The Waterharmonica concept; background, principles and implementation

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Introduction to the Waterharmonica

Theo Claassen

Wetterskip Fryslân

WETTERSKIP FRYSLÂN

Ruud Kampf

Waterboard

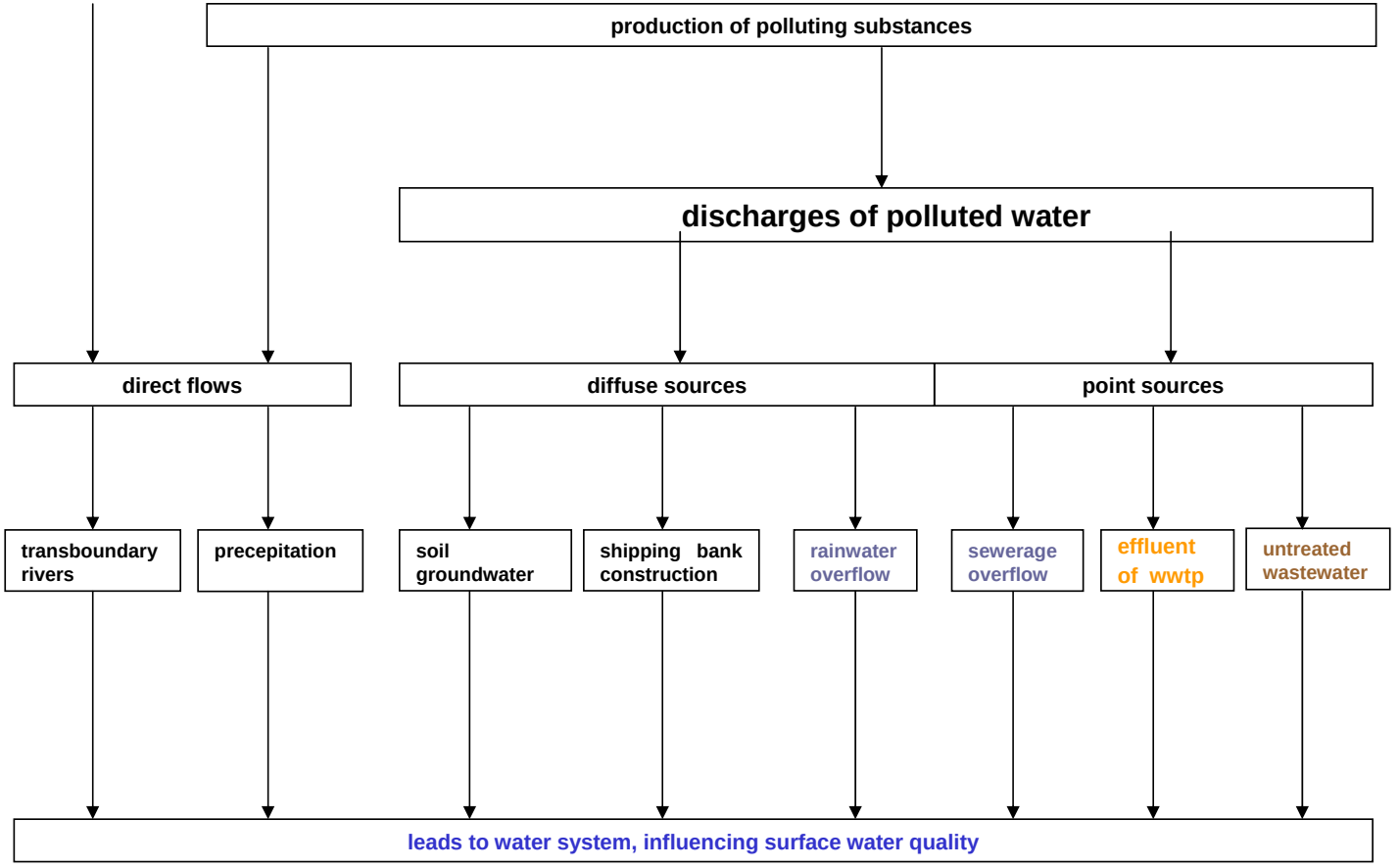
Hollands Noorderkwartier

hoogheemraadschap Hollands Noorderkwartier

This presentation

- **Water management in The Netherlands**
- Introduction to the Waterharmonica
- State-of-the-art and perspective

The Waterharmonica:
the link between wastewater and surface water


production of polluting substances
discharges of polluted water
direct flows
diffuse sources
point sources
transboundary rivers
precepitation
soil groundwater
shipping bank construction
rainwater overflow
sewerage overflow
effluent of wwtp
untreated wastewater
leads to water system, influencing surface water quality

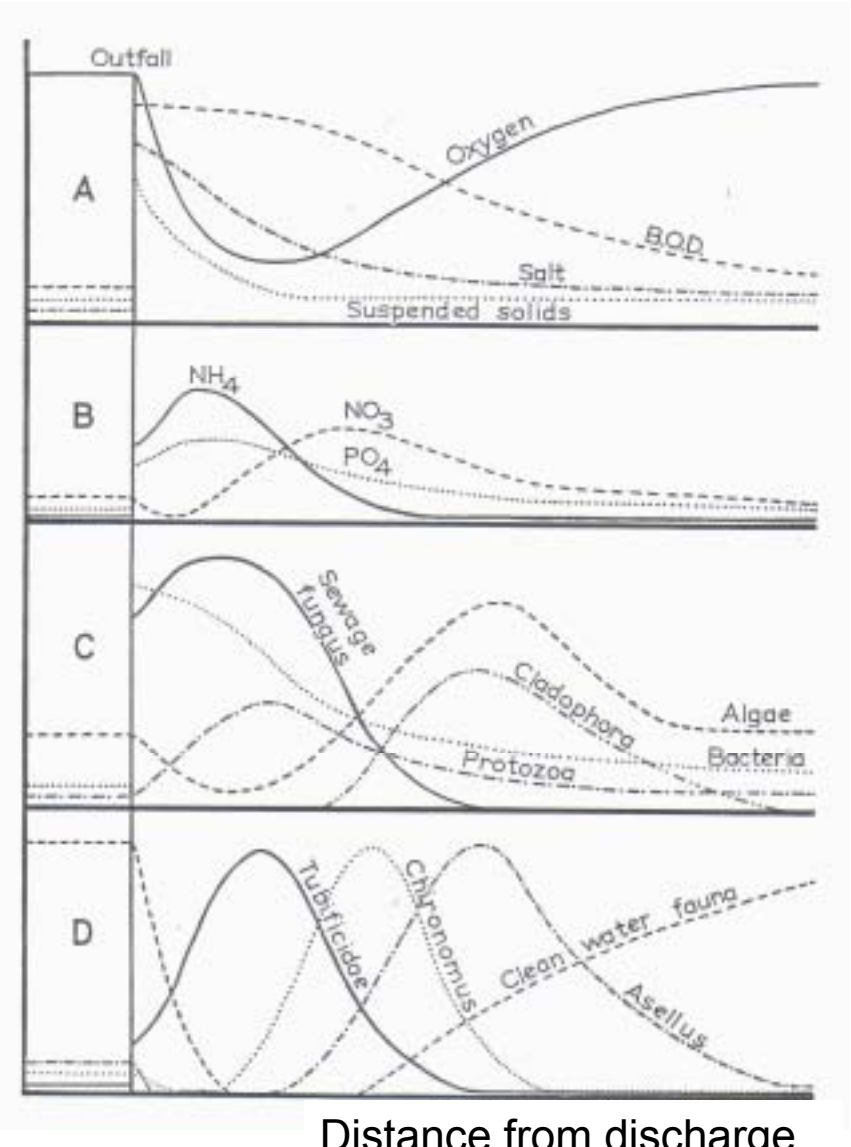
Schematic effect of discharges of wastewater

A physical – chemical

B nutrients

C micro-organisms

D macro-organisms



National policy plans related to water quality goals and standards

- 1970 Pollution of Surface Waters Act
- 1975 First Water Action Programme ’75-’79
- 1981 Second Water Action Programme ’80-’84
- 1985 Third Water Action Programme ’85-’89
- 1989 Third Policy Plan of Water Management (NW3)
- 1994 Evaluation of the Policy plan of 1989 (ENW)
- 1996 The 25th anniversary of STOWA
- 1998 Fourth Policy Plan of Water Management (NW4)
- 2000 Water Policy in the 21th century (WB21)
- 2000 EU Water Framework Directive
- 2003 National Governmental Agreement Water (NBW)
- 2003-04 STOWA Waterharmonica project

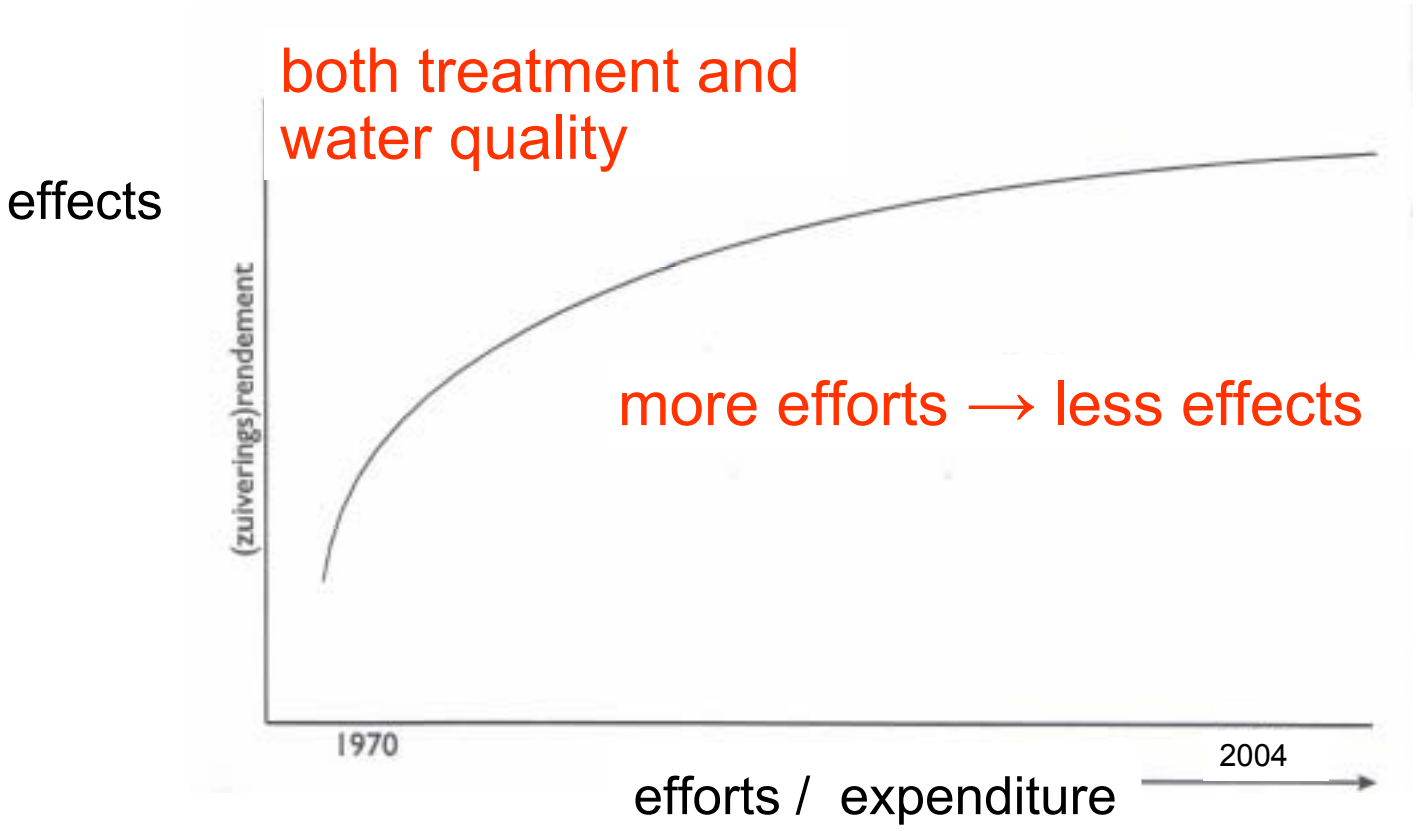
The combined approach: two separated strategies

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

Combined approach
25 years water pollution control and surface water management

- Functions and water quality standards
- Standards are not yet fulfilled
- “Effluent receiving waters”
- EU-WFD: further improvement needed
- Increasing demands for effluents
- Diffuse pollution still elusive
- Combined approach: separated strategies
- Increasing charges

The law of diminishing returns



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  from wastewater
- some basics principles

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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

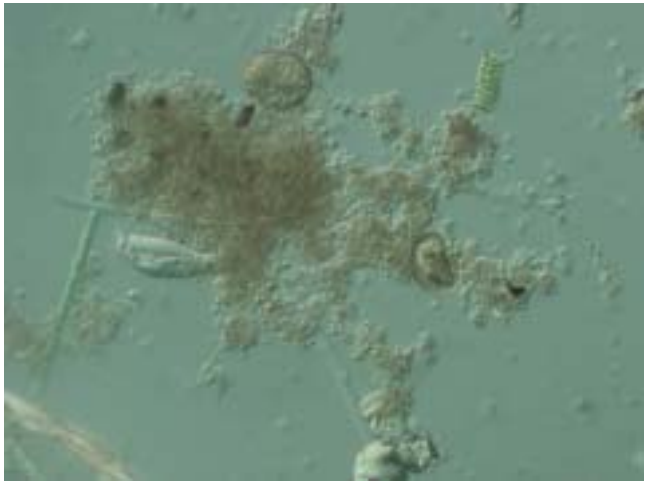
NB: faeces and urine = 80 % N, 75 % P and 100 % of pathogens

But every **disadvantage** has its **advantage**

(J. Cruijff, football philosopher)

Treated wastewater

- improvements: C, N, P
- regional WWTP's
- influence at effluent discharge:
  - sludge particles, flocks
  - loose bacteria
  - odour, foam
  - low O_2



Clear but "dead water", not satisfied with quality

Clear but “dead effluents”

It used to be the finest water we had:

it originates from drinking water and rain water

- Above that:
  - ⇨ regional WWTP’s
  - ⇨ concentrating the finest water from a region on one place

•but: it needs further treatment and care
(oxygen regime, bacteriological cleansing)

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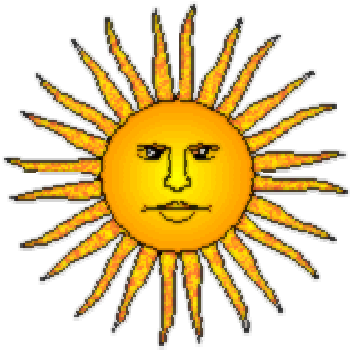
Constructed wetland

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



A constructed wetland to make “living water” from treated wastewater

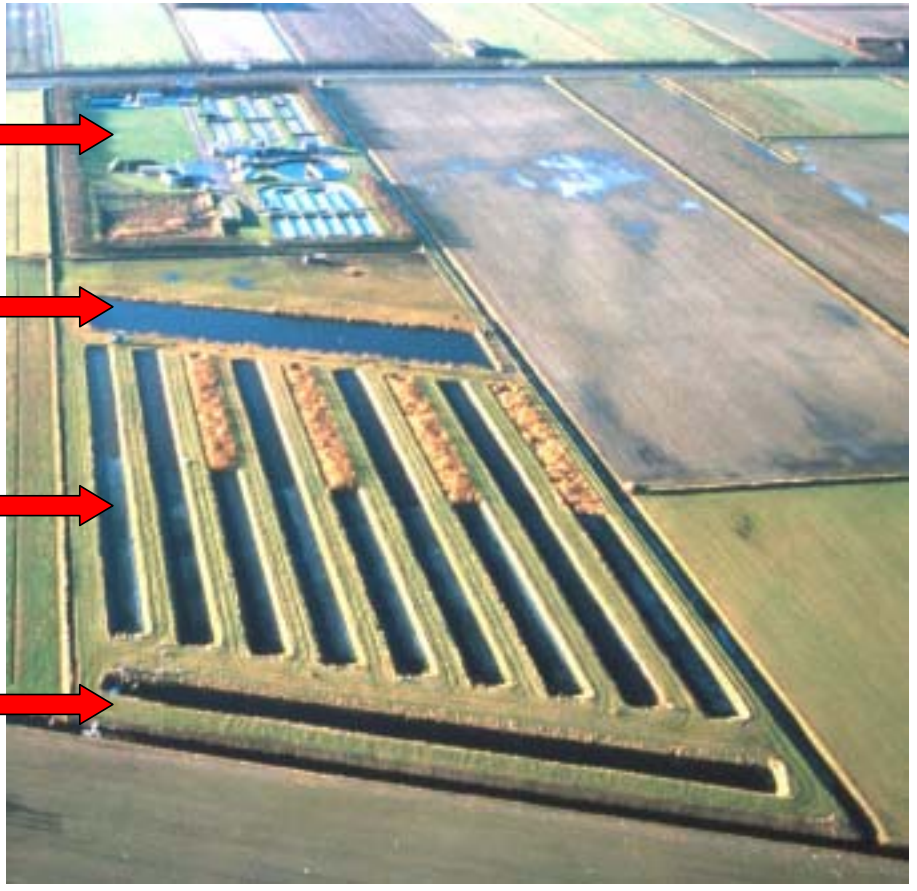
Aerial view WWTP Everstekoog

wastewater treatment plant

presettling basin

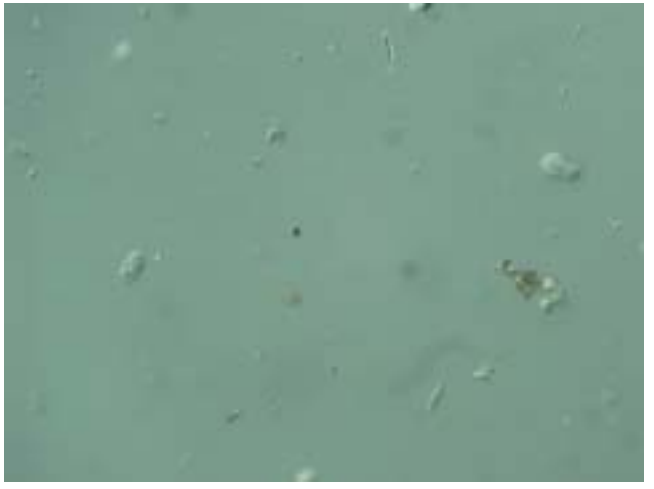
nine parallel ditches with reed/cattail and aquatic plants

discharge ditch

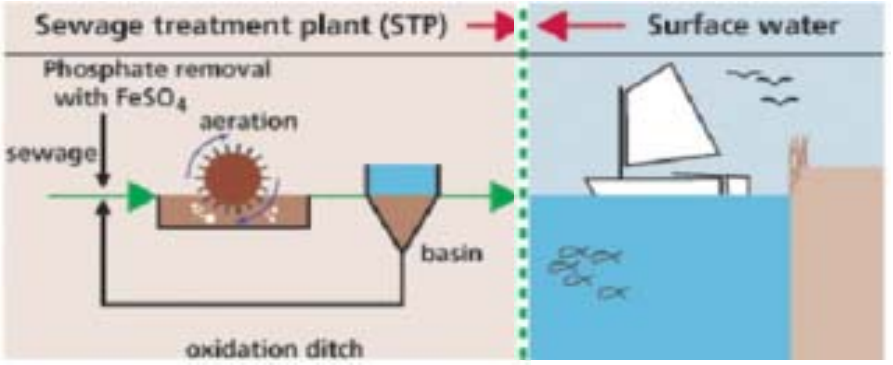


After constructed wetland ‘different water’

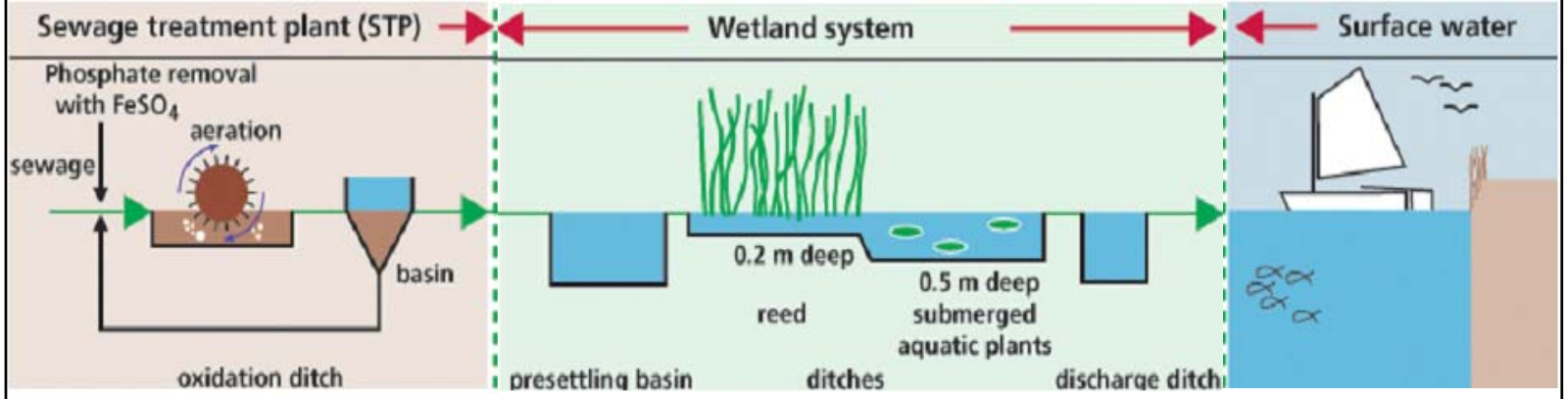
- Natural oxygen regime
- No odour
- Less sludge particles lead to disinfection
- More but different suspended solids
- Living water:
  - algae, *Daphnia*
  - all kind of aquatic life
  - fishes
  - birds



From wastewater to surface water



From the combined approach to a tripartition



Waterharmonica: combine the combined approach

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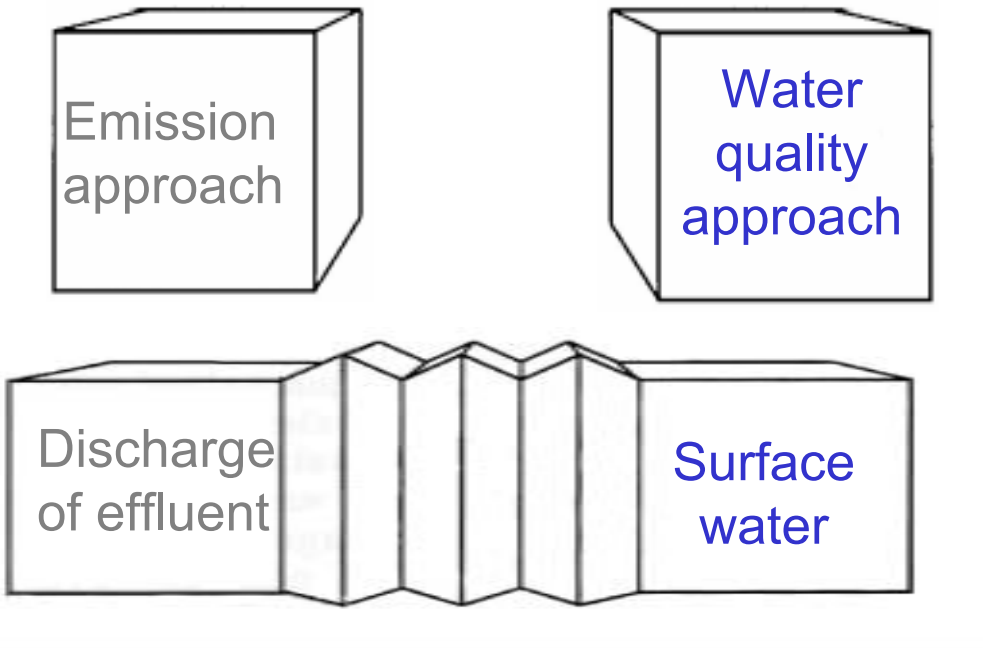
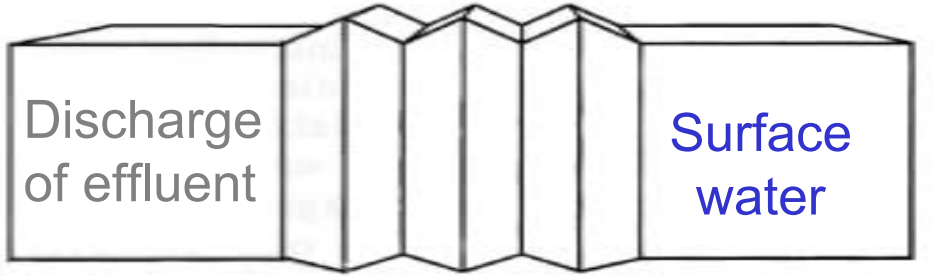
Waterharmonica as linkage-system



accordion, concertina, harmonic corridor

Waterharmonica as linkage-system



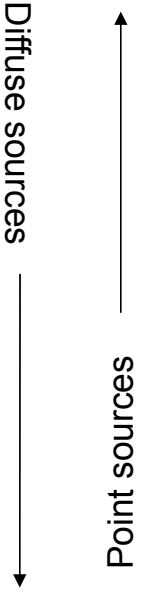
Ecological engineering

- Technology
- Artificial
- Concrete
- Pumps and pipes
- Fossil fuel
- Discharges
- Wastewater
- Control

- Ecology
- Natural
- Green
- Water, sediment and banks
- Sun energy
- Reuses
- Resources
- Manage

Waterharmonica examples of linkage-systems

- Over-dimensioning of watercourses
- Artificial shorelines
- Buffer zones, bank filtration
- Cascades
- Filtering systems, sewage farms
- Constructed wetlands



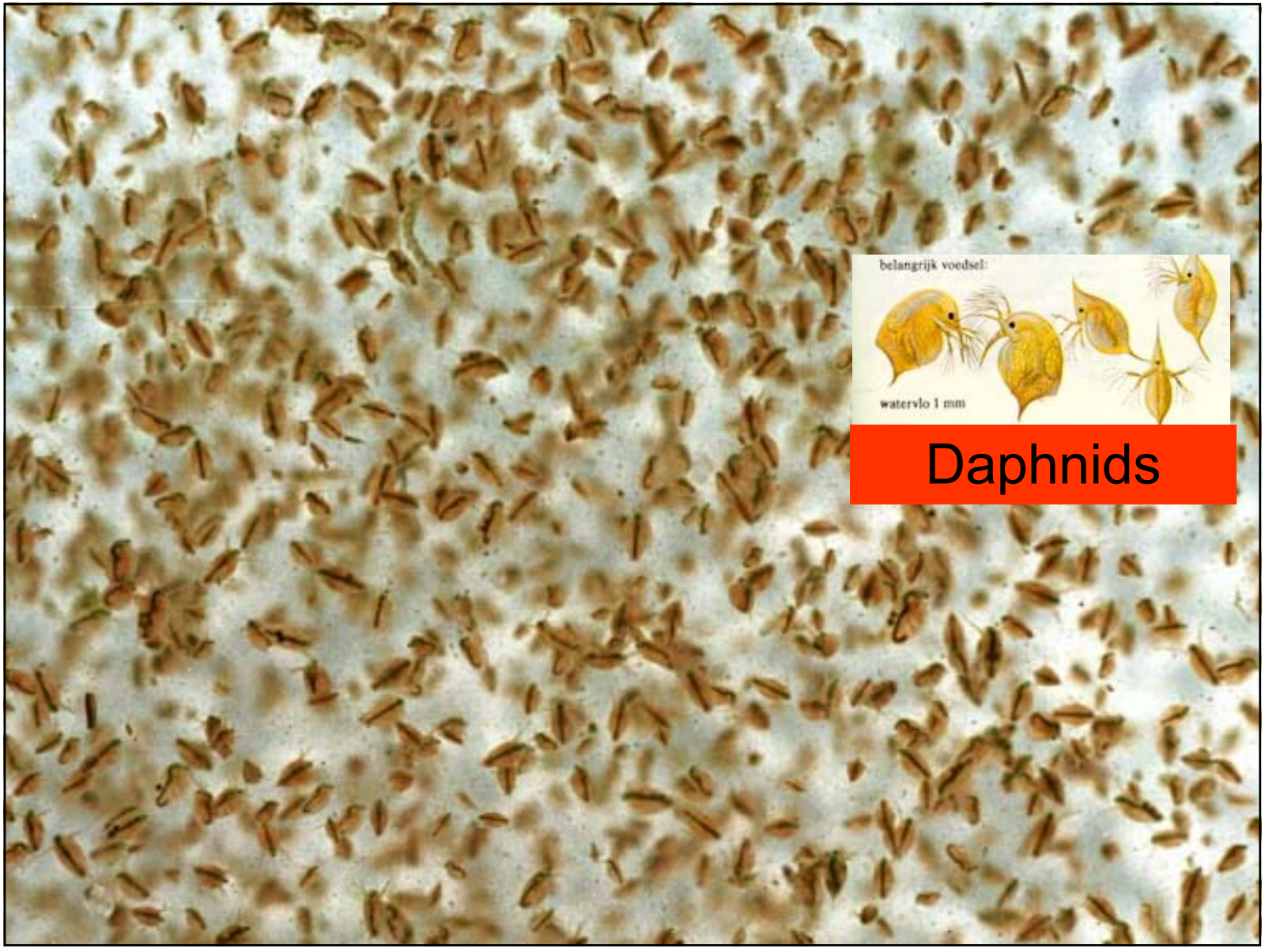
Characteristics of the Waterharmonica linkage-system

• Policy	space for possibilities, chances for ideas
• Objective	interweaving, multifunctional
• Theme	mitigate, connect, soften, cultivate
• Technology	technologically simple, ecologically well-thought
• Attainability	large, small-scale
• Sustainability	large, self supporting, less energy consuming, verifiable
• Environmental pressure	low, recycling
• Resources	reanimated water, supporting food chain

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 Sticklebacks per m^2


belangrijk voedsel:
watervlo 1 mm
Daphnids

Sticklebacks

Gastrosteus acculeatus

Pungitius pungitius

Spoonbills

Kwekelbaarsjes

"*Grickelbacks*"

growing ***Daphnia*** on treated wastewater of the WWTP

to grow **Sticklebacks**

as food for **Spoonbills**
(*Platalea leucordia*)

“Kwekelbaarsjes”

Growing *Daphnia* for nature

WWTP

Effluent

Growing *Daphnia*

Daphnia water-Unit

Harvested *Daphnia*

Water

Effluent for use in nature

Constructed wetland to make the effluent suitable for fish

Sticklebacks as food for Spoonbills

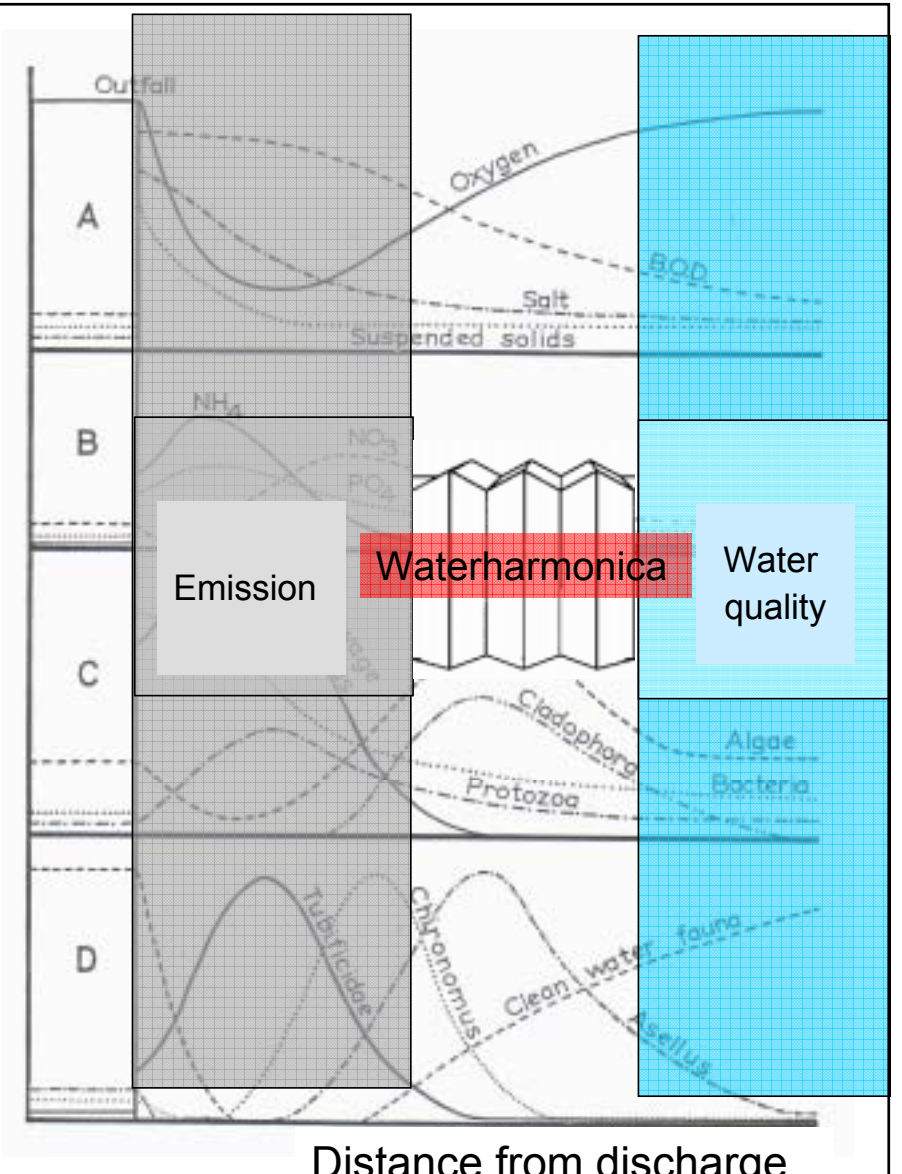
Schematic effect of discharges of wastewater

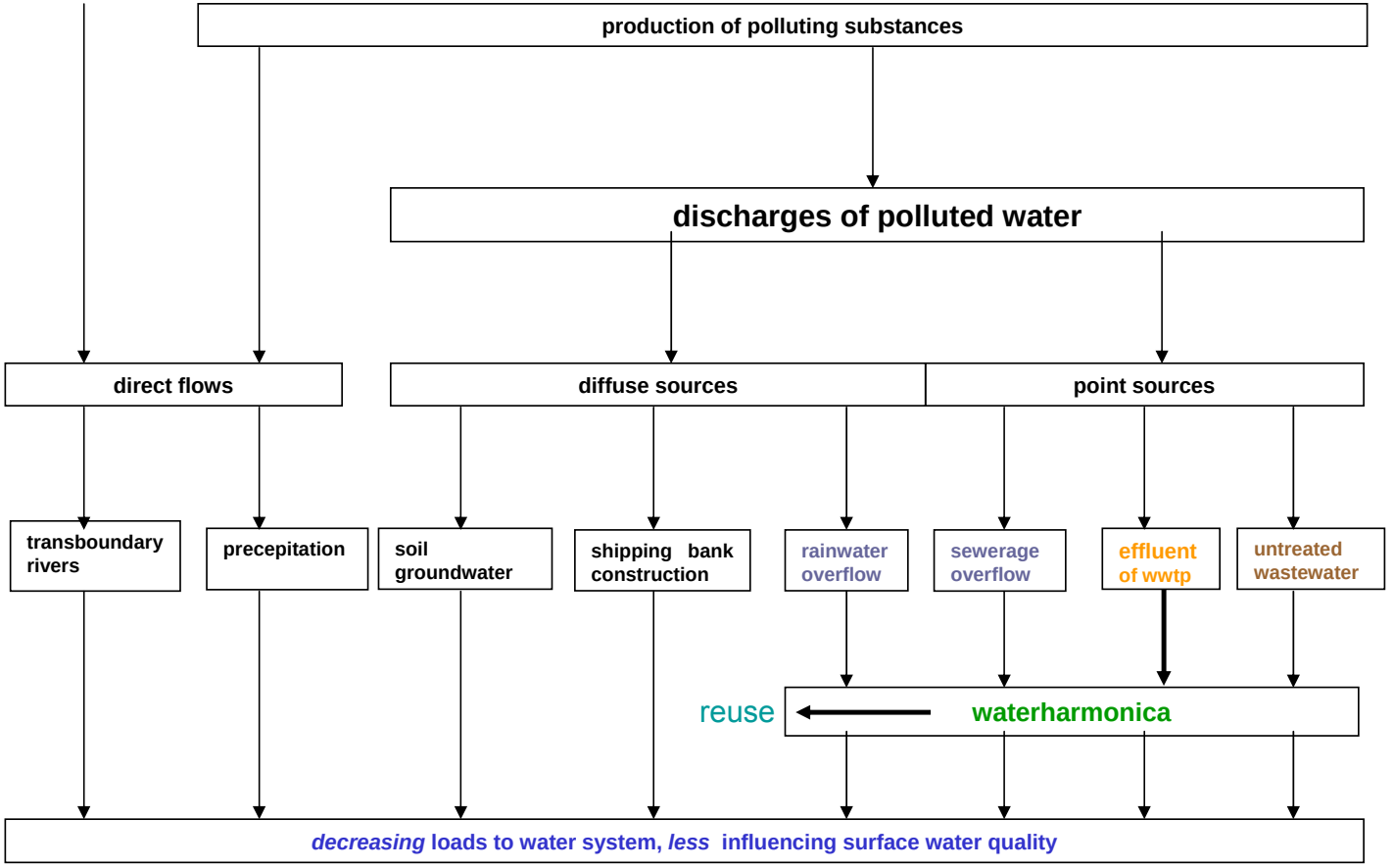
A physical – chemical

B nutrients

C micro-organisms

D macro-organisms

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reuse
waterharmonica
decreasing loads to water system, less influencing surface water quality

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From the Texel experiences

- Learning the processes by doing
- Resulted in a lot of knowledge and ideas
- Resulted in imitation elsewhere in The Netherlands
- Well treated wastewater can be reused and used for nature development

More sustainable, natural water systems

The Waterharmonica, as constructed wetland, is a promising E-E technique

- It makes different, living water
- It realises disinfection
- It contributes to nutrient removal
- It supports natural values
- It reduces total costs for the emission approach and water system improvements
- It contributes reaching the WFD standards

The Waterharmonica project

- Winning idea in 1996: 25 years celebration Dutch Foundation for Applied Water Research (STOWA)
- National and international interest and serving for a model

Ongoing STOWA project 2003-2004:
research and implementation

stowa

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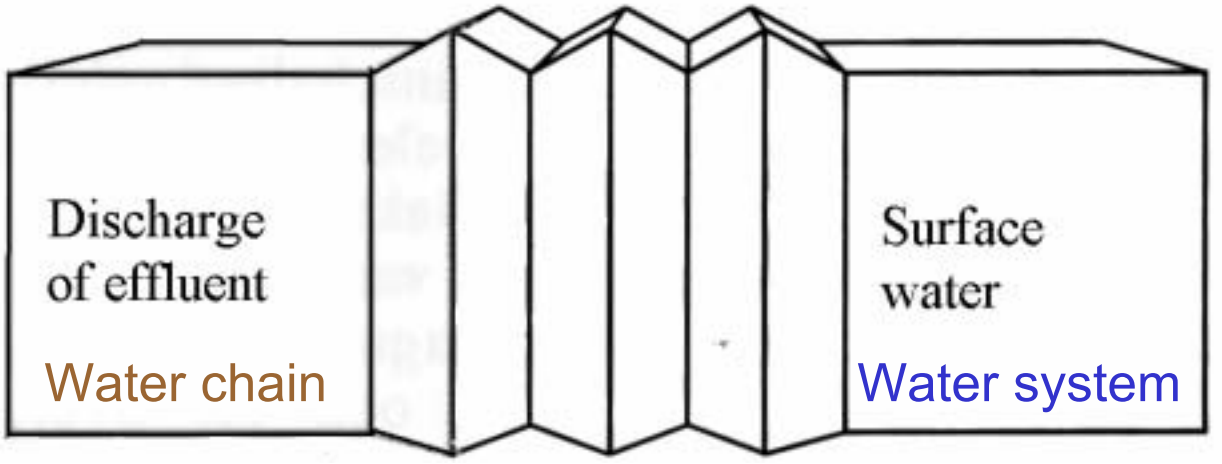
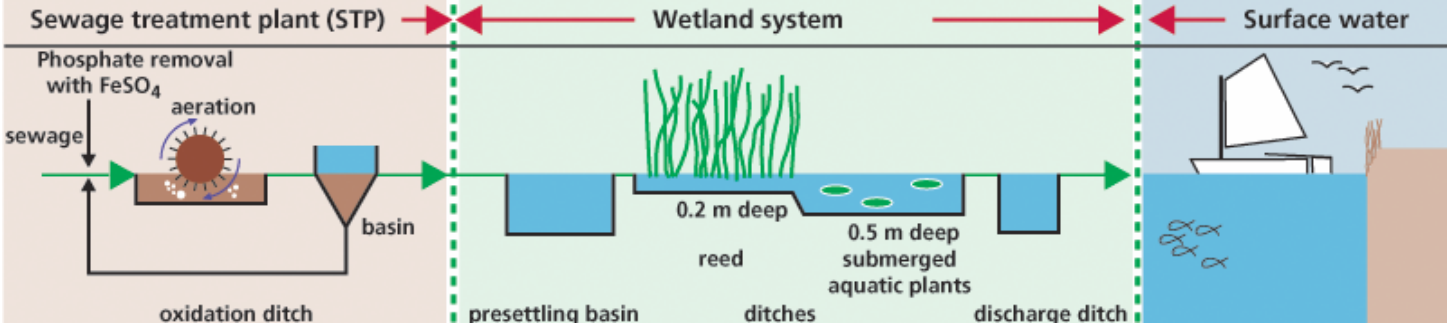
hoogheemraadschap Hollands Noorderkwartier

ROYAL HASKONING

LeAF





www.waterharmonica.nl

The Waterharmonica

- Sustainable solution
- Alternative for separate drainage and treatment
- Uses of treated wastewater
- Linkage-system between water chain and water system