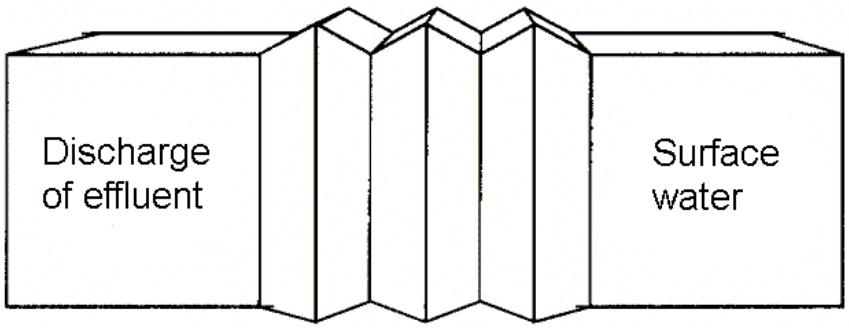
THE 7th INTECOL INTERNATIONAL WETLANDSCONFERENCE



The Waterharmonica session

afternoon July 29th

14.45 – 18.00

Jaarbeurs Utrecht

room 417

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

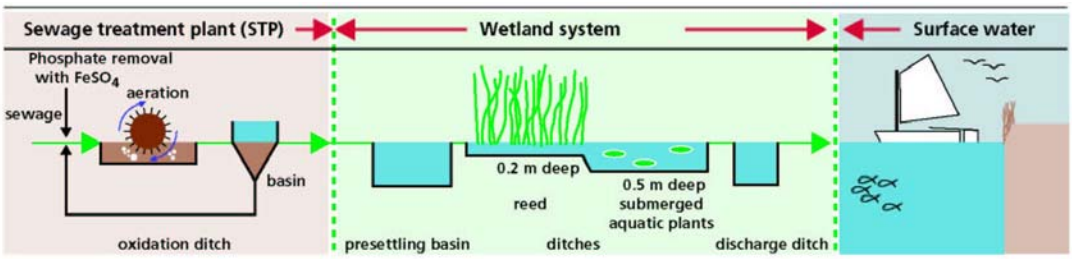
The Waterharmonica

Special Session Programme during the
7th Intecol International Wetlands Conference in Utrecht, The Netherlands

July 29th, 14.45

room 417

We want to learn from your scientific knowledge for use in our practice



www.waterharmonica.nl

A presentation offered to you by Dutch Waterboards and the project team

stowa

hoogheemraadschap Hollands Noorderkwartier

WETTERSKIP FRYSLÂN

ROYAL HASKONING

LeAF

Support Sponsorship Dutch Foundation for Applied Water Research Stowa , Waterboard Hollands Noorderkwartier, Purmerend, Wetterskip Fryslan, Leeuwarden, Royal Haskoning, Den Bosch and Lettinga Associaties Foundation (LeAF), Wageningen

Waterharmonica session, Programme afternoon July 29th

Chair: Ruud Kampf, Waterboard Hollands Noorderkwartier, Purmerend, Vrije Universiteit Amsterdam, The Netherlands

1	-	Opening of the Waterharmonica session
14.45 – 14.50		Lydia Snuif-Verwey, Member of the executive body of the Waterboard Hollands Noorderkwartier, Purmerend, The Netherlands.
2	-	Introduction to the Waterharmonica
14.50 - 15.05		Theo Claassen, Wetterskip Fryslan, Leeuwarden, The Netherlands
3	-	Description of the Stowa project the Waterharmonica, Dutch (=western situation)
15.05 – 15.25		Ton Schomaker, Royal Haskoning, Den Bosch, The Netherlands
4		Results from Dutch practice (learning process, policy making, bloopers)
15.25 – 15.45		Rob van den Boomen, Witteveen + Bos, Deventer, The Netherlands
15.45 – 16.00		Tea break
5		Effluent polishing in constructed wetlands in Europe
16.00 – 16.20		Lluis Sala, Consorci de la Costa Brava, Girona, Spain
6		Effluent polishing in constructed wetlands in the United States
16.20 – 16.40		Bob Gearhart, Humboldt State University, Arcata, United States
7		Some innovative reuse processes (Greenhouse, Baobabs)
16.40 – 17.00		Andreas Graber, University of Applied Sciences, Wädenswil, Switzerland
8	-	Waterharmonica in the "developing world"
17.00 – 17.20		Adriaan Mels, LeAf, Wageningen University, in cooperation with NOVIB/Oxfam en SIMAVI
9		Could the Waterharmonica play its role in the developing world?, a review of practical experiences, successful and less successful experiences
17.20 – 17.40		B. B. Jana, University of Kalyani, India
10		Summary, synthesis, discussion
17.40 – 18.00		Karin Tonderski-Sundblad, University of Linköping, Sweden

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De Waterharmonica

the natural link between well treated wastewater and a "healthy" surface water

The Waterharmonica already has several examples in the Netherlands

Waterschap Aa en Maas

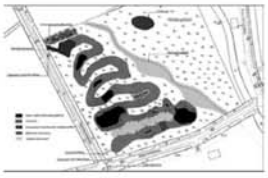
STP Land van Cuijk

Reuse of effluent water supply for agriculture and nature

Waterschap Zeeuwse Eilanden

STP Sint Maartensdijk

Natural after treatment within landscaping



Waterschap De Dommel

Waterpark Groote Beerze

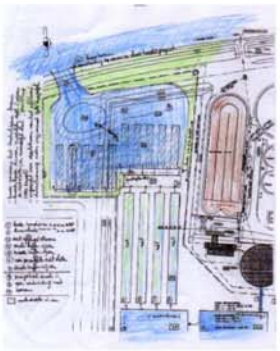
Combination of river restoration, tertiary treatment of effluent, marsh bunch and recreational area

WETTERSKIP FRYSLÂN

STP Grou

In Friesland a special wetland will be constructed in connection with the Frysian canal system:

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



De Waterharmonica

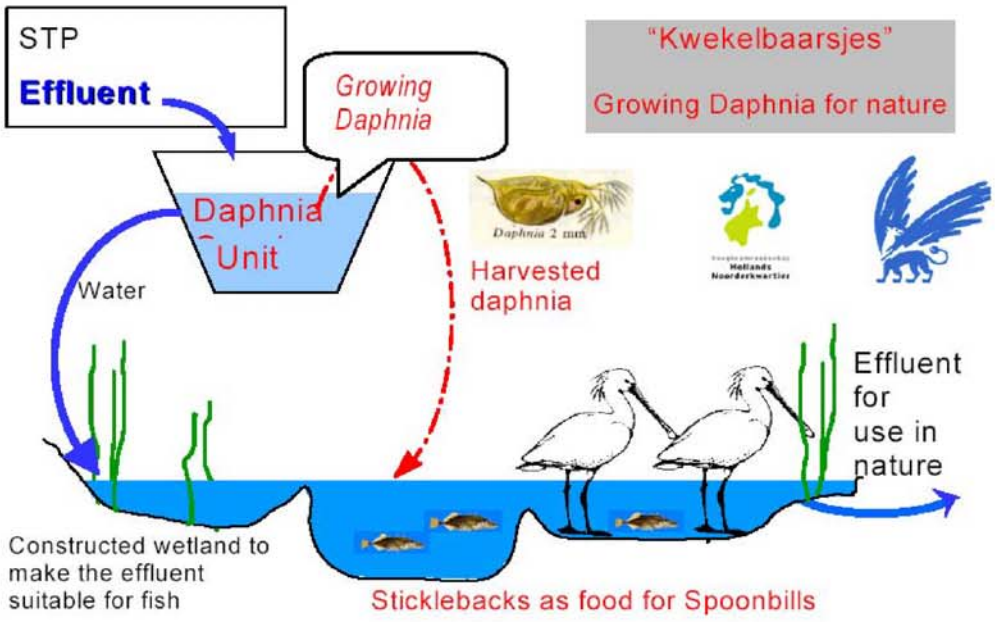
the natural link between well treated wastewater and a "healthy" surface water

Waterharmonica innovation "Kwekelbaarsjesproces"".

In the constructed wetland Everstekoog occur many Daphnia

and Stickleback

and Spoonbills



The "Kwekelbaarsjesproces" (or "Grickleback" = Growing Sticklebacks) is novel food-chain approach based on the conversion of activated sludge particles and nutrients in treated waste water in useable biomass combined with converting the effluent in a water suitable for fish

Abstracts

Waterharmonica session

Chair: Ruud Kampf, Hoogheemraadschap Hollands Noorderkwartier, Purmerend, The Netherlands (R.Kampf@hhnk.nl)

Opening of the Waterharmonica session

Lydia Snuif-Verwey (L.Snuif@hhnk.nl)
Executive body of the Waterboard Hollands Noorderkwartier, Purmerend, The Netherlands

In Dutch a Harmonica is a music instrument, called accordion in English. It is an instrument that is not easy to play. It is an old instrument dating from the middle ages, but still modern. A mechanical Water Harmonica was invented by the famous inventor, statesman, and philosopher Benjamin Franklin in 1761; a set of wine glasses mounted in a musical instrument, tuned with an amount of water, to play music.
In Dutch water management the Waterharmonica is a logical natural chain between well treated waste water and a "healthy and useable" surface water. The combination of treatment in constructed wetlands with cultivation of biomass, like Daphnia and fish, aimed at strengthening of natural values by using the nutrients from the waste water makes it a new practical form of ecological engineering.
The Waterharmonica project is a project of the Dutch Foundation for Applied Water Research, the waterboards Hollands Noorderkwartier and Fryslan (two of the largest Waterboards in The Netherlands) and is carried out by the consultancy firm Royal Haskoning together with the Lettinga Associate Foundation from Wageningen University and Research Centre.
We invite you to take part of the session to learn from your scientific knowledge for use in our practice

The Waterharmonica concept; background, principles and implementation

Theo Claassen[1], Ruud Kampf[2]
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[2] Hoogheemraadschap Hollands Noorderkwartier, Purmerend, The Netherlands (R.Kampf@hhnk.nl)

The emission approach has been and still is the basis for surface water quality improvement in The Netherlands. Diffuse sources are however hard to tackle and even nowadays they cause a considerable load to surface waters. Collection and treatment of wastewater has been tackled energetically. Nowadays point sources of untreated wastewater of any importance no longer exist in The Netherlands. However, effluents of wastewater treatment plants still have an important contribution to the loads of and impact on surface water quality. In general quality standards for surface waters have not yet been reached. Traditional measures to diminish diffuse pollution and to optimise wastewater treatment plants are very costly, as are measures in the surface water systems itself.
The Waterharmonica has been postulated as a general low-tech concept based on ecological engineering, to bridge the gap between the present day emission approach and the water system approach to reach good ecological conditions of surface waters. This concept has resulted in a research and implementation programme focused on effluent of wastewater treatment plants, and financed by the Dutch Foundation for Applied Water Research. Some Dutch water boards already have realised constructed wetlands according to this concept or are planning to realise them. An overview of these cases and the further perspective will be presented. Main advantages of these low-tech ecological engineering techniques above high tech solutions are reaching biologically reanimated water with a daily oxygen rhythm and a strong reduction of micro-organisms. It makes reuse of effluent attractive.

Description of the Stowa project The Waterharmonica, Dutch situation

Ton Schomaker
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The Waterharmonica concept fills the missing link between effluent quality of waste water treatment plants and the quality of receiving surface water. For Stowa, the Dutch Foundation for Applied Water Research, a study is carried out in 2003-2004 to determine the applicability of the Waterharmonica concept in practice. The results of this study will be reviewed by presenting an overview of Waterharmonica projects in The Netherlands, the status of the Waterharmonica according to Dutch and European policy for water quality (Water Framework Directive), highlights, gaps and developments in knowledge and, last but not least, social and scientific acceptance by policy makers, water quality managers and public opinion. Dissemination of the Waterharmonica concept in The Netherlands will be stimulated in two workshops, intended for water quality managers of the Dutch waterboards.

Results from Dutch practice (learning process, policy making, bloopers)

Rob van den Boomen
Witteveen+Bos consulting engineers, Deventer, The Netherlands (r.vdboomen@witbo.nl)

In the Netherlands, several constructed wetlands are build according to the concept of Water-harmonica. They function as a natural buffer between waste water treatment facilities and the receiving surface waters. Within the principle of Waterharmonica several applications are developed, differ from design (open water and ditches), residence time, type of vegetation, role of top soil layer, maintenance and pollutants to be reduced.
By designing, building and operating these systems for years now, several new insights are developed in the Netherlands. What should you do and what not? What have we learnt? Not only have we defined more detailed design criteria, but specially made clear what is still unknown or unpredictable. And do we need to estimate the resulting water quality exact or is a natural, more or less fluctuating output, acceptable?
In this lecture, special interest will be given to the process of learning by doing. Also attention will be given to conflicting situations in i.e. land use, enough water quantity or water quality, buffering peak discharges or not, et cetera. Mistakes are mentioned.

Multiple benefits of the environmental reuse project at the Aiguamolls de l'Empordà Nature Reserve (Costa Brava, Girona, Spain)

Lluis Sala and M. Serra[1], A. Huguet, J. Colom and M. Carré[2], S. Romero de Tejada[3]
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[2] SEARSA, Doctor Fleming, 12, E-17480 Roses, Spain. (searoses@arrakis.es)
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What is known today as the Parc Natural Aiguamolls de l'Empordà (Nature Reserve of the Empordà Wetlands) are the remains of a much larger wetland area located between the mouths of two Pyrenean rivers: the Muga and the Fluvià. These coastal wetlands included several freshwater lakes which were progressively drained starting in the XVIIIth century. The Parc Natural dels Aiguamolls de l'Empordà (PNAE) was created in the mid-80's in order to preserve the remains of these coastal wetlands from urbanization and have turned into a popular place for birdwatchers. To avoid summer dessication, the PNAE and the Consorci de la Costa Brava (CCB, Costa Brava Water Agency)

developed a project in order to be able to supply reclaimed water from the Empuriabrava WWTP for the Cortalet lagoon in the summer months. This project consisted of a 7 ha constructed wetland system consisting of 3 vegetated cells plus a shallow lagoon, a pumping station and a pipeline and wooden bridge for pedestrians to link the community of Empuriabrava (left bank of the Muga river) with the WWTP (right bank). The capital costs of this project were 1.44 million euros (1996 value), which were 80 % funded by the EU and 20 % by the CCB. This project has been in operation since summer 1998 and it produces between 500,000 and 750,000 m3/year, which are reused for environmental purposes at the Cortalet lagoon. The constructed wetland system itself has become another important point for waterfowl observation, whereas the reduction of discharges in the Muga river has produced a clear and measurable improvement in the bacteriological quality of the nearest beach.

Effluent polishing in constructed wetlands in the United States

Bob Gearheart
Environmental Resources Engineering, Engineering Department, Humboldt State University, Arcata, US
(rag2@humboldt.edu)

This paper will present examples of the various applications of Free Water Surface (FWS) constructed wetlands to produce high quality effluents in the United States (USA). The utilization in the USA of constructed wetlands to meet advance and tertiary discharge/reuse standards fall into several categories.

Free surface constructed wetlands are preceded by municipal secondary treatment systems and are being used to meet high TSS and BOD effluent discharge standards to meet Total mass discharge limits (TMDL) to receiving waters. Discharge levels of less than 10 mg/l met 99 % of the time is typical of this application.

A second category of FWS constructed wetland application is in reducing nitrogen forms, ammonia, nitrate nitrogen, and in a few cases phosphorus forms for variety of receiving water benefits. In those areas in the USA where toxicity and/or temperature sensitive fish population are found (anadramous, etc.) ammonia toxicity is an issue. FWS constructed wetland are being used to both reduce discharge thermal inputs and to reduce ammonia toxicity. The total nitrogen level is reduced due to plant uptake of ammonia nitrogen and the denitrification of nitrates. The temperature of the effluent in hot summer conditions have been shown to be reduced by as much as 3 to 4 degrees centigrade due to solar input interception and black body effects. FWS constructed wetland have been shown to produce ammonia nitrogen levels of less than 1 mg/l in several applications.

Phosphorus removal is a third category of advance treatment application for FWS constructed wetlands. These applications require significant land area and relatively low levels of phosphorus entering the system. There has been some successful application for use of FWS constructed wetlands to meet seasonal phosphorus standards (summer period) when receiving waters are reactive to phytoplankton stimulation by phosphorus.

A growing application for FWS constructed wetlands in water short states, specifically California, Arizona, Nevada, Florida, and Colorado, are being used to meet direct and indirect water reuse standards. These reuse standards generally require TSS, BOD, total nitrogen, to be less than 1 mg/l with turbidity levels of 1.0 NTU's or lower. Several large communities in the US Southwest, Phoenix, Arizona, Orange County Sanitation District, California, and Albuquerque, New Mexico are utilizing FWS constructed wetlands for reuse purposes. There are more FWS constructed wetlands in Florida than any other state in the United States. The majority of these systems are producing a tertiary effluent and are being used to directly and indirectly augment water supplies i.e. Orlando, Lakeland, Palm Beach Country Regional, and others.

It has been shown that not only do FWS constructed wetland meet technical discharge standards but they have also been shown to reduce fears and concerns associated with water reuse. The constructed wetland's unique characteristic, "natural treatment", has not only added to the publics acceptance of reuse of these effluent but has also added significant ancillary benefits.

Some innovative reuse processes in Cascade Systems

Andreas Graber
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Waterharmonicas link discharges of society with ecosystems through constructed wetlands. The human influence and control decreases from high in sewage treatment plants to low in wetlands to zero in natural open waters. Possibly separated from the natural environment, but in total human control are food production systems with closed nutrient cycles. This ecological sustainability can be achieved by a sophisticated combination of various production modules in polycultures. Each module uses the wastes of others as input and in turn produces resources for adjacing modules, is placed along the trophic food chain and functions by using nutrients and energy as a subsystem within a cascade. Examples for such Cascade Systems are wastewater-fed aquacultures, aquaponics (combined fish and vegetable production), but also complete ecosystem reconstructions like the Baobab Farm in Kenya. Sharing the concept of nutrient recycling, the Waterharmonica is essentially a Cascade System where man forgoes production values in favour of an autonomous and self-developing ecosystem, but profiting from recreational values and other ecosystem services. By illustrating the mentioned examples, the common ground and differences of both concepts will be presented and future applications discussed.

Waterharmonica in the "developing world"

Adriaan Mels[1], Joost Jacobi[2], Frans Huibers[2]
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[2] Wageningen University, Irrigation and Water Management Group (Joost.Jacobi@wur.nl), (Frans.Huibers@wur.nl)

By 2025, fresh water use is expected to have grown world wide by 40%, while the only source of fresh water that will increase significantly in the coming decades is urban wastewater. Increasing use of untreated or treated urban wastewater as an alternative source of water is therefore unavoidable. This paper discusses the use of eco-engineered systems, such as constructed wetlands, as an intermediate system between (partially treated) wastewater and water and nutrient reuse in e.g. agriculture and aquaculture. The principles of these systems tend to match quite well with the requirements for sanitation systems at many locations in the developing world, such as: i) A low or absent energy (electricity) requirement; ii) Easy operation without highly skilled operators; iii) Permanent and continuous operation without too much maintenance and with more or less constant effluent quality; iv) Possibility to produce biomass (e.g. duckweed, fish, crops) by making use of the available nutrients; v) Applicability at variable scale and especially feasible in rural areas.
The paper will be illustrated by a case study in the watershed of the city of Matagalpa, Nicaragua, executed in cooperation with Projecto Cuencas Matagalpa and NOVIB. Matagalpa is largely dependent on the rivers San Fransisco and Molino Norte for its drinking water supply. These rivers are diffusely polluted by agricultural and domestic wastewater.

Could the water harmonica play its role in the developing world? A review of practical experiences, successful and less successful experiences

B.B. Jana
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Water is the matrix of life, creating the benign environment that is required for the existence of life on earth. Much of our economic activity in the society is dependent upon the availability of fresh and clean water supplies, which is stated to be the lowest per capita in Asia. Recent focus on severe groundwater depletion warrants appropriate water saving strategies like groundwater recharge and discharge, conservation of water, sustainable use of water and water sources through various economy driven integrated holistic approaches maintaining a balance and harmony in the natural

hydrologic cycle necessary for sustainable development. More specifically, rational use and reuse, conservation and recharge of natural pool of water tune water harmonica in a rhythmic fashion. There is an urgent need for integration of hydrologic balance driven activities in the natural pool of water favourable to sustainable development. Since Ramsar Convention, wetlands have assumed worldwide movement of importance because of numerous services they discharge to the society. In India, these are of immense value to the humanity as millions are involved in earning their bread and butter from these wetlands. Majority of the world's population faces problems related to basic requirements of clean water, education, health care, food security and environment. There are many ways where end of the pipe solutions can be optimised for a larger degree of recycling. Economy driven utilization of wetlands for various activities has a major role for poverty alleviation and sustainable development. The ever-increasing rates of urbanization and industrialization have resulted in the generation of unprecedented amount of wastewater from point and diffuse sources. Sewage may become either a resource or a pollutant depending on the state of treatment and their use. Sewage fed aquaculture is a unique system for biological production using the 5 R policies of cleaner production. It is an integrated biosystem with at least two sub systems, the wastes from the first subsystem used by the next subsystem producing value added products. In this low cost environment friendly balanced ecosystem, organic wastes are recycled into fish biomass since fish may be the cheapest animal protein when grown on wastes or wastewater. Moreover, in tropical countries, fish grows more rapidly and thus replace the need for expensive supplementary feed and conventional chemical fertilizers. Apart from acting as a major source of fish protein to the masses, the wastewater fed wetlands can also be used for a multidisciplinary economy driven activities which help not only for their conservation but also for the upliftment of rural economy since they are used for the mass production of life food as natural food for fish, source of fertilizer for horticulture and crop farming, irrigation of water for agricultural activities, hydroponics for crop production and sludge as source of fertilizer. All these integrated multidisciplinary economy driven holistic approaches help not only poverty alleviation but also conserve water and wetlands, reclaim wastewater, combat environmental pollution in a more definitive balanced way that create a benign environment necessary for harmony in the natural hydrologic cycle conducive to the society. The paper examines the state-of- the-art of the immense value of wetlands to the millions of people for their livelihood through production of different value added products using the principles of systems ecology and will comment on the thoughts behind the waterharmonica concept as an appliance low cost ecological engineering.

Summary, synthesis, discussion

Karin Tonderski-Sundblad, University of Linköping, Sweden, (karsu@ifm.liu.se).

This special session will be reported by Maarten Claassen, Waterboard Amstel, Gooi en Vecht , Amsterdam, maarten.claassen@dwr.nl

Two papers

The Use of Treated Wastewater for Nature: The Waterharmonica, a Sustainable Solution as an Alternative for Separate Drainage and Treatment

R. Kampf*, T. H. L. Claassen**

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** Friesland Water Authority, P.O. Box 36, 8900 AA, Leeuwarden, The Netherlands

Paper presented at the IWA-Leading-Edge Technology, LET2004, WW5, 3 June 2004, 9:00, Prague, Czech Republic

Use of the Waterharmonica for conversion of treated waste water into a natural resource in the developing world

Ernst-Jan Martijn [a], Ruud Kampf [b], Theo Claassen [c] and Adriaan Mels [a]

[a] *Lettinga Associates Foundation (LeAF), Wageningen*
[b] *Waterboard Holland Noorderkwartier, Edam*
[c] *Friesland Waterauthority, Leeuwarden*
The Netherlands

Presentation at the conference Ecological Engineering for Integrated Water Management (Oct. 30 - Nov. 2, 2003) Harvard Graduate School of Design, Cambridge Mass., USA