in managing the following projects in Malawi;
- Improving Access to Safe Drinking Water and Food Security project funded by Canada Government 2004-2006
- Elections projects funded GTZ-Forum for Dialogue and Peace 2009-2010
- Water Sanitation for Icelandic International Agency partnership project 2006-2008
- Women Economic Empowerment funded by Royal Norwegian Embassy/ NGO Gender Coordination Network Programme 2012 -2015.
He has received several Awards e.g. Gender SADC Protocol Awards on Economic Development May 2013 in South Africa.

Waste Management and Renewable Energies Production

Amon Lukhele

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The Universal Declaration of Human Rights, 1948, Article 25 states that "Everyone has the right to a standard of living adequate for the health and well-being of himself and his family".

Most households do not demonstrate safe hygiene practices with 75% of households indicating having soap in their houses but only 45% claimed to use soap for hand washing at critical times and that 35% washed hands after using the latrine and less than 10% before feeding or cooking. Safe hygiene practices remains low leading to high prevalence of water and sanitation related diseases contributing to poor health, loss of productivity and exacerbation of poverty. Child Mortality Rate (CMR) is very high in Malawi estimated at 122/1000, which is attributed to mainly diarrhoeal diseases.

It is also estimated that 35% of the primary schools do not have improved sanitary facilities and that the average ratio of pupil to latrine remains quite high at 144 pupils to one unit compared to the recommended 60 pupils per one unit. It also estimated that 77% of all schools in Malawi do not have accepted sanitation facilities and that only 33% have basic sanitation facilities on site.

Lilongwe, a city of 2.2 million growing by 4.4%/year, has developed a sewage, solid waste and sanitation problem. Garbage is disposed of in city streets, open land-fills and unauthorized areas and raw sewage in returned to local fresh water sources untreated, thus posing a potentially catastrophic health risk.

Aim is:

- To provide City and town Councils a comprehensive waste management, water purification and sustainable energy production system that can be operated by Malawian technicians, business people and academic institutions.
- To establish the technological and educational infrastructure by 2015 that can be expanded for Malawi to be come energy independent by the year 2020.

Result:

Anaerobic digestion of the sewage will convert the water borne garbage to biomass fertilizer, semi-purified water and methane gas, which is a sustainable fuel by-product.

Conclusion:

We intend to create an integrated, City and Town Councils-wide system that manages waste through the following technologies:

- Consumes organic wastes (waterborne and others) and produces biogas (methane) and water as a byproduct.
- Separation of non degradable substances for recycling (plastics, rubber, glass, metals etc.)

Further more the government of Malawi will reduce its budget allocated for curing water borne diseases such as cholera. The biogas produced from the process will benefit the population at the household level; agriculture sector will benefit fertilizer recycled from garbage. Private companies will benefit from recycled plastics.

Suman K. Shakya

Dr. Suman K. Shakya, Executive Director of Environment and Public Health Organization (ENPHO) has both Academic and Community Development Experiences in Nepal with over 22 years. Dr. Shakya holds Ph. D. in Applied Natural Science from University of Agricultural Sciences, Dept. of Hydrobiology, Dept. for Sanitary Engineering and Water Pollution Control, Vienna, Austria in 2000, and has acquired extensive experience in the field of Environmental Research study, Climate change, Energy & Food security, Point of use drinking water treatment initiatives, WASH and Emergency, Community Management, Capacity building, Awareness generation, Networking & advocacy and NGO experts. He has been involving in Environmental research study and Community development activities since 1992. He has in depth knowledge on Environmental Management and Sustainable Development practices with empowerment of civil society voices in Decentralize Waste Water Treatment Systems (DEWATS), Water, Sanitation and Hygiene (WASH) sector in Nepal and abroad. He has strong knowledge on Knowledge management, advocacy and networking of issues related to WASH cluster.

Dr. Shakya is Member of Fresh Water Action South Asia, National WASH Cluster, NGO Forum for Urban Water & Sanitation, Resource Center Network of Nepal, Environment and Public Health Organization, National Drinking Water Quality Steering Committee and National Sanitation Steering Committee. Dr. Shakya is also associating as a lecturer in School of Environmental Science and Management of Pokhara University of Nepal.

Ecological Sanitation an Ecosystem Approach to Excreta in Nepal

Dr. Suman K. Shakya, Executive Director

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We witness the degrading condition of our once clean ritual importance rivers. Today these rivers are nothing more than big open sewers. We are polluting our surface water and ground water. The different water sources are full of organic loads and chemicals.

A great volume of drinking water is spent only to flush our toilets that in turn add up the waste volume. This is mainly due to conventional human sanitation systems. Both pit and flush sanitation systems do not work efficiently causing lots of seepage and overflow problems that adverse the natural condition. We are generating much more wastewater than we can manage and not treating our wastewater before its disposal at the safest level. The result: ill human environment and water crisis.

Ecological sanitation is an ecosystem approach to excreta disposal that can be defined as a system, which prevents diseases, protects the environment, conserves waste, recovers and recycles nutrients and organic matter. After the series of research and pilot program the few households in peri-urban areas of Nepal have been practicing ecosan toilets. They are familiar and easy with this practice. Till date more than 2000 ecosan toilets are constructed in Nepal. It has an attempt made to improve the sanitary condition of the community and acknowledge the inhabitants to follow sound sanitation practices. The source based sanitation facility minimized the cost for construction and operation. It cut offs the use of water to flush toilets as it is for conventional system. In that respect, ecosan is a sort of dry toilets. Water is used only to clean anus and washing hands thereafter. This paper argues that Nepal's historical acceptance of ecological sanitation, and its recent experience in using the approach-set out in the evidence presented here-mean that ecological sanitation could be very valuable. It could contort these problems and provide potential added value to the livelihood link through agricultural production and water and environment conservation. This paper highlights acceptance and use related issues, lessons learned and challenges experienced for scaling up.

Pervin Saygın

Pervin Saygin graduated from Hacı Fahri Zümbül Anatolian High School in 2006. She received her undergraduate degree in Chemical Engineering from Faculty of Chemical and Metallurgical Engineering at Istanbul Technical University. Her master degree in Chemical Engineering she received from Istanbul Technical University. The master's thesis is related to ''The Investigation of Different Disinfection Methods for Recovery of Household Greywater''. It is also shared at International Conference on Environmental Science and Technology (ICOEST Cappadocia 2013). She continued her study Ph.D degree in Materials Science and Engineering Ph.D Programme from Advanced Technologies Department at Istanbul Technical University.

The Effects of UV and Ozone Treatments on Microbiological Disinfection of Household Greywater

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As water is one of vital necessities for human life, water scarcity will result in loss of sanitization quality which will cause health problems, diseases and even death cases. On the other hand, due to the increase of urbanization, population growth and global climate change; decrease of water resources has turned into a serious threat for daily life. As a precaution for the risk of water scarcity, recent researches have been focused on water saving, recovery systems and greywater utilization on both academic and industrial studies. According to such studies, UV radiation and ozone disinfection can be a solution for the recycle of domestic drain water especially from washing processes, bath water and kitchen.

The main aim of this study is to compare the disinfection performance of two methods; UV radiation and ozone, and propose a procedure for the recovery of domestic drain water. In the presented study, the effect of UV and ozone disinfection methods on the survival of opportunistic pathogens which are Staphylococcus aureus, Enterococcus feacelis, Bacillus cereus, Aspergillus niger in the domestic drain water solution was evaluated.

In this experimental research, the reduction effect of UV radiation is investigated for two different power UV sources as a function of time. 5W and 11W UV sources were tested during 1 h circulation of the microbially contaminated 5 liter water. Ozone treatments were also conducted on an experimental set-up for the inactivation of microorganisms in 1 liter water solution by 0.2 liter/minute ozone gas flow ratio during 30 minute.

The performance of disinfection methods was determined by classical microbiology analysis methods where total aerobic and specific agar plates were used. Amount of microbial cells in the analyzed samples are given in the following graphics for each microorganism and method as a function time. Comparison of the test results shows that higher the UV radiation power, the treatment provides higher inactivation of all kinds of test microorganism depending on the power of UV source. According to ozone test results, reduction of over 4 log is achieved for S. aureus, E. feacelis and B. cereus even in 5 minutes. On the other hand, the results show that ozone does not have a significant effect on A. niger in the test conditions.

Ramin Niknam

Ramin Niknam is a irrigation specialized engineer of Ghods-niroo Engineering Co, a very big company with more than 1000 experts working on enormous projects in the fields of water, electricity, oil, gas, etc in Iran. He graduated in M. Sc of Irrigation and Drainage Engineering from Tarbiat Modares University, one of the high ranked universities in the Middle East. Besides he is working on several applied water resources projects. Before he worked on many scientific researches published in Farsi and English Journals.

Application of Treated Urban Wastewater Considering Environmental and Economical Aspects

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The purpose of this paper was to study the different applications of treated wastewater from an urban area. Four different applications including agriculture, industry, recreation and artificial recharge were considered. The local and international criteria of water chemical parameters based on risk to environment and human health were used to assess the suitable usage of the treated wastewater. Kerman city in Iran was selected as case study. The quality of wastewater plant effluent was compared with the national and international standards. Agriculture and groundwater artificial recharge were selected as feasible applicable sectors for the study. Considering the regional climate and soil conditions, pistachio was recommended to be irrigated by the treated wastewater. In addition, the high return from pistachio production gives a high economical value to the treated wastewater. Applications of the treated wastewater in recreational areas were not considered due to risk to human health factors and limited application was identified with regard to industrial usage. Artificial recharge was also considered a potential applicable sector of the treated waste water effluents. Residual value method was used to calculate the economic value of the treated wastewater and it was 0.97 dollars per cubic meters for the selected case study which is relatively high in the study area.

Rostom Gamisonia

Director of Non-governmental organization Rural Communities Development Agency (RCDA)
Doctor in agrarian economics
Major activities focused on utilization of biomass resources, water and sanitation, use of ecosan products in agriculture.

Sustainable Sanitation in Rural and Peri-urban Areas of Georgia– Including Agriculture and Energy

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In Georgia productivity of some lands has declined by 30% due to soil erosion and desertification. In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity. These are very real and at times severe issues.

The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species. Degraded lands are also often less able to hold onto water, which worsens flooding. Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation and erosion and the loss of valuable land to desertification. The success in these villages is instigated first of all by setting-up a Service Center in the village which provides the services – advice, construction, operation and maintenance. People have the choice of different UDDT designs, a concrete UDDT toilet seat, slabs made of tiles, and even a ceramic UDDT seat is available. E.g. in the villages Khamiskuri and Kheta in Western Georgia the toilet design was more and more improved and adapted to make the UDDT more affordable for even the most poor people.

The design as you see in the picture is now the favorite and cheapest as one can convert the pit latrine into a UDDT attached to the house.

The second factor is the link to gardening and agriculture so that the villagers are informed about how to make Terra Preta using the toilet products – sanitized urine and faecal matter, charcoal, organic waste, shreddered wood in their garden for subsistence agriculture. The villagers have started production of Terra Preta at small scale.Terra Preta is a treatment similar to composting which is an anaerobic lacto-fermenting process. It requires the addition of charcoal and shreddered wood and can be done on low tech level. It produces a high qualtiy humus rich dark soil which is a long-lasting nutrient donor in agriculture, leading to an improved soil productivity and increased crop production. Food security is being increased with a fertilizer that is readily available for all regardless of infrastructure and economic resources. In addition the service center provides access of rural people to the solar dryers where the fruits grown using the organic fertilizers (Terra Preta, urine and faecal compost) is dried and sold at the markets. Solar driers represent an affordable opportunity for local households, to generate additional incomes.

The third factor is the link to energy in terms of solar collectors and biomass dry distillation. The service center also supports the construction of solar collectors for warm water and biomass dry distillation device for the households built with local material. People appreciate very much to have a full bathroom including a UDDT and a shower with warm water from solar hot water collector integrated with UDDT. The greywater is treated in a simple soil filter and infiltrated into the ground.

Anara Choitonbaeva

Anara is the chair of the Kyrgyz Alliance for Water and Sanitation (KAWS). Socio-economist by background, she supports rural communities in planning, implementation and sustainable monitoring of improved rural water supply and ecological sanitation since many years.

Upscaling resource oriented sanitation in rural areas of Kyrgyzstan

Anara Choitonbaeva, Kyrgyz Alliance for Water and Sanitation
Aizhamal Bakashova, ALGA; Fedde Jorritsma, free lancer
Claudia Wendland, WECF

The urine diverting dry toilet (UDDT) or ecosan toilet is an innovative technology which can be implemented inside the house or attached to the house. The ecosan toilet does not need water for flushing, neither smells nor attracts flies. Urine diverting toilets do not mix urine and faeces by using a separating toilet seat. Urine is collected and stored in a reservoir which is commonly a recycling container of 500 l applied in Kyrgyzstan. Faeces, which are collected underneath the toilet, must be directly covered by dry materials such as saw dust, soil or ashes or a mixture of those. The toilet products – urine and faecal compost – can be used as organic fertiliser. Urine is an excellent liquid fertiliser containing nitrogen, phosphorus, potassium and many micronutrients.

The rural population of Issyk Kul region in Kyrgyzstan are very enthusiastic of the fertlilizing effect of urine and faecal matter. Field tests with onions, carrots, potatoes showed that the fertilised plant (with urine) grow faster, develop more leaves, produce higher yields and is more resistant against pests. The challenge is the safe application of urine and faecal compost which requires some basic hygienic agricultural considerations (acc. to WHO guidelines 2006) so that there is not again the spread of disease.

In 9 villages in Issyk Kul region, enabling frame conditions for upscaling ecosan toilets through resource centers and demonstrations have been set and now the feasibility for upscaling was investigated in a cost benefit assessment study which is still in progress. The results of the study will be presented on the conference.

Meeting of working Group "Food Security and Productive Sanitation Systems" of the Sustainable Sanitation Alliance (SuSanA)

Food security and the access to safe water and sanitation are fundamental human rights that for many people remain a promise unfulfilled. If current trends continue the targets set by the Millennium Development Goals - to halve the proportion of people suffering from hunger and to half the proportion of people without access to basic sanitation by 2015 - are likely not to be met. A great deal of the population growth will take place in urban areas with a substantial increase in urban food demand and consequently in the volume of organic waste, human excreta and wastewater to be managed in a safe and preferably productive way. Facing the number of people to be fed and the existing natural limitations on earth, it appears reasonable and inevitable to approach the food security issue from a perspective of resource preservation and recovery, in which productive sanitation systems play a key role.

Productive sanitation is a general term used for the variety of sanitation system solutions that aim at making productive use of the nutrient, organic matter, water or energy content of human excreta and wastewater in agricultural production and aquaculture. It should allow for the recovery of nutrients and/or energy in household wastewater, minimise consumption and pollution of water resources and support the conservation of soil structure as well as agricultural productivity and thereby contribute to food security.

The SuSanA working group 5 aims to raise awareness for the reuse-oriented sustainable sanitation approach, its prospective contribution to global food security and to promote this approach on a large scale. The group aims at bringing together all relevant organisations with global competence in agriculture (e.g. soil fertility, irrigation), sustainable sanitation and neighbouring disciplines, which are not yet fully involved in the sanitation discussions.

As Terra Preta Sanitation (TPS) can be seen as one of the most promising, innovative approaches in the sector to deal with excreta in a pedogenic and agriculturally productive way, the SuSanA working group 5 is offering to provide a permanent platform - also beyond the TPS conference - to discuss latest TPS trends, developments and potential bottlenecks and how TPS can influence and be further promoted within the wider SuSanA community.

All interested participants of the conference, TPS pioneers and those already active in the working group are invited to take part in the working group meeting (Friday, August 30, 09:00-10:30, Room N0008, N-Building) to discuss future collaboration, next steps and potential deliverables of the working group.