

The Waterharmonica Ecological engineering

Food-chain approach in re-use of treated waste



Ruud Kampf



IWE Seminar Series "Water and Health"

Thursday 6 April 2006 (10:30-12:15)

WUR, Nieuwlanden, P71

Resources

www.waterharmonica.nl

Pdf of this presentation:

www.waterharmonica.nl/iwe

Introduction

Ruud Kampf:

Hoogheemraadschap Hollands Noorderkwartier
The Netherlands



Close cooperation with **Theo Classen:** Wetterskip Fryslan



PhD at Vrije Universiteit Amsterdam and Technical University Delft



With support of Universiteit van Amsterdam



"Clear effluents"

Waste water was the finest water we had:

Originally
drinking water and rain water

Waste water
or
"waste in water?"



This presentation:

- **Introduction Waterharmonica**
- Texel: Tourists, Spoonbills, Master Plan Water
- Texel: the Eversteekoog constructed wetland to make a "living water" from waste water
- food chains and the Waterharmonica: "kwekelbaarsjes" or "gricklebacks"
- Europe: a Spanish example
- The Waterharmonica in Nepal and Tanzania:
 - sustainability, biodiversity, surface water quality, health

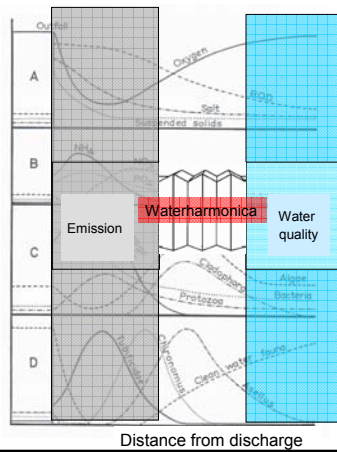
The Waterharmonica:
the link between treated waste water and surface water

Aerial view STP Eversteekoog



Schematic effect of discharges of wastewater

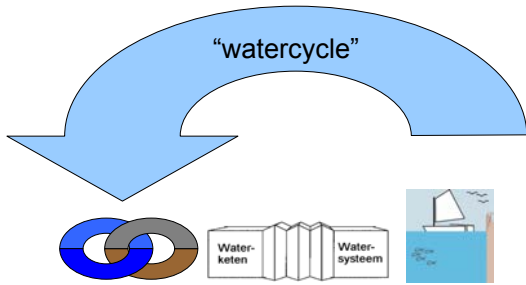
- A physical – chemical
- B nutrients
- C micro-organisms
- D macro-organisms



Two separate worlds

Emissions	Surface waters
reduction discharges	quality standards
black lists pollutants	aquatic ecosystems
best available techniques most feasible techniques	water systems
action programmes / regulations	general directives
legislation control	integrated water management master plan consensus involvement

Missing link in water management



The natural link from tap to source

The Waterharmonica project

- winning idea in 1996: 25 years celebration Dutch Foundation for Applied Water Research (STOWA) by Theo Claassen

STOWA project 2003-2004:
research and implementation

- for reports, papers conferences, etc:

www.waterharmonica.nl



Stowa reports

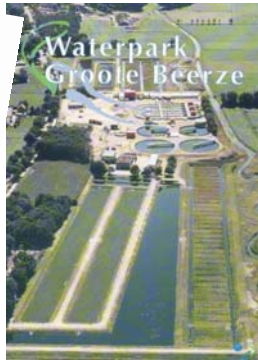


Pdf on
www.waterharmonica.nl

STP Land van Cuijk, Waterboard de Maaskant



Water park Groote Beerze



STP Hapert De Dommel

Main Conclusions

- Use your effluents !!
 - Do not throw away (waste) water
 - Manage the waste water quality
 - Make the effluent as 'clean' as possible
 - Nutrients, sludge particles, food chains
- Waterharmonica is a usable tool
 - Integrated water management
 - Engineers dare to meet biologists....

www.waterharmonica.nl

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- **Texel: Tourists, Spoonbills, Master Plan Water**
- Texel: the Eversteekoog constructed wetland to make a "living water" from waste water
- food chains and the Waterharmonica: "kwekelbaarsjes" or "gricklebacks"
- Europe: a Spanish example
- Discussion:
 - sustainability, biodiversity, European Water Frame Work Directive, membrane filtration, nature

The Waterharmonica:
the link between treated waste water and surface water

Texel



- Is a beautiful island
- A tourist resort
- A bird island
- Still a strong agricultural stronghold

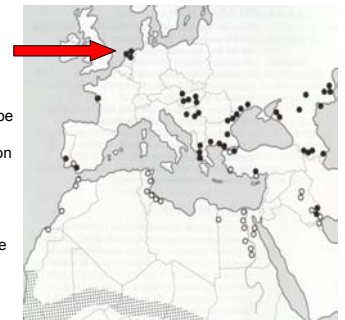


Spoonbills



Spoonbills in Europe

The Netherlands



One of the rarest birds in Europe

95 % West-European population in the Netherlands

Annex I European Bird directive

Symbol of good water management

Water on Texel

- Scarce
- Drinking water from mainland
- Masterplan Water Texel
- Projects like effluent diversion, etc

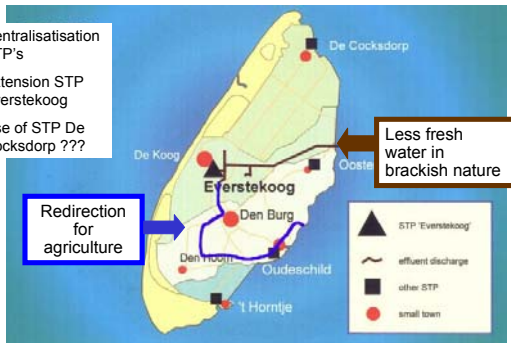


Effluent reuse on the island

Centralisation STP's
Extension STP Eversteekoog
Use of STP De Cocksdoorp ???

Redirection for agriculture

Less fresh water in brackish nature



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Aerial view STP Eversteekoog

sewage treatment plant
presettling basin
9 ditches with reed/cattail and aquatic plants
discharge ditch

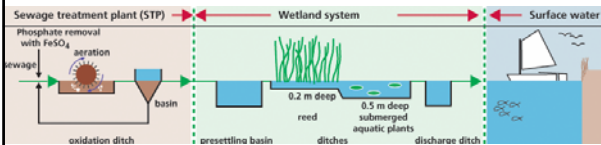


Research project 1995 - 1999

The Waterharmonica:

the link between treated waste water and surface water

From wastewater to surface water



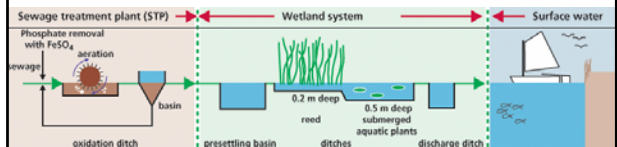
STP Oxidation Ditch

3.400 m³/d

Constructed wetland

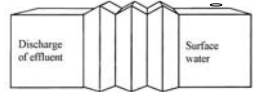
Surface water

A constructed wetland to make a "living water" from treated waste water

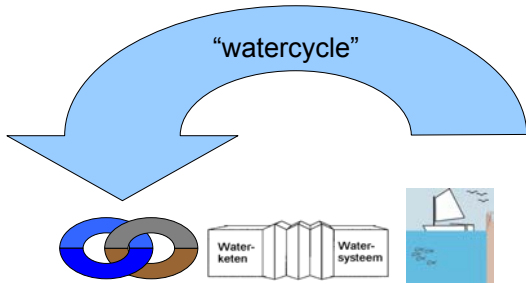


Water chain

Water system



Missing link in water management



The natural link from tap to source



Eversteekog



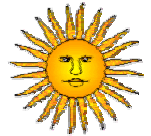
Eversteekog - ditches



July 2005

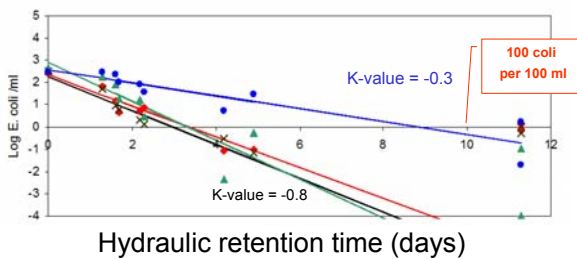
Constructed wetland

- a constructed, optimised water system
 - helophytes: reed, cattail
 - (submerged) water plants
 - plants on the banks
 - sediments
 - algae, Daphnia, etc
- works on solar energy



A constructed wetland to make a "living water" from treated waste water

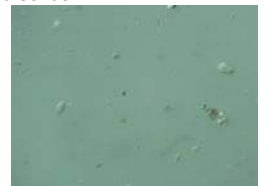
Log Fecal Coli (per ml) vs retention time



Spring Summer Autumn Winter

After constructed wetland different water

- Natural oxygen regime
- No odour
- Less sludge particles lead to disinfection
- More, but different suspended solids
- Living water:
 - algae, daphnia
 - all kind of "waterlife"
 - fish
 - birds



Conclusions Texel

A more natural constructed wetland:

different, living water

disinfection

nutrient removal

natural values

*After treatment of waste water
or
pre treatment of surface water?!*

Process technology constructed wetlands

- Oxidation ditch / carousel:
 - like polluted surface water
- Constructed wetland for effluent polishing:
 - like cleaner surface water
- Processes are comparable
 - settling, adsorption, (photo katalytic) biofilms, diffusion, growth, decay, etc.

→ combination van (bio)procestechnology,
agriculture, biology, etc.



→ ecological engineering: www.IEES.CH

Water Frame Work Directive

Very strict new effluent standards !!
Leads to new very expensive filtration /
membrane techniques

Engineering **vs** natural processes ??????

Or

Engineering **plus** natural processes ??????

Texel

*Learning the process by doing
Resulted in a lot of knowledge and ideas!!*

*well treated wastewater
can be a good source of life!*

More sustainable, natural water systems

Fish in the Eversteekoog constructed wetland



- in first pond no fish
- fish in ditches:
 - but only after 3 days retention time
 - after 10 days a lot of fish
up to 15 Stickleback per m²



Food chains!



<http://www.intartiles.com/robertekennedy.htm>

Daphnia - trivina



- Length: 0.3 - 5 mm
- Wet weight: 0.5 - 2 mg
- Filtration capacity: 4 ml/ind.hour
(1000 Daphnia/filtrates water 4 times per hour)
- Size of food particles between 1 - 40 µm



Protein: 60 %
Fat 10 %
Carbohydrates 6 %

C = 44 %
N = 8 %
P = 1.4 %



Sticklebacks



Harvesting Daphnia for research



“Kwekelbaarsjes”

growing **Daphnia**
on treated wastewater

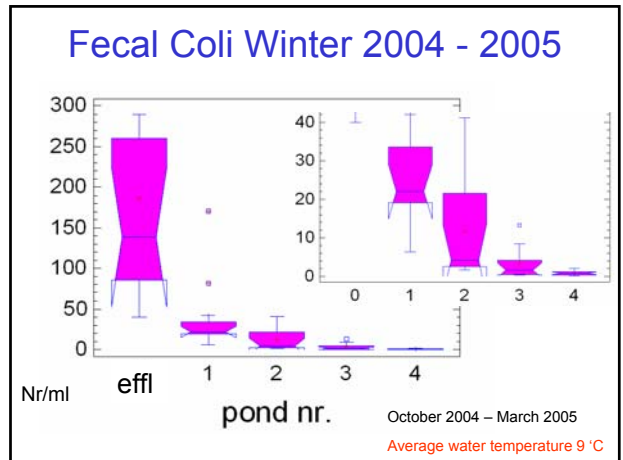
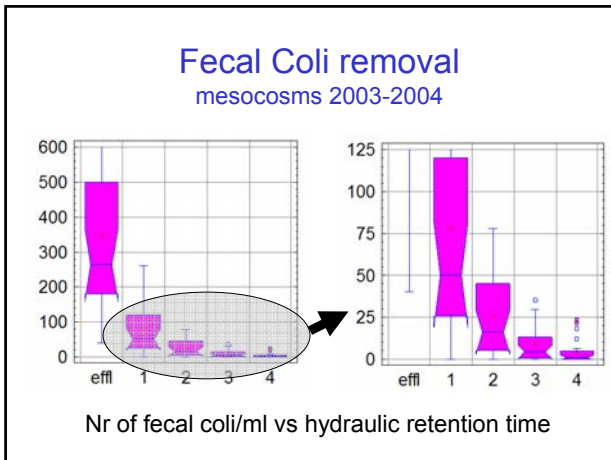
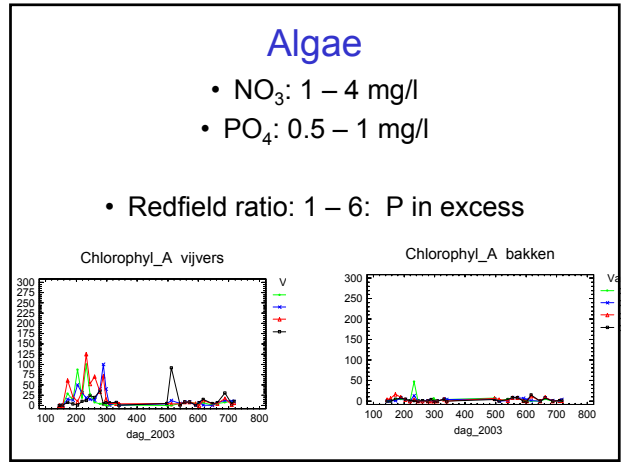
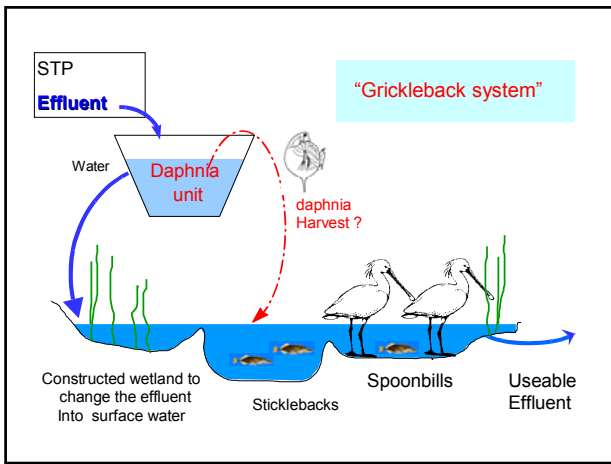


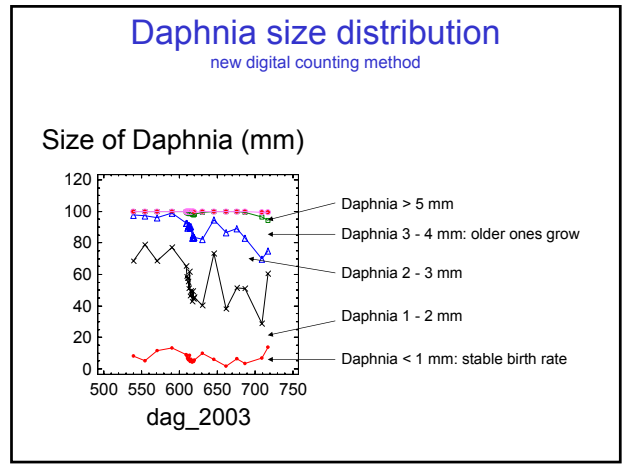
to grow **Sticklebacks**

“Gricklebacks”
=
Growing
Sticklebacks

as food for **Spoonbills**







“Gricklebacks”?

”Daphnia, Fish, Spoonbills and treated waste water”

- Feasible:
 - growing Daphnia:
 - Daphnia feed on sludge particles: disinfection!
 - Daphnia keep the ponds clear: no algae
 - Sticklebacks come to the constructed wetland
 - it attracts Spoonbills

Fits in the EU Water Framework Directive

Waterharmonica Grou

News: STP Stolpen near Schagen: plans for a Marsh harrier marsh

Diagram and drawings of CW at Grou Aqualân

Realisation in 2005

Combination with Pike stocking area

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- **Europe: a Spanish example**
- The Waterharmonica in Nepal and Tanzania:
 - sustainability, biodiversity, surface water quality, health

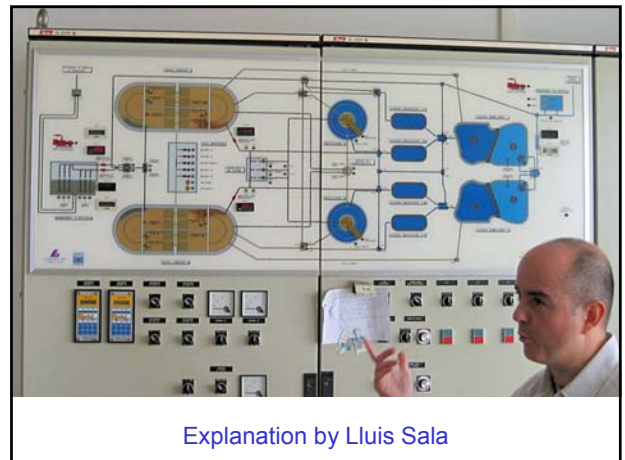
**The Waterharmonica:
the link between treated waste water and surface water**

The Empuriabrava WWTP



From Lluís Sala, Concorsi de la Costa Brava

Workshop 21 October 2005



Explanation by Lluís Sala

STP with the first ponds



Daphnia galleore



Part of the nature area
Hides
Hiking and biking



The constructed wetland



The more "natural" wetland

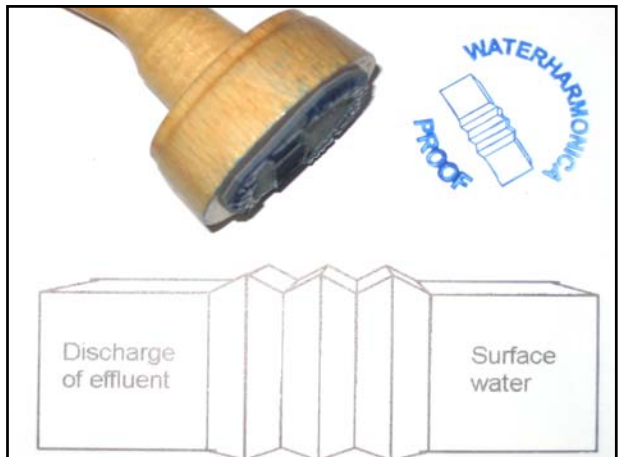


National park
Aiguamolls d'Empordà

Parc Natural
dels Aiguamolls
de l'Empordà



Use of enhanced waste water in nature



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**The Waterharmonica:
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Workshop on water management in Nepal



A Workshop on community management of waste water (treatment and disposal) in low-income, semi-urban communities in the Kathmandu Valley, Nepal, 2-13 November 1998

Closing the nutrient cycle Why and how

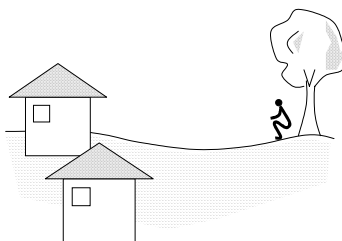
A way to reduce waste water problems in Nepal

More on www.rekel.nl/water
http://www.rekel.nl/water/nepal_workshop/index.htm

Present practice: unhealthy!

- Uncontrolled garbage management
 - even rats on the streets
- Open defecation or "shitting fields"
- Sewage on the streets, no sewers or gutters
- Polluted streams and rivers
- Risky fresh water
- Loss of nutrients with waste water
 - 4 kg N and 1 Kg P per year, value 3 Euro per person per year

Open defecation

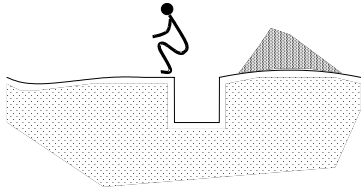


SANEX, Loetscher, 1998



Open defecation
or
"Killing fields"

Trench latrine



SANEX, Loetscher, 1998



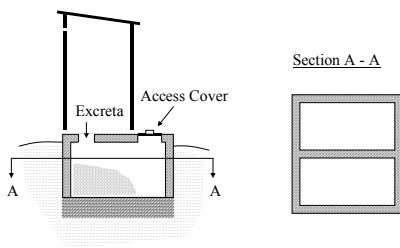
Col de Bretolet, Switzerland



Solutions - basics

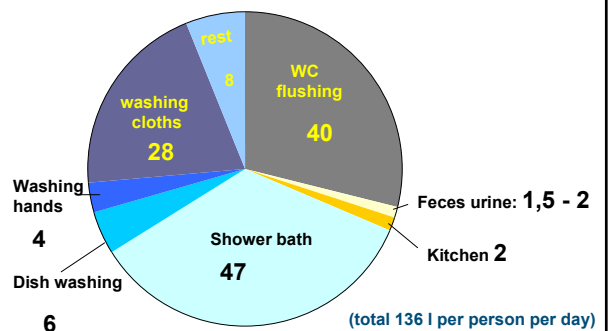
- Aimed on the communities, done by the communities
 - short term solutions:
 - self aid
 - long term solutions:
 - with foreign aid, but:
 - aimed on making jobs, income
 - minimise loss of nutrients = chemical fertiliser:
 - » close the nutrient cycle
- Based on the local culture and knowledge

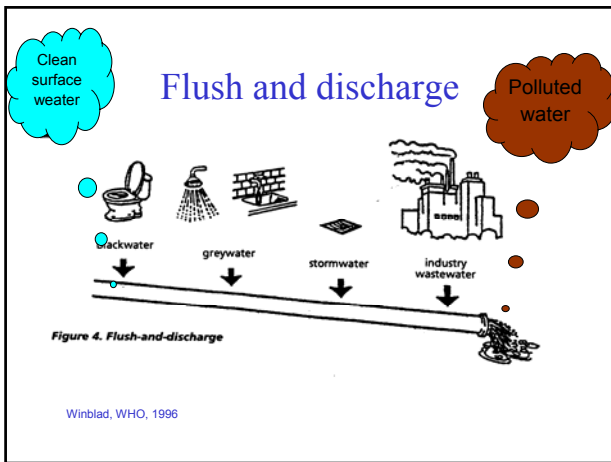
Double vault composting latrine



SANEX, Loetscher, 1998

Netherlands: how many liter water per person per day?





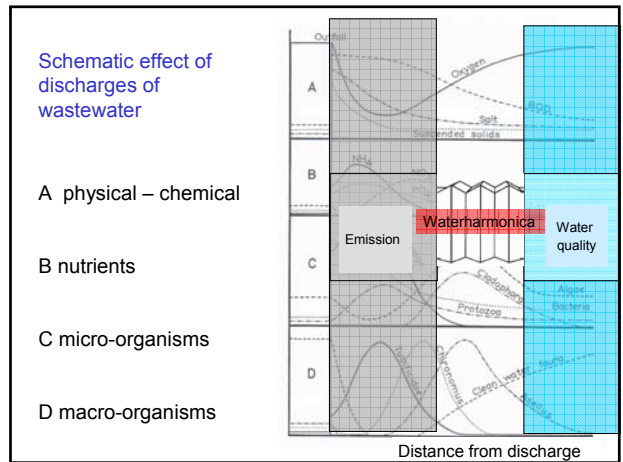
Dilution is the problem

	High-strength	Diluted Sewage
Volume l per cap per day	1.5 - 5	15
COD mg/l	35000	800
NH ₄ mg/l	3500	50
Dry solids .g/l	34	< 10
Metals	Fairly low	To high

Cost of water management in The Netherlands per family in Euro/year

Organisation	Cost
Waterboards "Dry feet"	50
Communities Sewers	100
Waterboards Sewage treatment + surface water quality	150
Water companies Drinking water	165
Total Euro 450 per family per year	

Based on Dutch Ministry of Transport, Public Works and Watermanagement, 1999



THE POTENTIAL OF WATERHARMONICA CONCEPT IN TANZANIA

Saxion Hogescholen

Waterboard Hollands Noorderkwartier

“The bridge between treated wastewater and surface water”

Presented by: Hamidar Chanzi
IBP 2004/5 - Environmental Science, Saxion University – Deventer
Waterboard Hollands Noorderkwartier, July 11, 2005

Waterharmonica

What is the potential of this Dutch initiative for Tanzania?

“The bridge between treated wastewater and surface water to fill the gap”

Main objective:

How can we use the basic ideas from Waterharmonica to use the “wealth of used drinking water” for poverty alleviation in Tanzania (local community)?

- Sewer system
- Type of sewage treatment
- Surface water quality, waterborne diseases
- How to organise?

It is a developing country:
500 Euro income per capita



Pit latrines



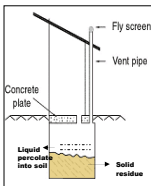
Practice:

- rural areas: 93 % people
- but many are leaking: ground water pollution

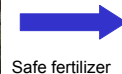
But Is already Ecological sanitation when:

- Kept dry (no water with faeces and urine)
- No leakage to groundwater
- Good infra-structure aimed on re-use of nutrients

Ecological sanitation is a great option but:
Combined with Source separation



Double Vault separation toilet



Short term solution
for 80 – 90 % of the
population

Enough fertiliser for
the country

A Dutch latrine



Waste water in Tanzania

wastewater only produced by 5 % of population

- but this 5 % is the wealthiest part
 - offices,
 - hotels, hospitals

“ like in most developing countries.....
and situation likely to worse”

Polluter pays?



The New Arusha Hotel
160 USD for double room
140 USD for single room
Dik Dik Hotel
120 USD for double room
100 USD for single room



Hamidar Chanz, Tanzania, 2005i

Polluter pays



Example Masai Mara National reserve :

- **“Mara Simba** is the only lodge in Kenya which has installed a Waste Water Treatment Plant. The plant was imported from U.S.A. This plant treats all the sewage and produces crystal clear water which is then used for irrigation. We are truly the only environmentally friendly lodge in Kenya”



Why not in Tanzania?

<http://www.marasimba.com/introduction.html>

Hamidar Chanz, Tanzania, 2005i

Use of treated waste water in Tanzania

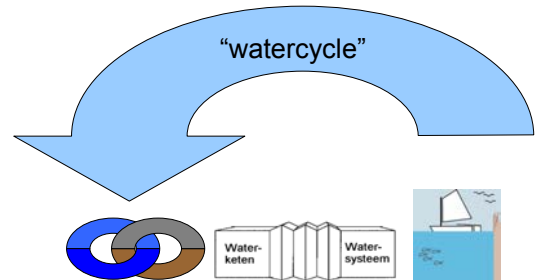
Some possible treatment methods:

- **Constructed wetlands:** “natural treatment”
- **Oxidation ponds:** ponds, mainly used in India
- **Oxidation ditches:** very simple aerobic treatment
- **UASB reactors:** anaerobic reactor

(Uplow Anaerobic Sludge Blanket)

Hamidar Chanz, Tanzania, 2005i

Missing link in water management



The natural link from tap to source

How?

- Ecological engineering
- Polishing and reuse of wastewater
- Link between treatment plant and surface water:

Hamidar Chanz, Tanzania, 2005i

Minimise risks

- **Treatment of wastewater**
 - Good quality of treated waste water
 - Degree of pathogen and chemical removal
- **Crops restriction**
 - Grow crops with less risks to worker and consumers
- **Proper use of crops and fish**
 - Boil, not eat fresh crops (vegetable or fruits)

Hamidar Chanz, Tanzania, 2005i

Conclusions

Waterharmonica concept is a promising approach that could promote the livelihood of local people in Tanzania

- Waterharmonica makes waste water safe
 - reduce water pollution: better surface water quality
- Safe fertilizer of nutrients from safe wastewater
 - agriculture, aquaculture
- Polluter pays make waste water a resource
- Water conservation
 - wastewater for irrigation; fresh water for domestic uses

Hamidar Chanz, Tanzania, 2005i

Finally: Some “wise words”

- “Waste water comes from drinking water”
- Do not talk about water reuse, it is “wise use”
- Polluters pay
- No drinking water when no money for sewers and treatment is available but separation
- When waste water: treat it well and use it
- Surface and (ground) water quality is important
- Think global(ly) and in water cycles

The Waterharmonica: natural link between tap and source !



“My success is the result of my failures”

Hamidar Chanz, Tanzania, 2005i



The Waterharmonica:

[The Waterharmonica in Nicaragua: Joost Jacobi](#)