How Can Natural Systems Contribute to Achieving the Required Paradigm Shifts in Integrated Urban Water Management?

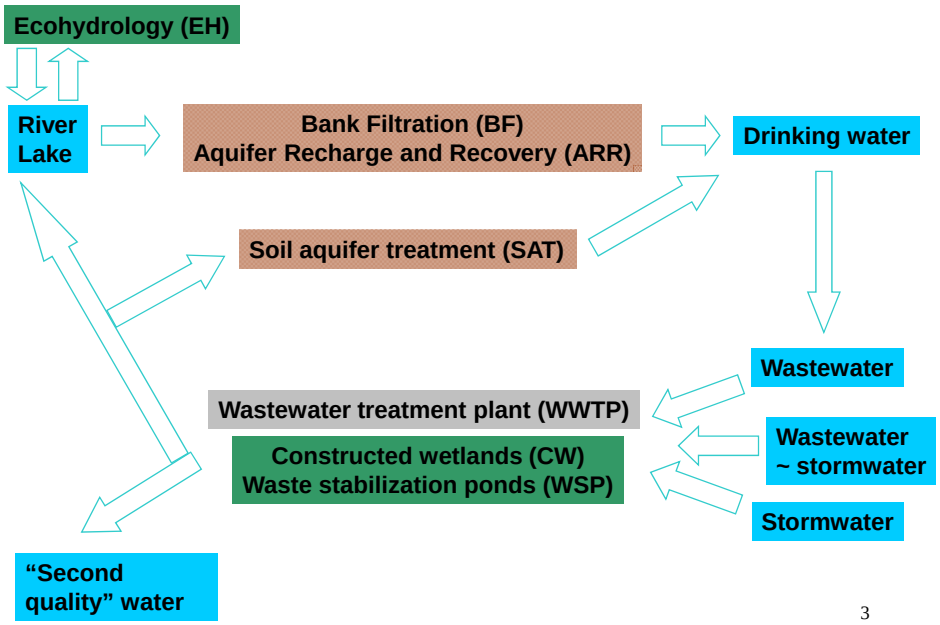
Diederik Rousseau, Saroj Sharma, Sung Kyu (Andrew) Maeng, Hans van Bruggen and Gary Amy

- 1 -
INTRODUCTION

SWITCH ScM – Belo Horizonte, Brazil – December 2, 2008

UNESCO-IHE Institute for Water Education

Natural Treatment Systems



3

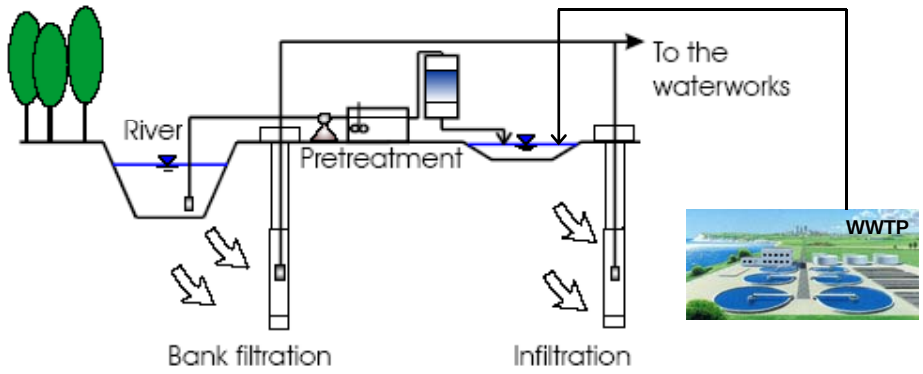
Specific Advantages of Natural Systems

- ***Natural* and *Sustainable* Treatment**
- A Multi-Objective (≈Contaminant) Process
- Removal of Turbidity and Suspended Solids
- Removal of Biodegradable Organics
  - Bulk Organic Matter
  - Trace Organic Compounds
- Removal of Microorganisms
- Removal of Nutrients (to varying degrees)
- Low Investment and Operation Cost
- Ancillary benefits

4

- 2 -
SYSTEM DESCRIPTIONS

Bank Filtration (BF), Infiltration (ARR) and Soil Aquifer Treatment (SAT)



River bank filtration (RBF) Lake bank filtration (LBF)	Aquifer Recharge and Recovery (ARR) Soil Aquifer Treatment (SAT)

(Source: Kuehn, 2003)

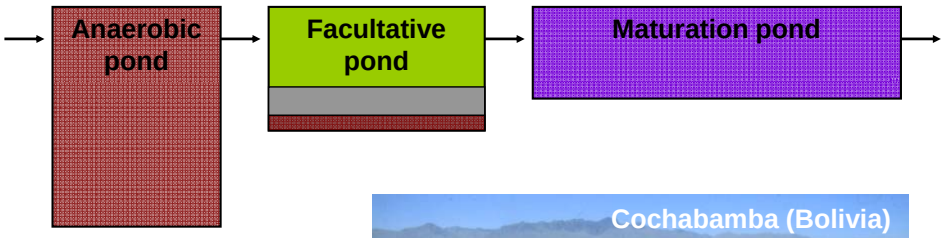
6

Limitations of RBF/LBF and SAT/ARR

- Only Limited Barrier for Certain Contaminants
  - Same is true for Granular Activated Carbon, Advanced Oxidation and Membranes
  - Proven Barrier for Microbes
- No Reliable Transfer of Experiences to Other Locations
  - Need for Pilot and/or Demonstration Scale Testing
  - Soil Column Experiments ⇨ Scale-Up?
- Possible Release of Fe and/or Mn at Some Sites
  - Need for subsequent oxidation (post-treatment)
  - Also, Possible Release of Arsenic (As) and Fluoride (F^-)

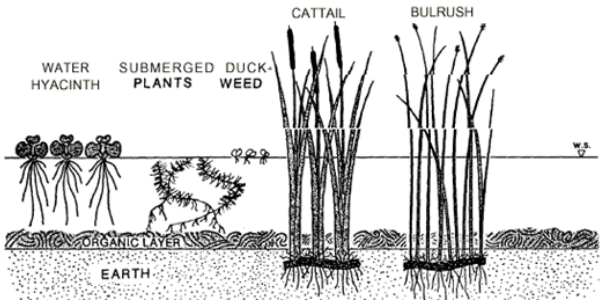
7

Main Types of WSP



Main Types of CW

- Based on water flow characteristics
  - surface flow (visible water surface)
  - subsurface flow (water below soil surface)
- Based on plant species characteristics
  - Floating, submerged or emergent plants



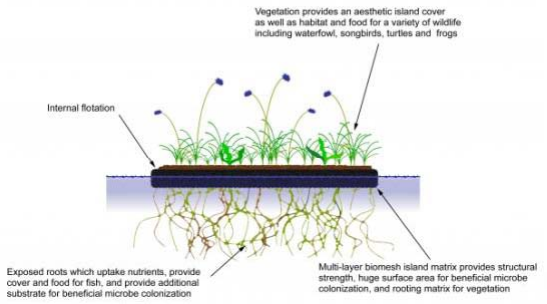
9

Limitations of CW and WSP

- Space requirement
  - Hybrid and tertiary treatment wetlands
  - Aerated wetlands and lagoons
  - Wastewater Storage and Treatment Reservoirs
  - High-rate algal ponds
- Lack of good models for design and operation
  - Currently only rules of thumb, first-order equations
  - Need for mechanistic models (2D/3D)
- Uncertainty about carbon balance
  - No consumption of fossil fuels
  - Anaerobic conditions ⇨ emission of N_2O and CH_4

10

Ecohydrological techniques



Floating islands

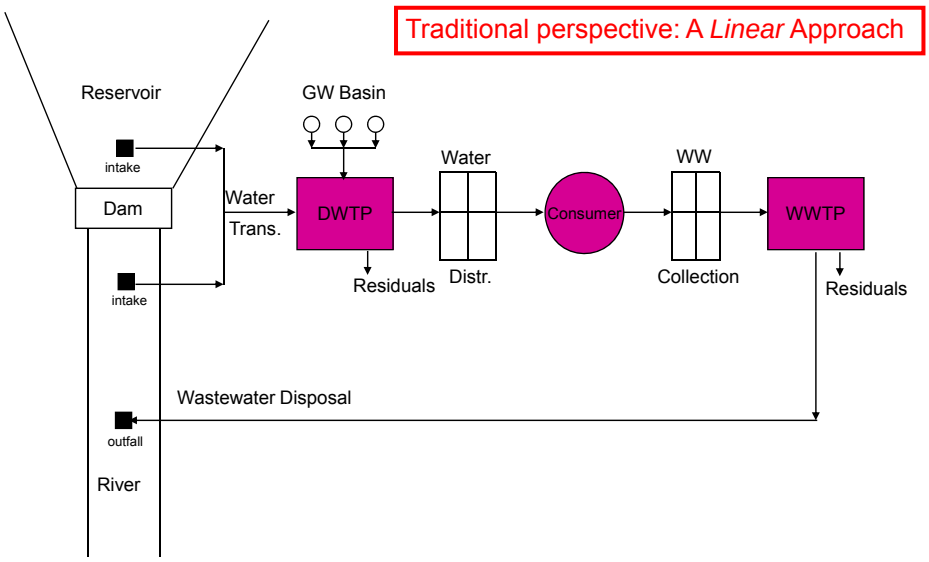
Controlled flooding area



- 3 -
PARADIGM SHIFTS

Paradigm 1: wastewater as a resource

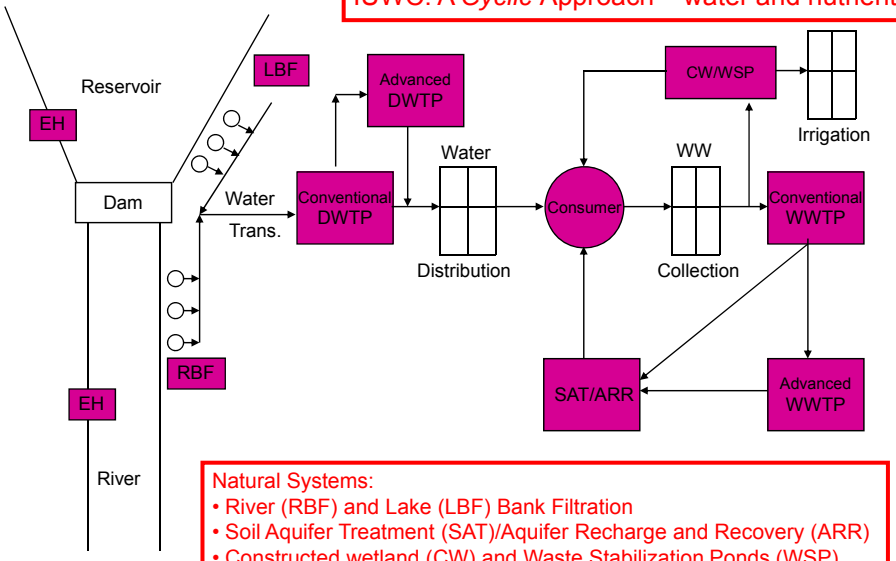
Traditional perspective: A *Linear* Approach



13

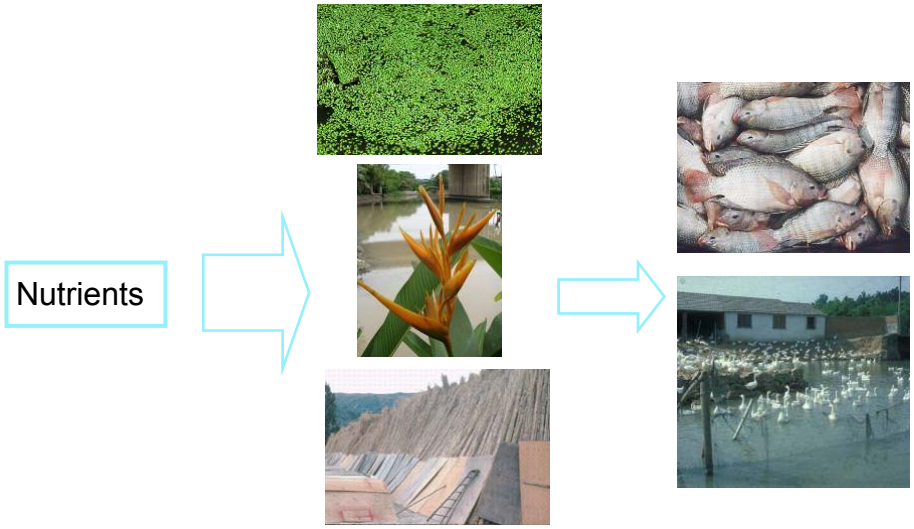
Paradigm 1: wastewater as a resource

IUWC: A *Cyclic* Approach – water and nutrients



Natural Systems:
- River (RBF) and Lake (LBF) Bank Filtration
- Soil Aquifer Treatment (SAT)/Aquifer Recharge and Recovery (ARR)
- Constructed wetland (CW) and Waste Stabilization Ponds (WSP)
- Ecohydrology (EH)

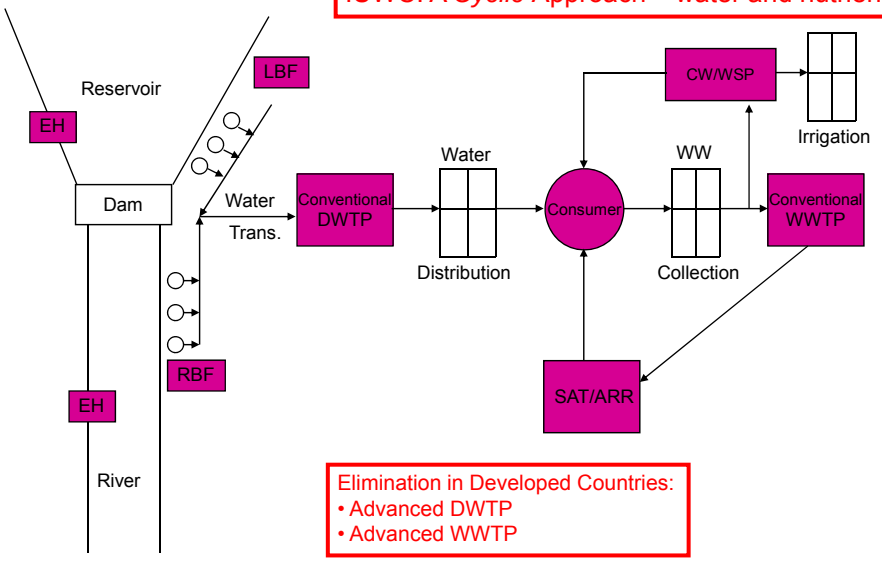
Paradigm 1: wastewater as a resource



15

Paradigm 1: wastewater as a resource

IUWC: A *Cyclic* Approach – water and nutrients

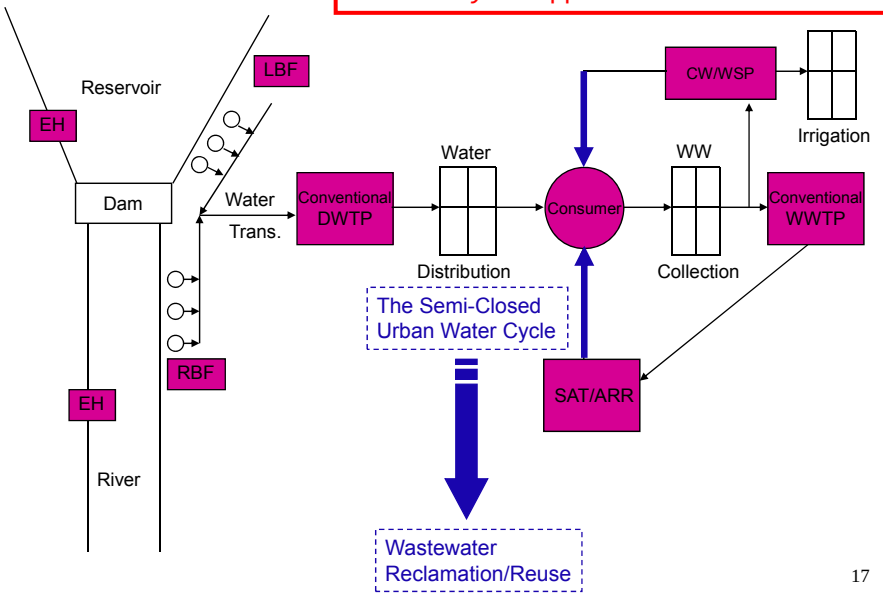


Elimination in Developed Countries:
- Advanced DWTP
- Advanced WWTP

16

Paradigm 1: wastewater as a resource

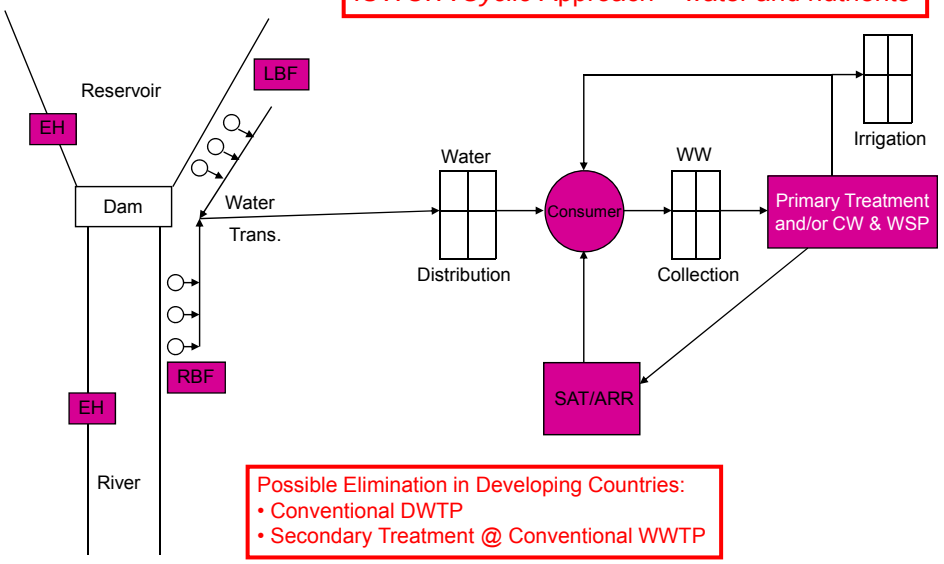
IUWC: A *Cyclic* Approach – water and nutrients



17

Paradigm 1: wastewater as a resource

IUWC: A *Cyclic* Approach – water and nutrients



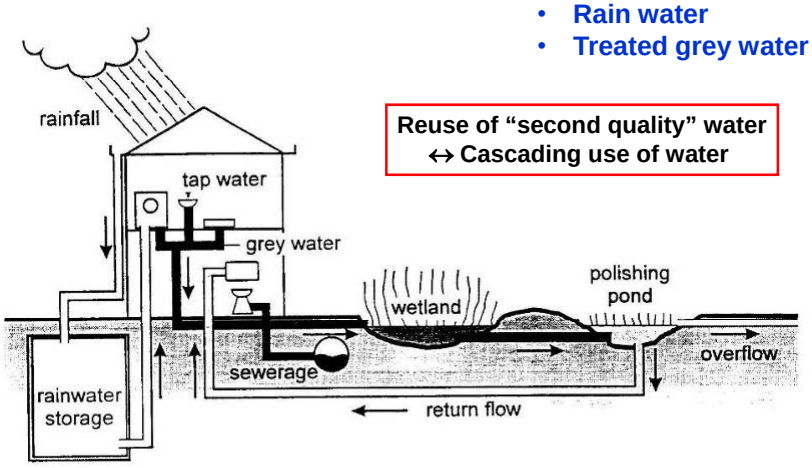
Possible Elimination in Developing Countries:
- Conventional DWTP
- Secondary Treatment @ Conventional WWTP

18

Paradigm 2: water quality according to use

Case Polderdrift (NL)

- **Potable water**
- **Rain water**
- **Treated grey water**



Reuse of "second quality" water ↔ Cascading use of water

50-60% water savings

19

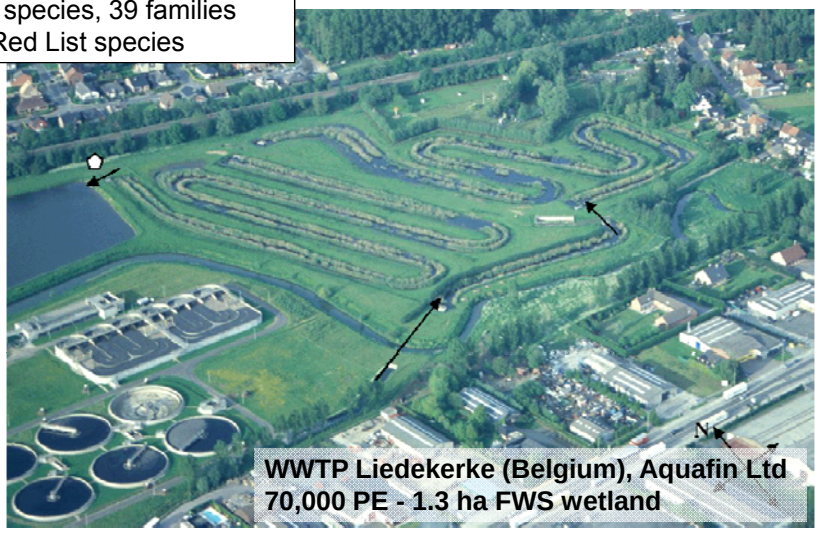
Paradigm 3: decentralization

GEWOONBOOT: autarctic houseboat as the Dutch answer to climate change?

20

Paradigm 4: diversity in solutions

712,834 birds spotted (2 yr)
132 species, 39 families
29 Red List species



WWTP Liedekerke (Belgium), Aquafin Ltd
70,000 PE - 1.3 ha FWS wetland

21

Paradigm 5: stakeholder involvement

Case Emaús, Brazil

22

- 4 -
SWITCH CONTRIBUTIONS

What Should be done to Promote Natural Treatment Systems?

- **Development of Design Guidelines, Nomographs, Software, Decision Support Systems for Application**
- **Including, and Officially Recognizing Natural-System Technologies for Water and Wastewater Treatment**
- **Information Dissemination: Making Design Engineers, Planners and Educators aware of the Potentials of Natural-System Technologies (training and capacity building; demonstration projects)**
- **Networking among professionals involved in Natural-system Technologies (at regional and national level) for information sharing and collaborative research**

24

Next presentations

Setup of an In-stream Treatment Facility for Urban Creek Revitalization - Belo Horizonte, Brazil

Marcos von Sperling (UFMG)

Mobility of Viruses in an Urban Sandstone Aquifer

Fernander Aller (University of Birmingham)

Alternative Hybrid UF-SAT or SAT-NF Treatments to Upgrade Effluent Quality

Avi Aharoni (Mekorot Water)

Bank Filtration as a Robust and Effective Barrier for Bulk Organic Matter and Organic Micropollutant Elimination

Andrew Maeng (UNESCO-IHE)



- 5 -
CONCLUDING REMARKS

Concluding remarks

- Natural Treatment Systems are cost effective and environment friendly technologies that can reduce stresses on water resources
- There is an enormous potential for application of natural systems for treatment of water and wastewater in developing countries
- Natural Treatment Systems should be considered as alternatives to conventional water and wastewater treatment technologies
- Natural Treatment Systems need to be adapted to suit the local conditions and requirements

27

THANK YOU !



d.rousseau@unesco-ihe.org
g.amy@unesco-ihe.org