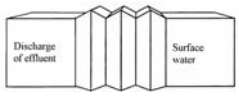
Use of Treated Wastewater for Nature:

The Waterharmonica



a sustainable solution as an alternative for separate drainage and treatment

AQUA TECH AMSTERDAM 2004

International Conference 'Upgrading of Wastewater Treatment Plants'

Amsterdam 30 September - 1 October 2004

The Waterharmonica:

a tool to convert used water into surface water

Ruud Kampf
Waterboard
Hollands Noorderkwartier

Theo Claassen
WETTERSKIP FRYSLÂN

This presentation:

- Black, White and Grey
- ***why is treated waste water not surface water??***
- constructed wetlands to make a "living water" from waste water
- Texel:
  - the Everstekoog constructed wetland
  - "kwekelbaarsjes" or "grickelbacks"
- examples and plans in The Netherlands and abroad
- food chains and the Waterharmonica

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

Sewer systems

- Already available on a big scale
- Relatively cheap
- Long life span

- But……..

Is a sewer system clever ??!!

Per inhabitant per year:

50 l faeces, 500 l urine plus 100 l kitchen wastes

+ 15.000 l drinking water, mainly for "transport"

+ 15.000 l rain

➡ large and expensive sewers

But as we will learn:
every **disadvantage** has his own **advantage**

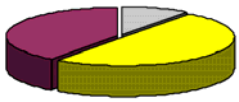
COD, N and P in separate flows

- Grey water
- Urine
- Faeces

→ Black

COD

N



P

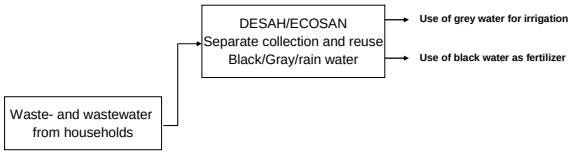
faeces 100 % of pathogens

Source: Adriaan Mels, LeAf

Separation of water flows

- **White** - rain
- **Black** - faeces and urine
- **Grey** - washing and rinsing, kitchen
- **Mixed** - do not mix??

Source separation?

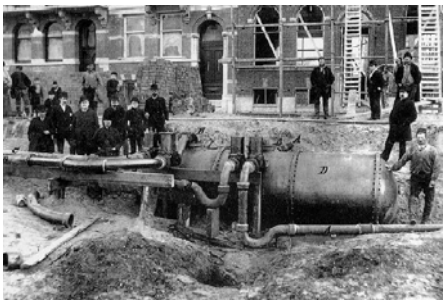


Based on Mels, 2004

Separate drainage is not new

The Boldoot car: Honey buckets in Amsterdam

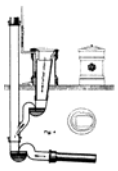
The vacuum sewage system of Charles T. Liernur (1828 - 1893)



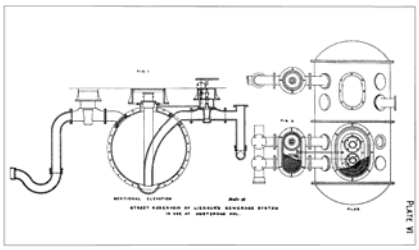
With thanks to Adriaan Mels (LeAF, Wageningen UR), based on Thesis Van Zon, 1986

Liernur collection of black wastes for reuse in agriculture

- Underground iron sewer
- Vacuum transport of faeces and urine



•iron toilets



Steam mobile with air pump used by Liernur

http://www.bronnenuitamsterdam.nl/weergave.asp?ID=16

Around 1900

Practical use of Liernur system in:

- Leiden 1200 people; 1870-1915
- Dordrecht 800 people; 1872-1887
- Amsterdam 1700 people; 1872-1912

- St. Petersburg 22.000 people
- Prague 10.000 soldiers

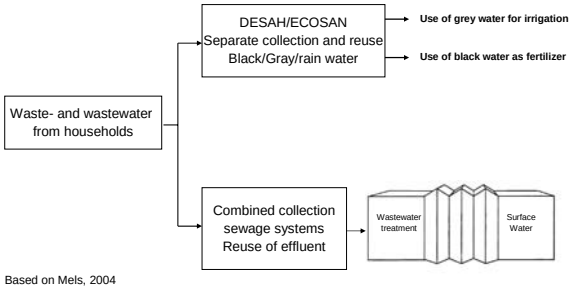
Liernur: profitable production !!

- manure or “poudrette”
- ammonium sulphate

In Amsterdam profitable from 1897 - 1915 !!

Disappeared:
- Ahead of time?
- Introduction of water closets

Source separation or mixing?



Based on Mels, 2004

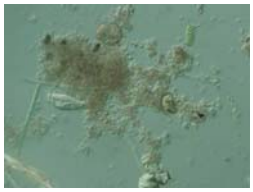
“Clear effluents”

It used to be the finest water we had:

Originally
drinking water and rain water

Treated wastewater

- improvements: C, N, P
- regional STP’s
- influence at effluent discharge:
  - sludge particles, flocs
  - loose bacteria
  - odor, foam
  - low O_2



“Dead water”, not satisfied with quality

Typical effluent quality oxidation ditch STP

- BOD: 2 - 3 mg/l
- NH4: 0.1 - 1 mg/l
- NO3: 3 mg/l

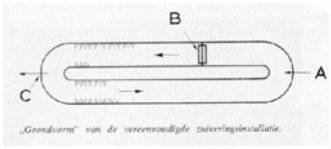
- Suspended solids: low

Better than many surface waters !!!

But faecal coli: 400 - 800 per ml !

Oxidation ditch

developed in the Netherlands, A. Pasveer 1909 - 2001



basic idea:

just a normal ditch with an aerator, no sludge retention

only later:

the “race track” shape with activated sludge

- simple
- but still modern
- good effluent

0.05 kg BOD per kg d.s. per day

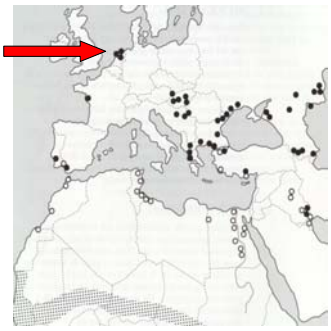
1 kg dry sludge/p.e and 250 - 300 l/ p.e. volume

Texel

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

Spoonbills in Europe

The Netherlands

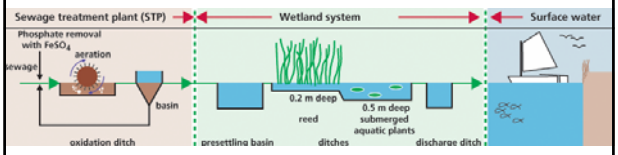


Spoonbills

Water on Texel

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

From wastewater to surface water



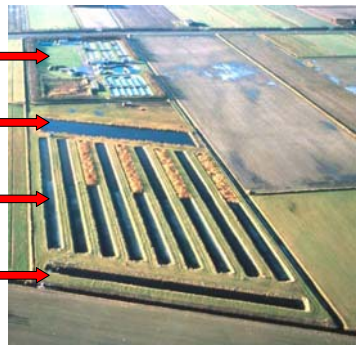
STP Oxidation Ditch

Constructed wetland

Surface water

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

Aerial view STP Everstekoog



sewage treatment plant

presettling basin

9 ditches with reed/cattail and aquatic plants

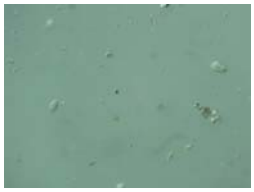
discharge ditch

Research project 1995 - 1999

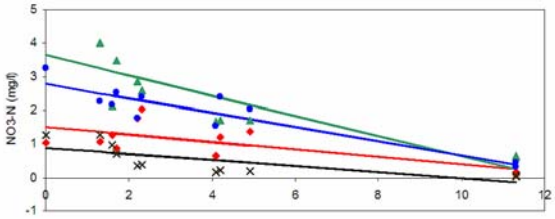
Everstekoog

After constructed wetland different water

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



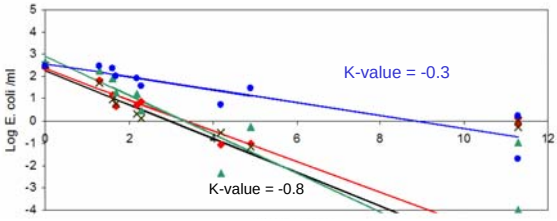
Nitrate (mg/l) vs retention time



Hydraulic retention time (days)

Spring Summer Autumn Winter

Log E.Coli (per ml) vs retention time



Hydraulic retention time (days)

Spring Summer Autumn Winter

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 Everstekoog 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 m^2

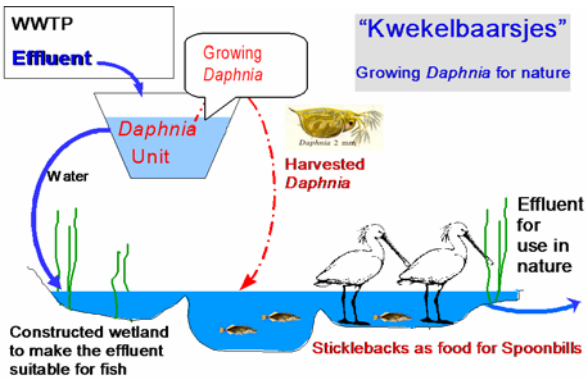
Sticklebacks

"Kwekelbaarsjes"

growing **Daphnia**
on treated wastewater

to grow **Sticklebacks** *Grickelbacks*

as food for **Spoonbills**



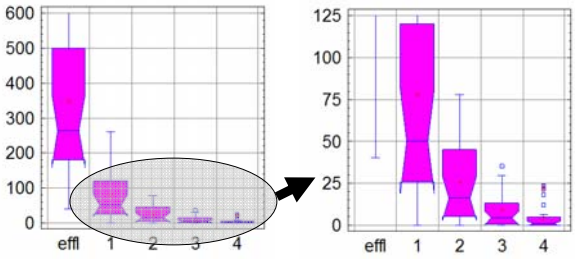
Experimental set-up Everstekoog

4 ponds

4 mesocosms

Fecal Coli removal

mesocosms 2003-2004



Nr of fecal coli/ml vs hydraulic retention time

Harvesting Daphnia for research

Kwekelbaarsjes ?

"Daphnia, Fish, Spoonbills and treated waste water"

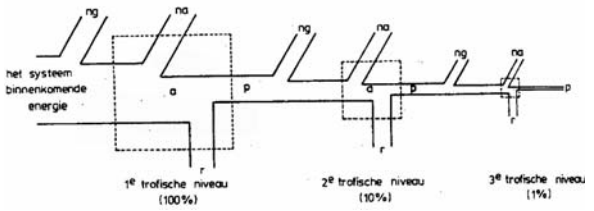
- Feasible:
  - growing Daphnia:
    - Daphnia feed on sludge particles: disinfection!
    - Daphnia keep the ponds clear: no algae
  - Sticklebacks come to the constructed wetland
  - it attracts Spoonbills

Fits in the EU Water Framework Directive

Food chains!

http://www.intarttiles.com/robertekennedy.htm

Food chains + energy flows



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?!

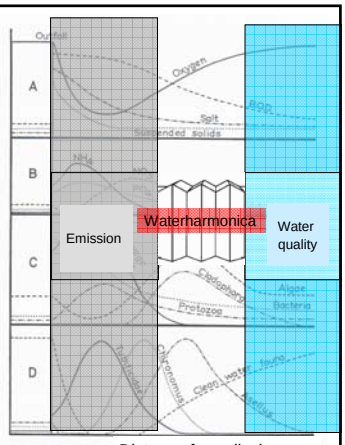
Schematic effect of discharges of wastewater

A physical – chemical

B nutrients

C micro-organisms

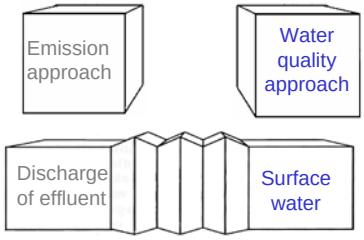
D macro-organisms



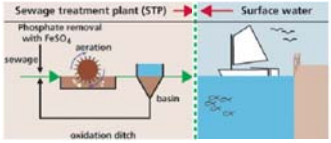
Two separate worlds

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

Waterharmonica as linkage-system

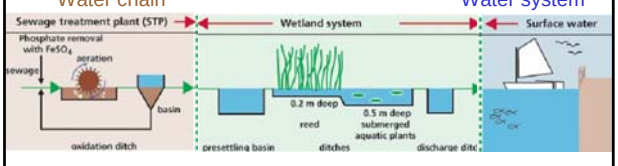


accordion, concertina, harmonic corridor

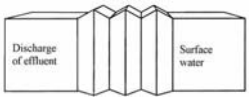


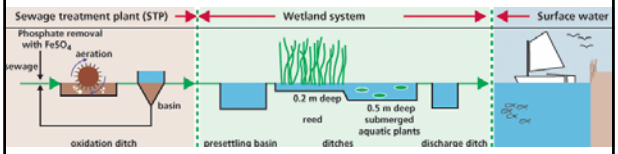
Planning of a waste water treatment

Water chain — Water system



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





www.waterharmonica.nl

The Waterharmonica project

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

Ongoing STOWA project 2003-2004:
research and implementation

- see project site www.waterharmonica.nl for reports, papers conferences, etc

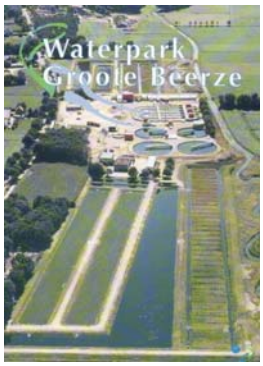
stowa WETTERSKIP FRYSLÂN Hollands Noorderkwartier ROYAL HASKONING LeAF

Increasing interest in The Netherlands for constructed wetlands for effluent polishing

Realised:
- Land van Cuijk, *Waterboard De Maaskant*
- Waterpark Groote Beerze, Hapert, *De Dommel*
- Efteling, Kaatsheuvel, *West-Brabant*
- Sint Maartensdijk, *Zeeuwse Eilanden*

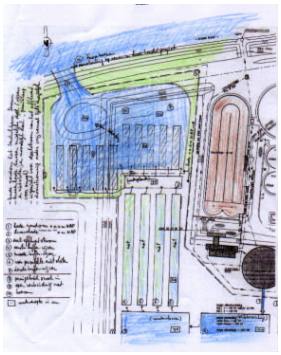
In preparation:
- Waterpark Schoonbroek, Apeldoorn, *Veluwe*
- Grou and Ameland, *Friesland Water Authority*
- Ootmarsum, *Regge en Dinkel*
- Wervershoof, Geestmerambacht, De Cocksdorp, *our waterboard*

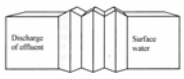
Water park Groote Beerze



STP Hapert De Dommel

Waterharmonica STP Grou?!





- Effluent polishing
- Spawning area for fish
- Fish ladder to polder water
- Water buffer

Ekeby wetland, Eskilstuna, Sweden

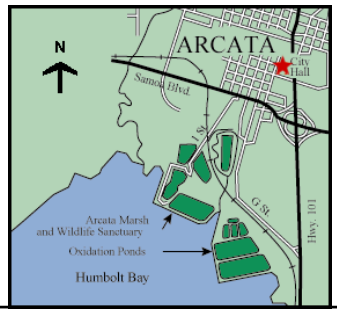
http://www.kuai.se/~leilin/vatmark/wetland.htm

The Empuriabrava WWTP

From Lluis Sala, Concorsi de la Costa Brava

Arcata Residents

"Flush With Pride"



ARCATA MARSH

INTERPRETIVE CENTER

to stimulate understanding of the Arcata Marsh Wildlife Sanctuary, it's relationship with Arcata's integrated wastewater treatment system…….

Arcata Welcomes Birders

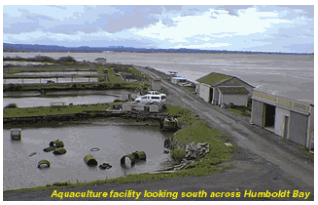
Arcata Marsh, aerial view

Arcata Aquaculture Project

City of Arcata, Humboldt State University

THE BENEFITS OF WASTEWATER

- •Cultivate fish on waste water
- •Stock wild fish population



Conclusions- 1

- Source separation is very attractive
  - But:
    - up to now only on small scale
    - expensive when sewer system already exists

www.waterharmonica.nl

Conclusions - 2

- Alternative: 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

The Waterharmonica, applies Ecological Engineering

- makes different, living water
- realises disinfection
- contributes to nutrient removal
- supports natural values
- reduces total costs for the emission approach and water system improvements
- fits within European Water Frame Work Directive

www.waterharmonica.nl

Thank you !!

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