Integrating Sanitation, Bio-waste, Energy and Agriculture: Terra Preta

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aww
Institute of Wastewater Management and Water Protection
City

- Water
- Food
- Energy
- Wastewater
- Solid waste

LIVING Humus Soils
Water Key Issues: Soil 1st!
- Humus rich soil Soil has a very high water uptake, cleans it, stores it, keeps moisture for plants
- Rainwater Harvesting and Reuse,
- How to convert dryland to green land

Innovative Sanitation
- Pollution to be avoided at the source: Water Protection
- Efficiency of water utilisation: irrigation, households
- Blackwater Loop: Sanitation as fertiliser and humus factory
- Terra Preta Sanitation

Energy - Water - Soil
Woodgas stoves and power/cooling/charcoal production for Terra Preta Composting of biomass

Conclusions
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Conclusions
Loss of Soil Fertility (slow but dramatic, global scale) counteraction is THE key issue for a good future for Many including Climate Change (Map from WWW.FAO.ORG)

Philipppe Rekacewicz, UNEP/GRID-Arendal
The World has lost ONE THIRD of all fertile soils between 1950 and 1990

UN Millenium Ecosystem Assessment Report
Industrial agriculture tends to destroy humus in the long run, what will likely cause starvation for billions of people. "Bio-Energy" is often causing soil destoriation, can create water pollution and less food production.
Good Soil can retain and regenerate water

Must See: lessons of the loess plateau, John D. Liu
Good Soil prevents drought and flooding
Lost your good soil around?
Rainwater Harvesting

Many techniques to supply rainwater collected from surfaces (roofs, ground surface, rock surface) for domestic or agricultural use.

Three main components:
- Catchment area
- Storage / reservoir
- Delivery system

However, before you start look for the overall situation (looking for the overall situation, deliberate or accidental). Forests, ground vegetation, uncontrolled or unplanned community groups.

Legal situation: soil quality, logging, stakeholding, sustainability, soil erosion, slope, topography. How does it look before you start?
Stopping Erosion in Ethiopia, Konso hill slopes turn productive waterstorage, March 2012
Check dams for erosion prevention

capture soil and water

from: Dying Wisdom, Indias Traditional Water Harvesting Systems, CSE, India

Moringa Trees for Food Security, Fodder and more

Video: Miracle Water Village, India
Good Soil makes more and better food
Good Soil makes lots of food and organic material for good soil. Organic agriculture is growing strongly, and it can still improve.
Endocytosis

root-hair-cell

vesicle
protozoa
fungus
bacteria

dead organic matter
Figure 1. Roots of axenically grown Arabidopsis and tomato were incubated with \textit{E. coli} or yeast expressing green fluorescent protein (GFPE. coli or GFPyeast). GFPE. coli was detected at the surface of roots and root hairs (A and C), and inside roots and root hairs (B and D). GFPYeast was present inside roots and root hairs (E and F). (A, D and F) and (B, C and E) correspond to tomato and Arabidopsis root, respectively. Fluorescent images were taken by confocal laser scanning microscopy (CLSM).
2 Simple and vivid experiments in matters of feeding plants

- Soil with NPK-mineral fertilizer and trace elements in optimum supply
- Soil with stone powder, plenty of humus, without mineral fertilizer
- Leaf mulch
2 Simple and vivid experiments in matters of feeding plants
Higly Productive Organic Gardening in Norway, Northern Europe

Most People fed per hectar with the least Energy requirement

Feeding the humus directly with fresh ground clean organic bio-waste once per month, Needs to be kept moist, mulch! (based on Hans-Peter Rusch Bodenfruchtbarkeit, OLV publishers)

18 kg of onions per m² over many years (normal yield: around 3 kg / m²)

Herwig Pommeresche: Humussphäre Highly productive at 65% Humus!
www.youtube.com/watch?v=pSShndKiA3g&feature=youtu.be
See also: www.youtube.com/watch?v=tKxD0Z7ctMs
Too may free grazing may eat too many plants, less protection for the soil, erosion, degradation...

Another mainstream belief, most are wrong...

This animal may only be mismanaged...
Allan Savory: Savory Institute

Holistic Planned Grazing

www.savoryinstitute.com

• Video

www.youtube.com/watch?feature=player_embedded&v=5LHoh-OKUfU#!

Video: Holistic Planned Grazing
Good Soil makes Water

Humus

- Aeration of the soil
- Excellent Water storage
- Important biofilter for groundwater protection
- Storage for slow release nutrients
- Less Erosion
- Carbon sink
- More buffering capacity
- Improved water cycle
Humus needs Fodder!!!
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Conclusions
Volume $\text{l/(P*year)}$

Yearly Loads $\text{kg/(P*year)}$

Greywater $25,000 \text{ - 100,000}$

Flushwater can be saved $6,000 \text{ - 25,000}$

Urine $\text{~ 500}$

Feaces $\text{~ 50}$
(option: add biowaste)
## Teilstrombehandlung bietet sich an...

<table>
<thead>
<tr>
<th>Yearly Loads</th>
<th>kg/(P*year)</th>
<th>Volume (l/(P*year))</th>
<th>Greywater 25.000 - 100.000</th>
<th>Urine ~ 500</th>
<th>Feaces ~ 50 (option: add biowaste)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>~ 4-5</td>
<td>~ 3 %</td>
<td>~ 87 %</td>
<td>~ 10 %</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>~ 0,75</td>
<td>~ 10 %</td>
<td>~ 54 %</td>
<td>~ 40 %</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>~ 1,8</td>
<td>~ 34 %</td>
<td>~ 54 %</td>
<td>~ 12 %</td>
<td></td>
</tr>
<tr>
<td>COD</td>
<td>~ 30</td>
<td>~ 41 %</td>
<td>~ 12 %</td>
<td>~ 47 %</td>
<td></td>
</tr>
</tbody>
</table>

S, Ca, Mg and trace elements

Treatment

Reuse / Water Cycle

### Treatment

- Biogas-Plant
- Composting

### Biogas-Plant

### Composting

Flushwater can be saved 6.000 - 25.000

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<table>
<thead>
<tr>
<th>Type of Toilet</th>
<th>Daily Flow per P.</th>
<th>Pro and Con's</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flushing toilet</td>
<td>25-40 l</td>
<td>+ widely accepted - waste of water - high dilution</td>
</tr>
<tr>
<td>Vacuum-toilet</td>
<td>9 l</td>
<td>+ low water demand + well developed (ships) - high-tec / expensive</td>
</tr>
<tr>
<td>Separating toilet</td>
<td>6 l / 1,5 l</td>
<td>+ little water / little dilution + simple fertiliser reuse - little experience</td>
</tr>
<tr>
<td>Waterless Urinal</td>
<td>1,2 l</td>
<td>+ no water / no dilution - maintenance required</td>
</tr>
<tr>
<td>Composting-toilet</td>
<td></td>
<td>+ no water needed - high space demand - maintenance needed ++ Desiccation for hot climates</td>
</tr>
<tr>
<td>Desiccation toilet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Teilstrombehandlung erfordert neue Toilettensysteme
Settlement Lübeck-Flintenbreite
Water consumption 65 l/capita/day

Double-Houses

Terraced Houses
Hamburg Water Cycle by Hamburg’s Water Utility
Vacuum-biogas system for 2,000 inhabitants, production of electricity and heat from waste  Start in 2010
Freshwater demand: 10 to 20 litres / person/d

Highest possible water efficiency for very dry areas

Freshwater demand (rain, lake, river): 10 to 20 litres /person/d

INTAQUA™ AG worldwide patents

Option: seawater

energy savings

Terra Preta Compost from the solids

Blackwater

BlueLoop plant (MBR)

Compost, fertilizer

Toilets, kitchen waste grinder

Greywater

Evaporation losses

Tap water

Bath, kitchen, washing

Flushing water

Pumping station

Soil

Extraction

Infiltration, irrigation

Bath, kitchen, washing

Toilets, kitchen waste grinder

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Soil

Extraction

Infiltration, irrigation

Bath, kitchen, washing

Toilets, kitchen waste grinder
Bio-Reactor / (Fixed Bed)
Ultra-Filtration
Nano-Filtration
High Efficiency
Very Low Costs
Integrated with soil building
very comfortable:

Terra Preta Sanitation
Toilets that make Good Soil
Naturally very poor tropical soil degrades very soon with lack of organic matter. The same soil: highly fertile and carbon rich over many generations long ago with lactofermented vermicomposted biowaste and faecal matter + 10% charcoal. Terra Preta. Poor soil can become highly fertile with clever management of biowaste and sanitation.
Sanitation with lactic acid fermentation in pots: Hypothesis of Dr. Haiko Pieplow, Ministry of the Environment, Germany
TERRA PRETA Sanitation: Ecosan for making rich soils

- Solves the odour problems far better than desiccation
- Only one vault needed
- Anaerobic collection without smell
- Closing toilet and chamber after usage is possible
- Leads to black soil production
- Can upgrade pit latrines at almost no costs
Cleansing of bowl with spray bottle or spray hose, also suitable for anal cleansing. Low dilution is needed. The toilet gets lactic acid bacteria with some sugar source to make it smell free. Collection once per week and transport to composting site where the compost can be used.
Options for Terra Preta Sanitation 1

**Lactic Acid Bacteria**
add 500ml concentrated LAB plus plenty of waste Sugar (2-3g/Person/year)

**Cleansing with Spray Bottle or Spray Shower**
LAB can be added (Food Quality)

**Tanc Transport or Suction Truck or Mazerator Pump**

**Composting Unit**
where compost can be utilized!!
Terra Preta Composting of feacal matter, TUHH for City of Hamburg, BSU

Fig. 1: Set up for vermicomposting composting with 5 Compartments of 1 m²
City

Water

Food

Energy

Greywater recycling

Soil Fodder

Biovaste & Excreta for reforestation
Boden
Verbesserung der Humusschicht

Lebensmittel

Kalium
Phosphor
Stickstoff
Kohlenstoff

Energieversorgung

Schwarzwasser
Bioabfälle
Recycling

Verbesserung

Verdauung

Baden erwünscht

geringer Wasserbedarf

Regenwasser

Versickerung

P < 1%
N < 1%
wenig Kohlenstoff
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Conclusions
Building living Humus-Soils:

woody waste to woodgas
stoves produce charcoal
compost with charcoal

Terra Preta Systems..
Woodgas Stoves: Clean and very Efficient by Jörg Fingas Climatefarmi
2.1 Développement du foyer
quelque étapes

Woodgas Stoves: Clean and very Efficient
by Jörg Fingas  Climatefarming, Germany
Soil improvement is needed: Clean charcoal can help

**Good Luck:** Power, Heat, Cooling and charcoal can come together

Rice Husc to Power and charcoal Senegal, Climatefarming, Jörg Fingas
Rice Husc to Power and charcoal
Senegal, Climatefarming, Jörg Fingas

2011/5/20
Organic waste is DRAMATICALLY NEEDED for keeping humus levels up!

Good Luck:
Power, Heat, Cooling and charcoal can come together

Rice Husc to Power and charcoal
Senegal, Climatefarming
grow Bamboo with greywater treatment
Productive Water Catchment

Starting tree nursery with Terra Preta Compost from Biowaste and Sanitation

Moringa for soil building and fodder production
Check dams for erosion prevention capture soil and water

from: Dying Wisdom, Indias Traditional Water Harvesting Systems, CSE, India
Rural Development, less urbanisation!

- City
- Greywater recycling
- Water
- Food
- Solar & Woodgas
- Soil Fodder
- Biowaste & Excreta for reforestation
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Conclusion

We need to get away from mainstream and look at the systems and their interactions to optimize them for all people.

- www.tuhh.de/aww
- www.terra-preta-sanitation.net
- www.anamed.net
- www.rainwaterharvesting.org

Books: David Montgomery: “Dirt”
He shows scientifically correct that many civilizations went down after soil deterioration.