Forum on Eco-Efficient Water Infrastructure Development: Good Practices of Eco-efficient Water Infrastructure

Decentralised Waste Water Treatment System (DEWATS)

Presentation by

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Urban Water - Status and Trends

Water abstraction

– Although increasing, water withdrawal for urban use is relatively low: industrial (including energy) use is 20%, domestic use is 10%.

– Urban growth increases indirect demand for water needed to sustain cities e.g. agriculture, energy, etc.

– Worldwide, groundwater provides more than 30% of urban water supply.

– More than 40% of 100 world's largest cities rely on runoff-producing areas that are fully or partially protected e.g. New York City.

– Uncertainties exist about the scale of future demands influenced by population growth and changing consumption patterns.

Urban Water Status and Trends: Discharge of wastewater

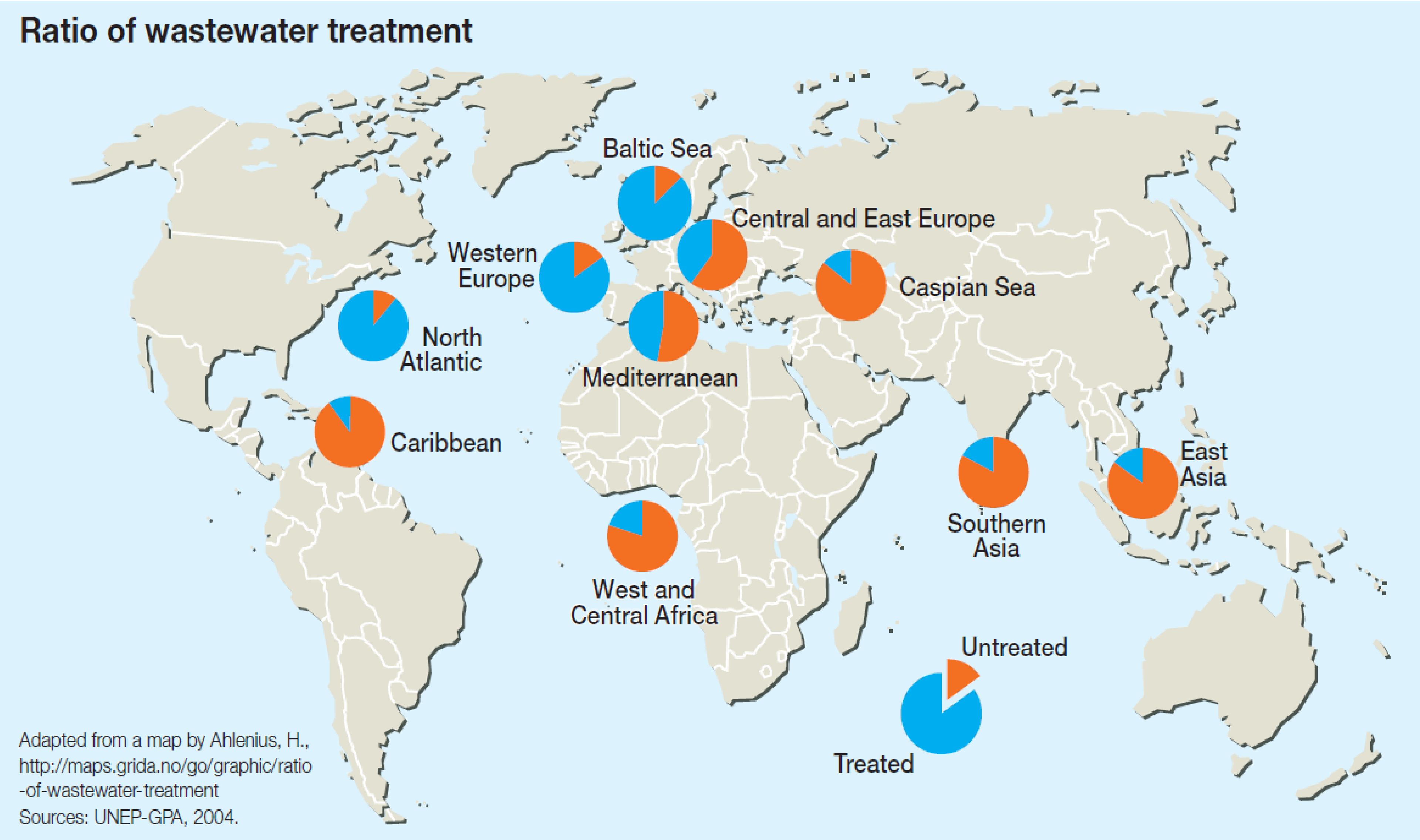
- Urban settlements are the main source of point-source pollution. Urban wastewater is particularly threatening when combined with untreated industrial waste.
- Treatment of urban sewage is largely limited to high-income countries, improvements are still possible e.g. Urban Wastewater Treatment Directive in Europe led to improved treatment capacity.
- In many fast growing cities(small and medium sized cities with populations < 500,000) wastewater infrastructure is non-existent, inadequate or outdated.

Urban Water Status and Trends: Discharge of wastewater

In Jakarta (population: 9 million) less than 3 % of the sewage generated daily -1.3 million m3 -is treated. Sydney (population: 4 million) treats nearly all its wastewater (1.2 million m3 per day).

–Point sources such as sewage discharge are increasingly controlled, concern now shifting to non-point pollutant loads from storm-generated runoff.

Wastewater treatment worldwide



Impacts of urban water on ecosystems: Discharge of Waste Water

- Also it resulted in breakdown of water supply and wastewater treatment systems and hence in heavy pollution of rivers and drinking water supplies e.g. downstream cities, industrial and mining regions.

- –Major losses of sea-grass habitats occurred in the Mediterranean, Florida Bay (USA), and Australia, and increasing e.g. in Southeast Asia and the Caribbean.

Impacts of urban water on ecosystems

- Worldwide, **freshwater ecosystems most significantly changed by human activities:**
  - Wetland ecosystems (lakes, rivers, marshes, coastal regions of 6 meters depth at low tide) being degraded and are lost more rapidly than other ecosystems.
  - In many parts of the world, the capacity of ecosystems to provide clean and reliable sources of water has declined over the past 50 years.
  - Freshwater deterioration particularly acute in cultivated systems, dry lands, **urban areas, and wetlands.**

Impacts of urban water on ecosystems

- **Impacts of urban water on ecosystems not fully and systematically studied. Cities highly diverse, impacts vary.**

Water abstraction

- **Increasing water demands leading to over-abstraction from groundwater, areas outside cities, upstream watershed areas, rural areas.**
- Excessive groundwater abstraction result in **water quality degradation and land subsidence.**
- Bangkok, Manila, Tianjin, Beijing, Chennai, Shanghai, and Xian experienced 10-50 meters decline in water table levels resulting in many cases to water quality degradation and land subsidence.

Impacts of urban water on ecosystems

- Mexico City: supplying aquifer fell by 10 meters as of 1992 resulting in land subsidence of up to 9 meters.
- Over-abstraction in coastal areas results in **saltwater intrusion: In Europe 53 out of 126 groundwater areas show saltwater intrusion, mostly aquifers used for public and industrial water supply.**

Impacts of urban water on ecosystems: Discharge of Waste Water

- **Wastewater contributes to increase in eutrophication and dead zones. About 245,000 km2 of marine ecosystems are affected by dead zones, impacting on fisheries, livelihoods and the food chain.**
- **Discharge of untreated wastewater shifts problems to downstream areas. In coastal ecosystems, sea grass ecosystems/habitats in coastal areas are damaged; invasive species increasing in estuarine ecosystems.**
- The 1990s economic recession and decline in highly polluting industries led to reduced discharge of wastewater and pollutants in Eastern Europe, improving river quality in many places.

Urban water, ecosystems and economies

- **Investments in wastewater treatment or upstream watersheds have high returns including water supply security.**

  –Integrated watershed management in Catskill Mountains ensures water supply for New York city (> 9 million users) at cost of USD 1 billion instead of investing USD 4-6 billion in a large water treatment facility.

- –Xiamen generated funds from collecting fees for use of sea areas, waste disposal and improving waste standards, and invested USD 2 billion in sewage treatment, resulting in increased treatment of industrial sewage (20 % in 1994 to 100 % in 2000s) and of domestic sewage (28 % in 1995 to 85 % in 2007). Now Xiamen attracts immigrants, tourists,

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Urban Wastewater

- Most of the cities in developing countries have no sewerage system
- The world's developing cities not only face the challenge of supplying adequate sanitation facilities to its residents, but must also ensure that the available water resources are not contaminated.
- The discharge of untreated wastewater is a major contributor to deteriorating health conditions and pollution of nearby water bodies
- The problem is expected to increase due to rapid pace of urban growth, unless measures are taken to control and treat effluents.

Treating Urban Wastewater is Challenging

- Only less than **8% wastewater in developing world** are treated
- **Latin America:**
  - less than 20% of the wastewater collected is actually treated
- **Europe:** of 540 major cities,
  - only 79 cities have advanced tertiary sewage treatment, 223 have secondary treatment,
  - 168 cities have no or an unknown form of treatment of their wastewater
- **Canada:** need to upgrade its treatment facilities in cities cost C$ 33 billion
- **United States:** Spent about US$ 70 billion on STP since 1972
- **China:** Investing USD 41 billion for STP in between 2006 to 2010.

About DEWATS – as a Concept

- DEWATS stands for ***"Decentralized Wastewater Treatment Systems"***
- It is a technical approach rather than merely a technology package.
- DEWATS applications are based on the principle of low-maintenance since most important parts of the system work without technical energy inputs and cannot be switched off intentionally.
- DEWATS applications provide state-of-the-art-technology at affordable prices because all of the materials used for construction are locally available.

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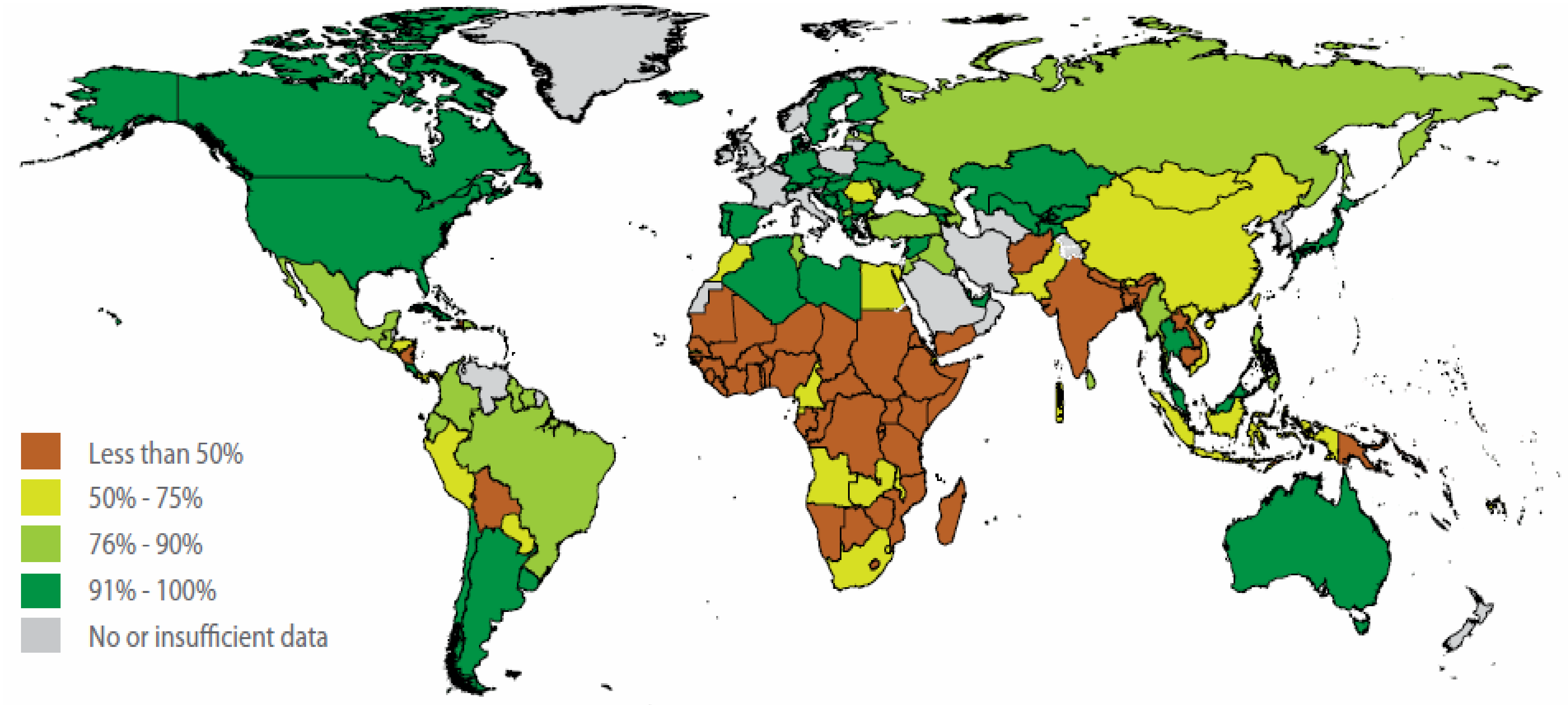
Improved Sanitation Coverage, 2006



Progress on Drinking Water and Sanitation: Special Focus on Sanitation. UNICEF, New York and WHO, Geneva, 2008

Types of Waste Water Treatment Facilities

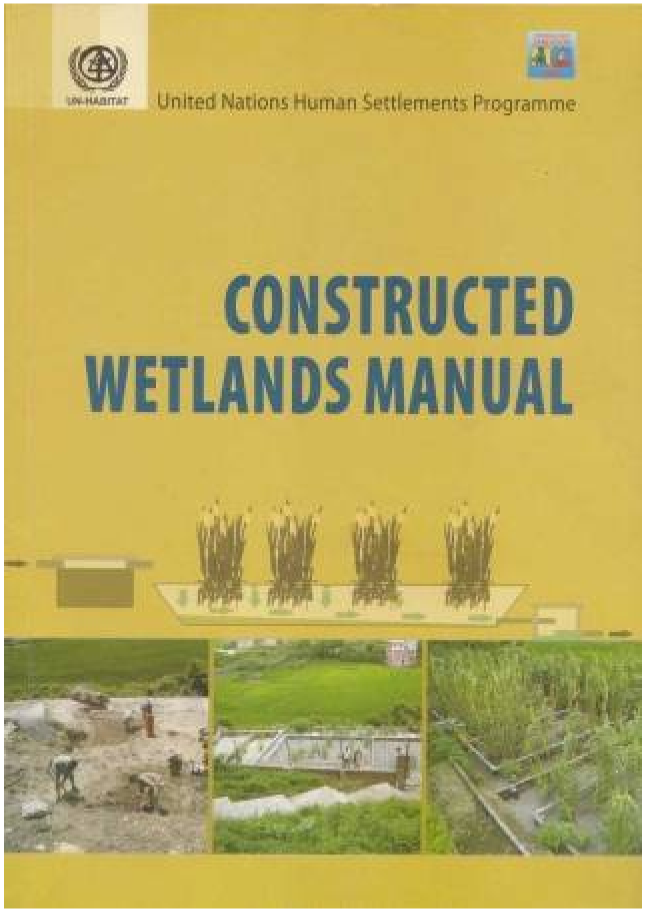
Decentralized

- Septic tank (Commonly used at domestic level)
- Waste stabilization ponds
  - Facultative lagoon
  - Maturation lagoon
- Land treatment
- Decentralized Waste Water Treatment System (Constructed wetland)

Centralized (Sewerage system)

DEWATS: Application

- DEWATS complement conventional treatment systems for more sustainable and effective service
- Provide treatment of waste of both domestic and industrial sources
- provide treatment for organic wastewater flows from 1-1000 m^3 per day
- DEWATS applications are reliable, long lasting and tolerant towards inflow fluctuation
- Needs no sophisticated maintenance




VF Constructed Wetland
HF Constructed Wetland
ABR
SDB
13 6 2007

DEWATS: Basic Technical Treatment

- Primary treatment: sedimentation and floatation
- Secondary anaerobic treatment in fixed-bed reactors: baffled upstream reactors or anaerobic filters
- Tertiary aerobic treatment in sub-surface flow filters
- Tertiary aerobic treatment in polishing ponds

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DEWATS – Low Maintenance Technology

Advantages of DEWATS:

- Efficient treatment for daily wastewater flows up to 1000m^3
- Modular design of all components
- Tolerant towards inflow fluctuations
- Reliable and long-lasting construction design
- Expensive and sophisticated maintenance not required
- Low maintenance costs

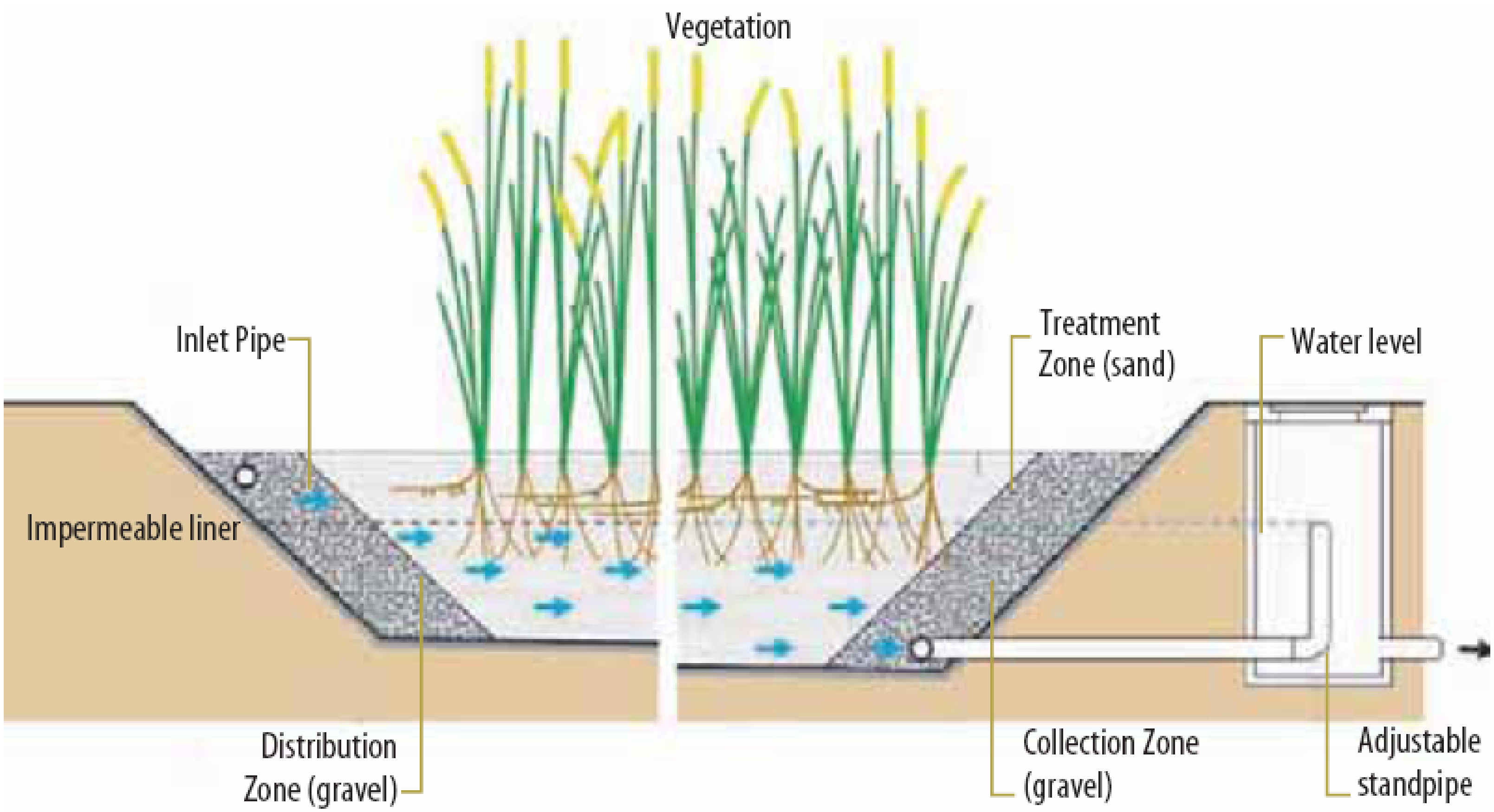
Hence, DEWATS technology is an effective, efficient and affordable wastewater treatment solution

Limitations of Constructed Wetlands:

- Large area requirement
- Wetland treatment may be economical relative to other options only where land is available and affordable.
- Design criteria are yet to be developed for different types of wastewater in different climatic conditions.

DEWATS :Horizontal flow System

Wastewater is fed in at the inlet and flow slowly through the porous substrate under the surface of the bed in a more or less horizontal path until it reaches the outlet zone.



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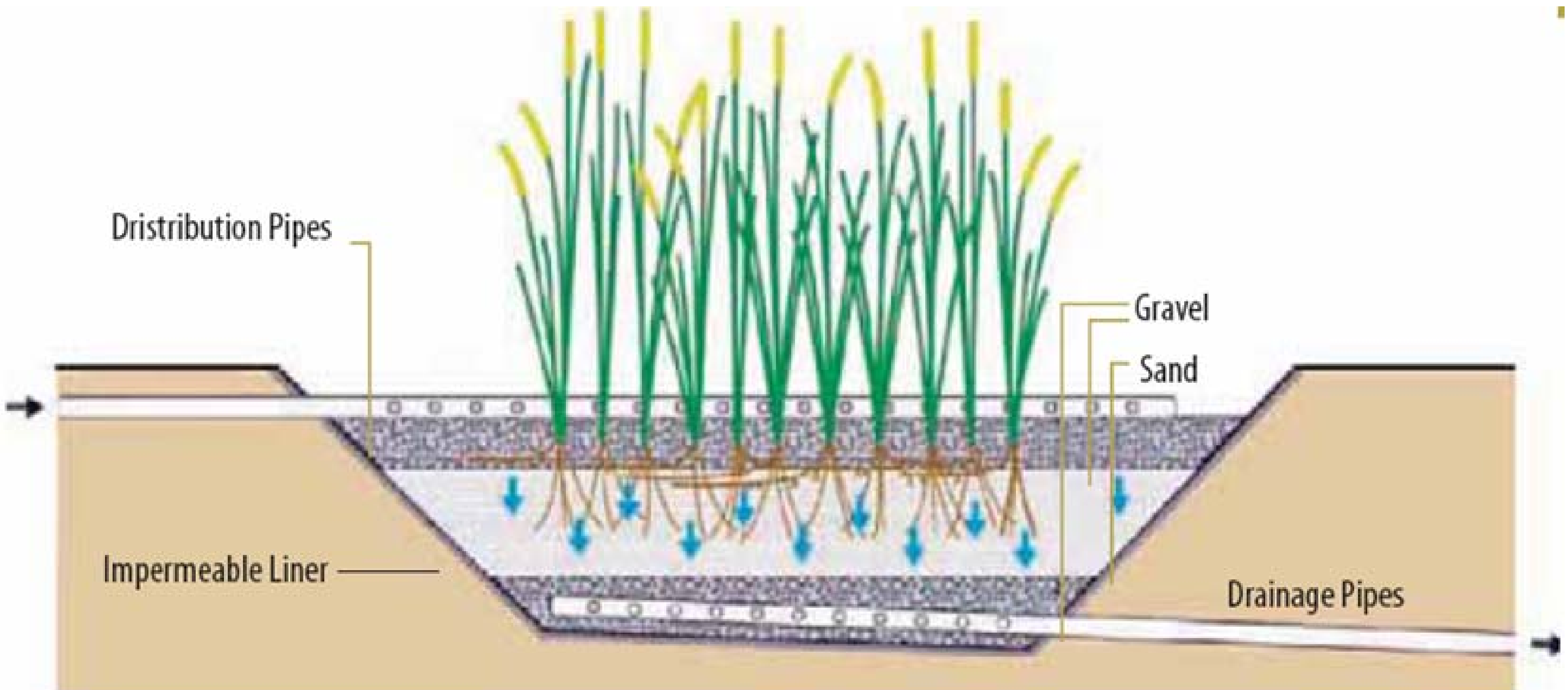
DEWATS :Vertical flow System

The wastewater is fed from top flow slowly down through the porous substrate under the surface of the bed



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O&M of DEWATS System

The most critical items in which operator intervention is necessary are:

- Adjustment of water levels
- Maintenance of flow uniformity (inlet and outlet structures)
- Management of vegetation
- Odor control
- Maintenance of berms (walls)

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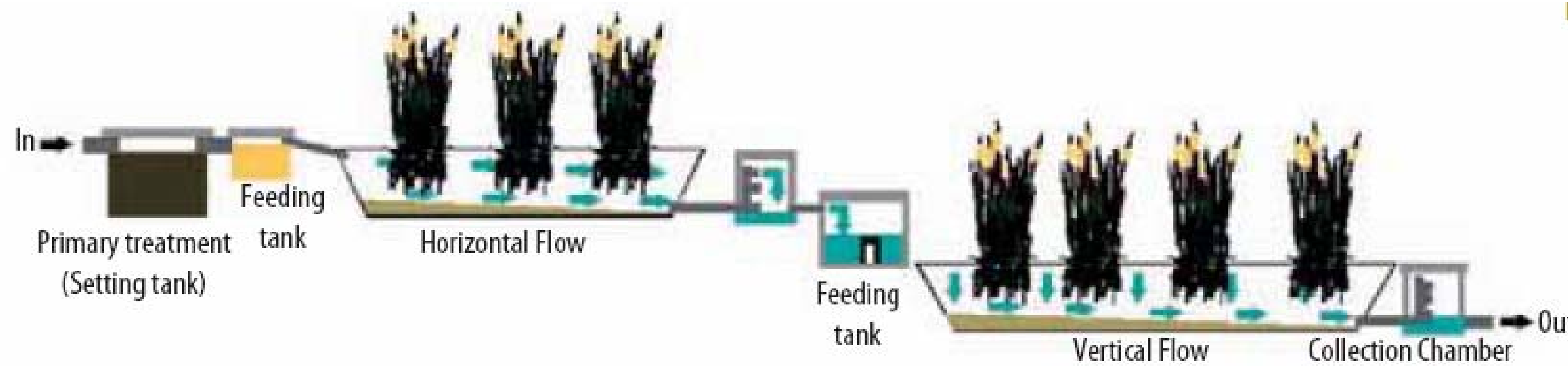
Dissemination of Wetland Technology

- Information seminars and workshops to introduce wetland technology to key-stakeholders
- Co-financing of demonstration projects
- Sector specific information-seminars and Technical training

Case Studies
Hospital Wastewater Treatment System
(Dhulikhel Hospital, Nepal)

- DEWATS at Dhulikhel Hospital was constructed in the year 1997.
- It comprises of a three chambered settling tank (16.5 m^3) and a hybrid constructed wetland – Horizontal Flow (HF) followed by Vertical Flow (VF).
- The wetlands are earthen basin sealed with plastic liner.
- The total area of the constructed wetland is 261 m^2 (HF – 140 m^2 and VF – 121 m^2).



Case Studies
Hospital Wastewater Treatment System
(Dhulikhel Hospital, Nepal)

Performance:

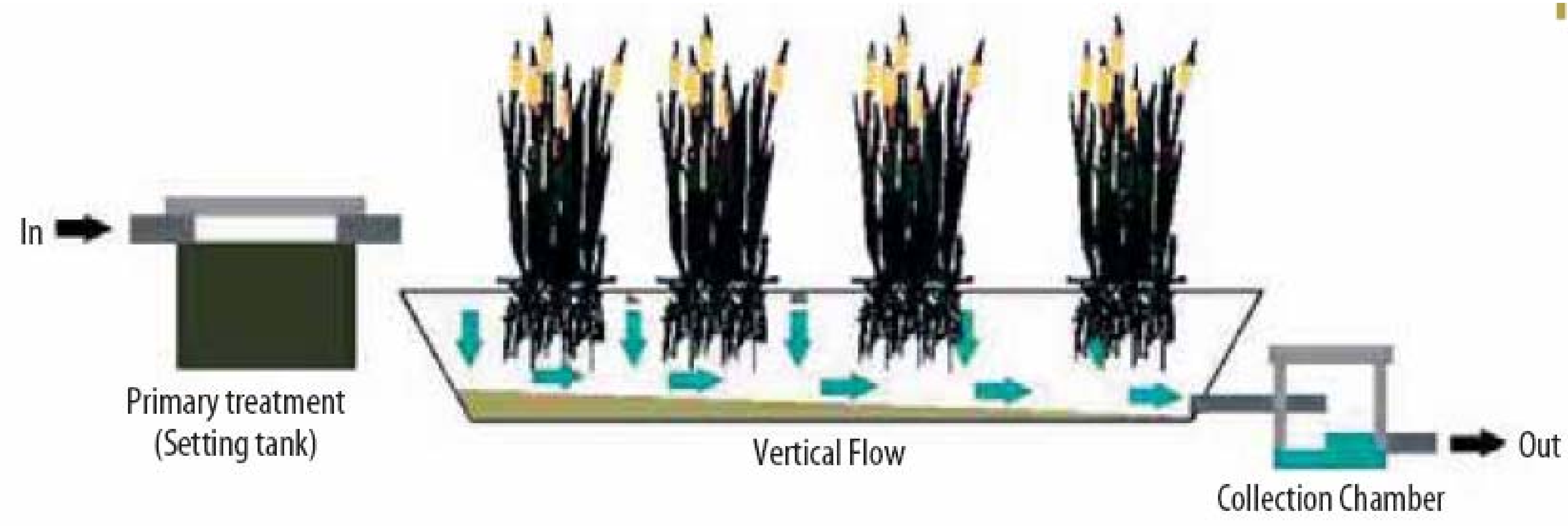
- The removal efficiencies of BOD5, COD and TSS are good till the increase of wastewater flow from 10 m^3/day to 35 m^3/day but have decreased when the wastewater flow is 75 m^3/day, however, the effluent quality is still within the tolerance limits for the wastewater to be discharged into inland surface waters from combined wastewater treatment plant

Costs:

- US$ 16,000 (i.e. US $ 60 per m^2 of wetland).
- Average O & M cost is about US $ 150 annually.
- About US $ 430 has been spent for the replacement of pipes and manhole covers in the last 10 years.

Case Study
Combined laboratory and domestic wastewater treatment & reuse (ENPHO, Nepal)

- System was constructed in the year 2002.
- Constructed wetland comprises of a settling tank (0.5 m^3) and a vertical flow constructed wetland (15 m^2).



Case Study
Combined laboratory and domestic wastewater treatment & reuse (ENPHO, Nepal)

Performance:

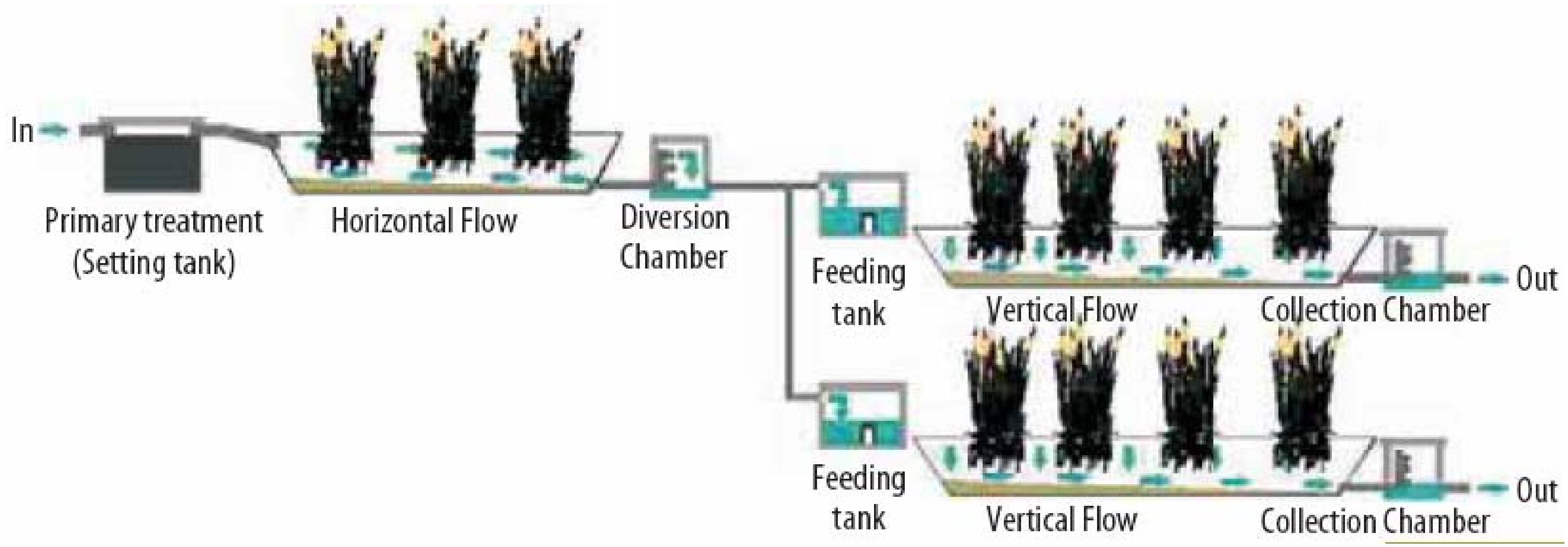
- The performance of the wetland is good. The removal efficiencies of the organic pollutants are also good

Costs:

- US $ 570 (i.e. US $ 40 per m^2 of the wetland).
- The operation and maintenance costs are reported to be negligible.
- In addition, the reuse of treated wastewater resulted in saving of water expenses of ENPHO.

Case Studies
Institutional wastewater treatment
(Kathmandu University, Nepal)

- The wetland was constructed in the year 2001.
- It comprise of a settling tank (40 m^3) and a hybrid constructed wetland – Horizontal Flow (HF) bed followed by two Vertical Flow (VF) beds.
- The total area of the constructed wetland is 628 m^2 (HF – 290 m^2 and VF – 338 m^2).



Performance:

- The performance of the wetland is good. The removal efficiencies of the organic pollutants are also good

Costs:

- The total construction cost of the wetland amounted to US $ 26,000 (i.e. US $ 40 per m^2 of the wetland).
- The average O & M cost of the wetland is about US $ 290 annually.

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