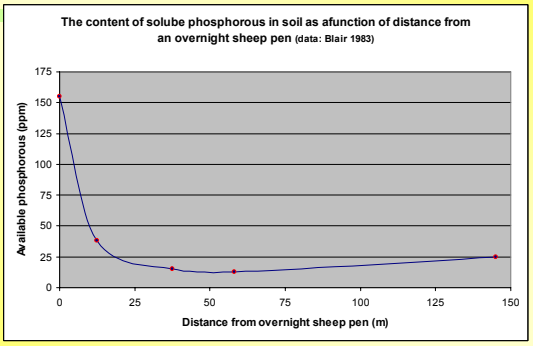
Holistic sanitation systems - a part of agricultural production

The sanitation imperative and the results



Holistic sanitation systems - a part of agricultural production

Introduction to ecosan
world water and sanitation crises

- Increasing scarcity and degrading quality of freshwater
- 1,1 billion people no access to safe drinking water
- 2,6 billion people inadequate/no sanitation
- 90 % of wastewater either poorly treated or not treated at discharge (only 25% of WWTPs built in DCs functioning)
- Expected growth of global population by 2 billion within the next 25 years, mostly in urban areas in developing and emerging market economies. By 2010, estimated 42,7% of the African population will live in urban areas (400 Million people)
- 80 % of all diseases and 25 % of all deaths in developing countries can be attributed to polluted water (WHO)
  - → Sub-Saharan Africa at least 1/3 of incomes spent to treat water-borne diseases, more than 200 Million bilharzia infections (Hansen, 2004)
  - → Europe - of 540 major cities around 1/3 have no treatment or treatment unknown (before expansion)

Holistic sanitation systems - a part of agricultural production

Introduction to ecosan
millenium development goals (MDGs)

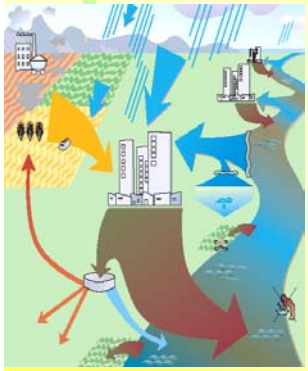
- <u>Set target for water and sanitation</u>:

  To halve the proportion of people without access to safe drinking water and to adequate sanitation by 2015

→ To reach this the sanitary provision rates of the '90s will have to be quadrupled (UN WWDR 2003)

Holistic sanitation systems - a part of agricultural production

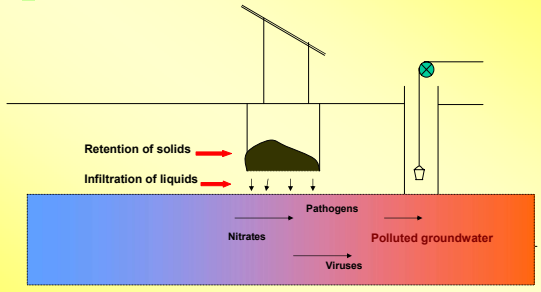
Introduction to ecosan
shortcomings of conventional watercarriage sanitation



- Unsatisfactory purification or uncontrolled discharge of more than 90 % of wastewater worldwide
  - → Severe water pollution, health risks downstream
- Consumption of (drinking) water for transport of waste
- High investment, energy, operating and maintenance costs
- Frequent subsidisation of prosperous areas and neglect of poorer settlements
- Loss of valuable nutrients and trace elements contained in excrements due to discharge into waters
- Problems with contaminated sewage sludge in combined, central systems
- **Linear end-of-pipe technology**

Holistic sanitation systems - a part of agricultural production

Introduction to ecosan
shortcomings of conventional „drop and store" sanitation

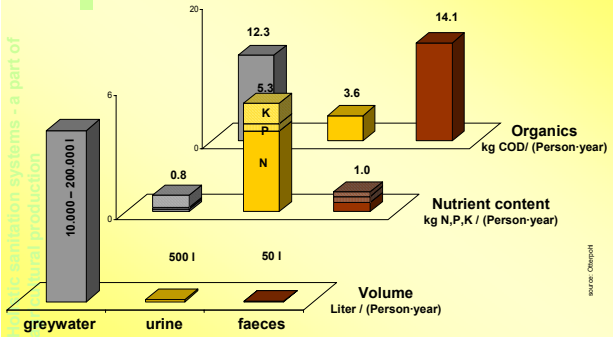


Holistic sanitation systems - a part of agricultural production

need for a new paradigm in sanitation

- Conventional systems have failed - costs, resource efficiency, safeguarding public health and sustainability,
- wasting our non-renewable resources
- the global water, hygiene and soil degradation crisis requires new approaches
- Innovative, holistic and sustainable approaches needed to provide safe and decent sanitation, reduce poverty, contribute to food security, preserve our environment and maintain the natural basis of life

composition of household wastewater

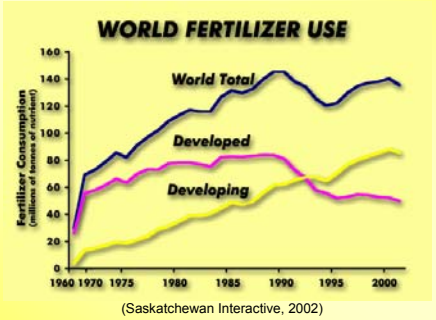


Nutrient excretion

Country	Nitrogen kg/cap, yr	Phosphorus kg/cap, yr	Potassium kg/cap, yr
China, total	4.0	0.6	1.8
Urine	3.5	0.4	1.3
Faeces	0.5	0.2	0.5
Haiti, total	2.1	0.3	1.2
Urine	1.9	0.2	0.9
Faeces	0.3	0.1	0.3
India, total	2.7	0.4	1.5
Urine	2.3	0.3	1.1
Faeces	0.3	0.1	0.4
South Africa, total	3.4	0.5	1.6
Urine	3.0	0.3	1.2
Faeces	0.4	0.2	0.4
Uganda, total	2.5	0.4	1.4
Urine	2.2	0.3	1.0
Faeces	0.3	0.1	0.4

The estimation of nutrients excretion per capita vary from country to country and even within the same region, according to food habits of people and the food itself

Trend of fertilizer consumption



(Saskatchewan Interactive, 2002)

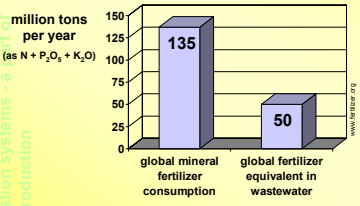
phosphate

	Mine production 2001	Mine production 2002e	Reserves	Reserve base
United States	31,900	35,800	1,000,000	4,000,000
Australia	1,890	1,800	77,000	1,200,000
Brazil	4,700	4,700	330,000	370,000
Canada	800	1,000	25,000	200,000
China	21,000	21,000	6,600,000	13,000,000
Israel	3,510	3,500	180,000	800,000
Jordan	5,840	7,000	900,000	1,700,000
Morocco and Western Sahara	21,800	24,000	5,700,000	21,000,000
Russia	10,500	10,500	200,000	1,000,000
Senegal	1,700	1,500	50,000	160,000
South Africa	2,550	2,800	1,500,000	2,500,000
Syria	2,040	2,400	100,000	800,000
Togo	1,060	1,100	30,000	60,000
Tunisia	8,000	7,500	100,000	600,000
Other countries	8,710	8,000	1,000,000	2,000,000
World total (rounded)	126,000	133,000	17,000,000	50,000,000

source: US Geological survey, 2003

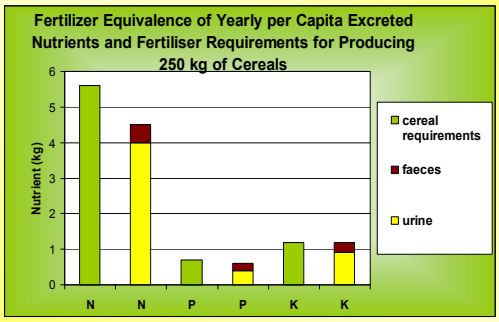
- **World demand for phosphate fertilizers continues to expand in relation to increased world population and food requirements.**
- **For the period 2003-07, world phosphate consumption is forecasted to increase by 2.6% annually.**
- **Within about 60 years, all economically explotiable phosphate reserves are expected to be exhausted.**
- **Future conflicts on the access to phosphate are possible, due to concentration of limited resources in a small number of countries.**

excreta as a valuable resource



- Represents nutrients with a market value of around 15 Billion US dollars.

fertilizer potential of human excreta



advantages of ecological sanitation

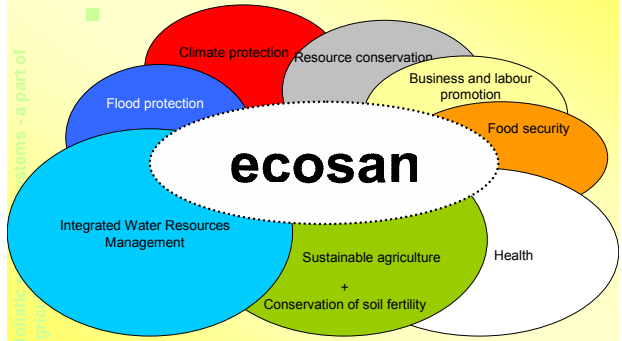
- Improvement of health by minimizing the introduction of pathogens from human excrements into the water cycle
- Promotion of safe, hygienic recovery and use of nutrients, organics, trace elements, water and energy
- Preservation of soil fertility, Improvement of agricultural productivity
- Conservation of resources
- Preference for modular, decentralised partial-flow systems for more appropriate, cost-efficient solutions
- Promotion of a holistic, interdisciplinary approach
- **Material flow cycle instead of disposal**

eco-sanitation concepts and strategies

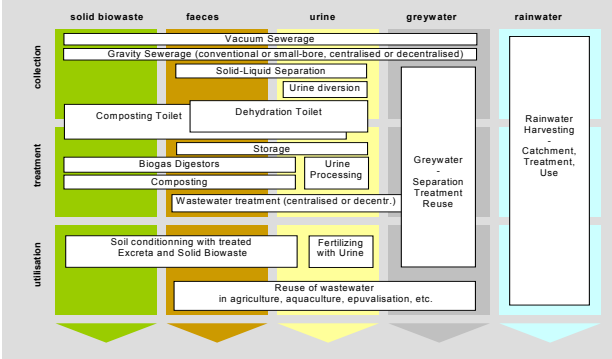
eco-sanitation…

- … is not a specific technology, but a philosophy based on an eco-system-oriented view of material flows to deal with what is presently regarded as waste and wastewater for disposal
- … applies the basic natural principal of closing the loop by using modern and safe sanitation and reuse technologies
- … opens up a wider range of sanitation options than those currently considered.

ecosan is a cross-sectoral approach



overview of ecosan technology-components



urine storage

Various containers for urine storage:
Gebers, Schweden
Lambertsmühle, Deutschland

ecosan system components
agricultural use


direct injection of liquid fertiliser


irrigation


urban agriculture


dried faeces - „soil amelioration")

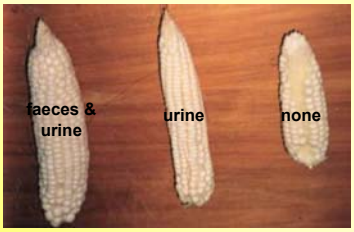

composting with organic waste


urban agriculture

Reuse

Benefits of nutrients reuse: soil fertility

Restoration of soil fertility: by reusing nutrients the soil is humus-rich and makes the difference in crops production



Source: Vinnerås, 2003

Benefits of nutrients reuse: soil fertility

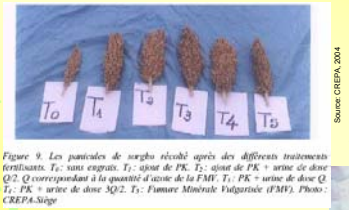

Green peppers:
Left - excreta compost
Mid - 1/2 compost, 1/2 soil
Right - soil


Spinach: Left - local soil
Right - compost


Lettuce: Left - local soil
Right - excreta compost

Source: Peter Morgan, 2004

Benefits of nutrients reuse: soil fertility



Source: CREPA, 2004

Figure 9. Les panicules de sorgho récolté après des différents traitements fertilisants. T_0: sans engrais. T_2: ajout de PK. T_2: ajout de PK + urine de dose Q/2. Q correspondant à la quantité d'azote de la FMV. T_3: PK + urine de dose Q. T_4: PK + urine de dose 3Q/2. T_5: Fumure Minérale Vulgarisée (FMV). Photo : CREPA-Siège

Sorghum:
To : nothing
T1 : with P and K
T2 - T4 : P and K plus urine
T5 : mineral fertiliser

Spinach: Left - local soil
Right - urine (1 / 3)


Source: Peter Morgan, 2004

Benefits of organic reuse: soil quality


After one week without water

Source: Peter Jensen

Improved soil quality: organic reuse (as compost) enhances the water - holding capacity, ameliorates the soil structure, the buffering capacity and by supporting the soil micro-organisms

The fertilising effect of urine

Treatment	N rate kg/ha**	Yield ton ha*	N yield kg/ha**
A Urine every 14 days	150	54	111
B Urine twice	150	51	110
C Urine every 14 days + extra potassium	150	55	115
D Unfertilized	0	17	24

* ton/ha= kg/10 m^2
** kg/ha= gram/10 m^2

Results of a field trial using human urine as a fertiliser for leeks (Sweden)

The fertilising effect of urine

Plant, growth period and number of repetitions n	Unfertilized plants g	Fertilized, 3:1 water/urine application 3x per week g	Relative yield fertilized to unfertilized
Lettuce, 30 days (n = 3)	230	500	2.2
Lettuce, 33 days (n = 3)	120	345	2.9
Spinach, 30 days (n = 3)	52	350	6.7
Covo, 8 weeks (n = 3)	135	545	4.0
Tomato, 4 months (n = 9)	1680	6084	3.6

Yields (grams fresh weight) in plant trials with urine as a fertiliser to vegetables in Zimbabwe (Morgan, 2003)

The fertilising effect of excreta compost

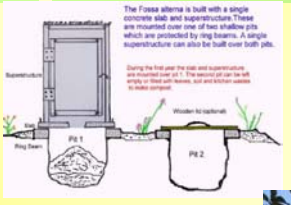
Plant, soil type and number of repetitions	Growth period	Fresh weight topsoil only g	Fresh weight 50/50 topsoil/ FA*soil g	Relative yield fertilized to unfertilized
Spinach, Epworth soil (n = 6)	30 days	72	546	7 .6
Covo, Epworth soil (n = 3)	30 days	20	161	8 .1
Covo 2, Epworth soil (n = 6)	30 days	81	357	4 .4
Lettuce, Epworth soil (n = 6)	30 days	122	912	7 .5
Onion, Ruwa soil (n = 9)	4 months	141	391	2 .8
Green pepper, Ruwa soil (n = 1)	4 months	19	89	4 .7
Tomato, Ruwa soil	3 months	73	735	10 .1

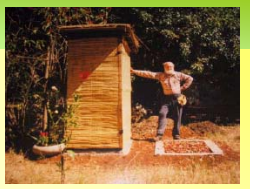
** Fossa alterna* soil

Average yields (grams fresh weight) in plant trials comparing growing in poor topsoil only, with growing in a mixture consisting of 50% topsoil and 50% Fossa alterna compost (Morgan, 2003)

Gains are less pronounced on better quality soils

Zimbabwe / Mozambique





The “fossa alterna”

Source: Peter Morgan, 2004

ecosan pilot projects

experimental on-site sanitation in Koulikoro, Mali (supported by GTZ)

Experimental on-site sanitation module consisting of a urine diverting dehydrating latrine, shower and greywater garden

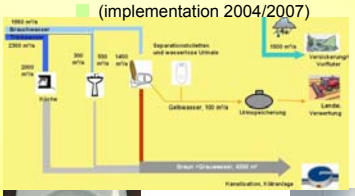
Urine diverting concrete slab

Greywater garden

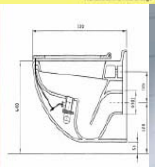
ecosan pilot projects

GTZ headquarters, main building, Germany

separation, processing and agricultural reuse of urine (implementation 2004/2007)



GTZ House1 Eschborn, Germany



Urine diversion toilets and waterless urinals

ecosan pilot projects
ecosan dry toilet promotion in Guangxi-Province, China

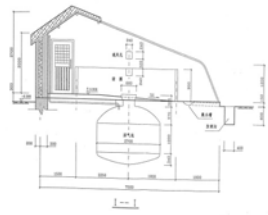
Photos: Sandec, Text: Mi Hua

- Large ecosan project in the phase of up-scaling
  - 1997, pilot project funded by SIDA/Unicef, 70 ecosan (urine diverting dehydration toilets) built in pilot village, Dalu Village
  - 1998, 10,000 urine-diverting toilets were built in 200 ecosan villages in Guangxi
  - 2002, 100,000 ecosan toilets in Guangxi
  - 2003, 685,000 ecosan toilets in 17 provinces (Ministry of Public Health)
- Factors of success: cultural acceptance, political commitment, technical flexibility, low cost, income generation, pressure from water pollution and water scarcity, promotion and marketing

ecosan pilot projects
Chinese „four in one“ model

pig – toilet – biogas – vegetable

- **combined with Greenhouse Production**
- **more than 10 000 000 times in Northern China**
- **Use of nutrients, organics, energy and carbon dioxyde**



ecosan pilot projects
GTZ supported ecosan activities around the world

ecosan activities supported by GTZ

main challenges

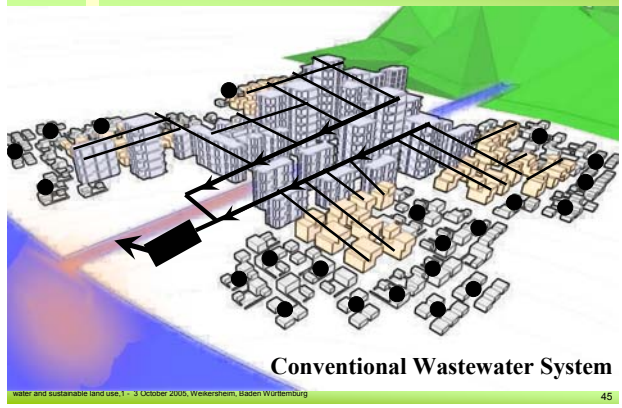
- increasing of awareness
- integration of reuse into planning from the beginning
- revision of legal frameworks & technical standards
- establishment of full cost analysis and risk and benefit comparisons
- finding innovative investors and adapting financing instruments
- **implementation of large scale urban demonstration projects (in Africa large degree of experience with pilot installations - urgent need to go to scale)**

Source: Petter Jenssen

Greywater treatment in Norway

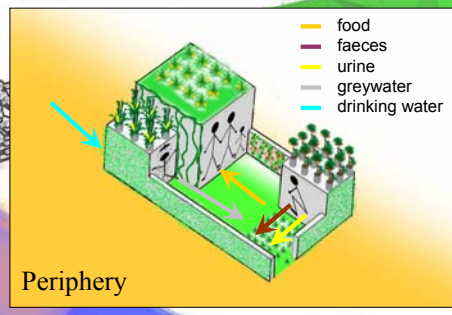
conclusion
Thanks for your attention & interest!!!

urban ecosan concepts



urban ecosan concepts

urban ecosan concepts



urban ecosan concepts

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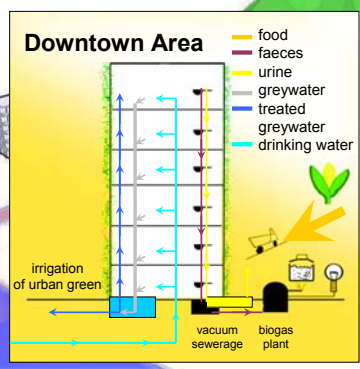

urban ecosan concepts