Waterharmonica in the ‘developing world’

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Claassen (1996) Concept at 25th Anniversary of STOWA

“explore the application potential of the Waterharmonica in developing countries and preparation of demonstration projects in Nicaragua and Nepal”
What is the Waterharmonica?

1. Dutch water policy instrument highlighting the ‘missing link’ and quality gap between treatment plant and surface water (or ‘water chain and water system’)
2. Eco-engineered post treatment
3. Food chain approach (daphnia, fish production)
4. Transition zone between ‘society and nature’
How can such a typical Dutch / European approach be transferred / translated to a developing world context?

1. Hardly any wastewater treatment plants available in major part of the world

2. Water and wastewater problems in developing world are related to untreated wastewater discharge, health, water shortages etc. and not to ‘MTR’ values and nature development
Population not served with improved sanitation

Total unserved: 2.4 billion
Population not served with improved water supply

Total unserved: 1.1 billion
Evolution of global water use

Note: Domestic water consumption in developed countries (500-800 litres per person per day) is about six times greater than in developing countries (60-150 litres per person per day).

Inefficient Water Usage, Loss of Soil Fertility, Pollution of Rivers, Lakes and the Seas
UN Millennium Water Goals, Johannesburg, 2002

• By 2015 to reduce by one-half the proportion of people without access to hygienic sanitation facilities

• By 2015 to reduce by one-half the proportion of people without sustainable access to adequate quantities of affordable and safe water
Domestic wastewater is a potential resource of water and nutrients in agriculture and aquaculture.

Some potential benefits:

• Alleviation of water scarcity: treated wastewater can replace higher quality water resources

• Reduced need for fertilization: treated wastewater provides crops and fish feed with nutrients;

• Treatment and biomass production maybe integrated and may form an attractive economic activity
Waterharmonica in developing countries:

Instrument for integrated planning of treatment and reuse with eco-engineered system as the ‘missing link’
<table>
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<th>Characteristic</th>
<th>Effects</th>
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| Plant macro nutrients                  | • Benefit is a reduced need for fertilization  
• A major point of attention: nitrogen overdose might result in nitrate contamination of ground and surface water  
• Excessive N&P may lead to micro nutrients deficiency (Pathogenic micro-organisms)  
  • health risk to farm workers, nearby residents, crop handlers and consumers.  
  • Pathogens do NOT penetrate the crops, only at places of injury and under conditions of extremely high pathogen concentration (Crook 1998)  |
| Pathogenic micro-organisms             |                                                                                                                                               |
| Inorganic soluble salts                | • Long term application may lead to degradation of agricultural land (soil salinisation and sodification)  
• Ion specific plant-toxicity, mainly associated B, Na and Cl  
• Corrosion or clogging of irrigation water distribution and filter systems  |
| (Ca, Mg, Na, K, B, Cl, Carbonates and Sulphates/Sulphides) |                                                                                                                                               |
| Biodegradable organic matter and suspended solids | • Too high concentrations may result in clogging of water distribution systems and / or soil pores. |
| Trace elements                         | • Trace elements include heavy metals and trace organic toxic or carcinogenic substances (e.g. pesticides, insecticides, drug residuals and endocrine disrupting compounds);  
• The concentration of most trace elements is generally lowered by 70-90% during secondary treatment;  |
| Effluent flow-rate                     | • Matching demand and supply; the irrigation water requirements are in most cases not continuous, while the effluent production is (although it may vary).  
• Need for construction of effluent storage tanks / basins which could be combined with tertiary treatment (e.g. ponds)  |
Eco-engineered wastewater treatment, appropriate technology:

Requirements for sanitation systems in transition countries tend to match quite well with the principles of ecological engineering, such as:

• Can be combined with agriculture and aquaculture (wastewater is potential source of water and nutrients)
• Easy to construct with locally available material;
• Relatively easy operation (although maintenance required!);
• Low or absent energy (electricity) requirement
• Especially feasible in rural, agricultural areas
Food chain approach: production of biomass

• Tropical wetland plants have a high productivity and continuous growing season. The annual production of e.g. naturally grown papyrus can be more than 100 tonnes per hectare per year. In constructed wetlands where nutrients are not limiting, it may be even higher (Denny, 1997).

• Duckweed production in combination with fish culture (e.g. Tilapia)

• Production of Vetiver grass

Wastewater treatment might turn into an economic activity?
Part II: potential demonstration project

Application of eco-engineered solutions to prevent pollution of the Cuencas (river basin system) of Matagalpa, Nicaragua that is used as a source for the drinking water supply
City of Matagalpa: 160,000 inhabitants (4% growth / year)

Located in centre of Nicaragua in the mountainous river basins (‘Cuencas) of Moline Norte and San Francisco
River basins of Matagalpa are main source of drinking water of the city:

- Water quality is affected by upstream coffee farmers and domestic wastewater
- Water discharge of the rivers is decreasing
- Wood for fuel leads to deforestation (approx. 50%): enhancing erosion and decreasing water holding capacity
Projecto Cuencas Matagalpa (PCM) – Platform of 22 water stakeholders in the region

- Awareness raising and education
- Reforestation
- Alternative fuels (biogas / waste products of coffee production
- Water quality improvement

Supported by Novib and Aqua 4 All (Netherlands)
Fact finding mission

Joost Jacobi of Wageningen UR:

- Inventory of water quality and quantity
- Application of eco-engineered solutions?
Coffee farmers

15 large farmers (min 140 ha): 80% of production
115 smaller farmers
Drinking water intake

Main intake point (80%)
Coffee production season during critical discharge period: Februari - May

- River discharge low
- Water consumption relatively high
- Coffee wastewater = 5-10% of river water
- High BOD and nutrient load
All upstream river water is used for drinking water during dry period

Main intake upstream of Molino Norte

Survey among population of Matagalpa
• Taste / odour and skin irritation
• Situation has improved (!)
• Filtration or buy water during the coffee season
Drinking water treatment of Matagalpa: physical-chemical treatment; not sufficient to removal pollutants during coffee season
Process
Dry method  Semi washed  Washed

Harvesting
Pre-sorting, cleaning, floating

Pulping
Mechanical Mucilage Removal

Finish Fermentation

Washing

Drying and Hulling

Products
Inhomogeneous Coffee Cherries
Homogeneous Coffee Cherries
Demucilated, wet parchment coffee
Green coffee

By Products
Sticks, stones
Unripe and overripe cherries
Coffee Pulp
Pulping water
Liquified or raw mucilage
Wash Water
Coffee Husk

‘Agua Mieles’
pH ~ 3.5; COD ~ 5 g/l

Drying and reuse as briquettes
Existing wastewater treatment at coffee farmers

- Drying of pulp and reuse as briquettes
- ‘Pilas’ (infiltration pits)
- Partial anaerobic treatment at 6 larger coffee farms
- One farm with full treatment (‘La Hammonia’)
Incentives / constraints for all farmers

• Legislation will require treatment in coming years (COD < 200 mg/l)

• Financial: World Market Price of Coffee is dramatically low, no ‘willingness to pay’

• Lack of knowledge on cost effective treatment
World Market Price of Coffee

International Coffee Price 1993-2002

Year

US$/QQ

0 20 40 60 80 100 120 140 160

Coffee farm ‘La Hammonia’

- Reservoirs
- Neutralisation tank (NaOH)
- Settling tank for agua miel
- Bioreactors (2 x 150m³)
- Recycling (+/- 50%)
- Filter and aerobic treatment
- Bio filter
- Lagoon (regulation outflow)
- Lagoon (regulation outflow)
- Washing water from cowshed
- Washing water from chicken stable

Sprinkler irrigation

Recycling (+/- 50%)
Why did La Hammonia implement this system?

- More activities (agriculture diversification, hostel for tourists)
- Financially strong (large farm)
- Pro-active...?
Follow-up

Formulate a set of ideas / strategies that could be used by PCM, NOVIB and Aqua for All:

Technical ideas
• Decentralised wetlands for treatment of coffee wastewater combined with production of wood / reed for charcoal
• Centralised wetland before the drinking water intake (possible to combine with nature development / tourism?)

General
• Financial strategy, support for coffee farmers for implementation, combined payment by all stakeholders?
• Knowledge transfer...
Knowledge transfer...

Aqua for All and NOVIB have mobilized volunteers of two Water Boards (Hollands Noorderkwartier and De Dommel) to offer technical assistance