ROLE OF WETLAND AND CONSTRUCTED WETLAND IN WASTEWATER TREATMENT

Dr. Le Quoc Tuan
Faculty. of Environment and Resources
Nong Lam University, Vietnam

Introduction

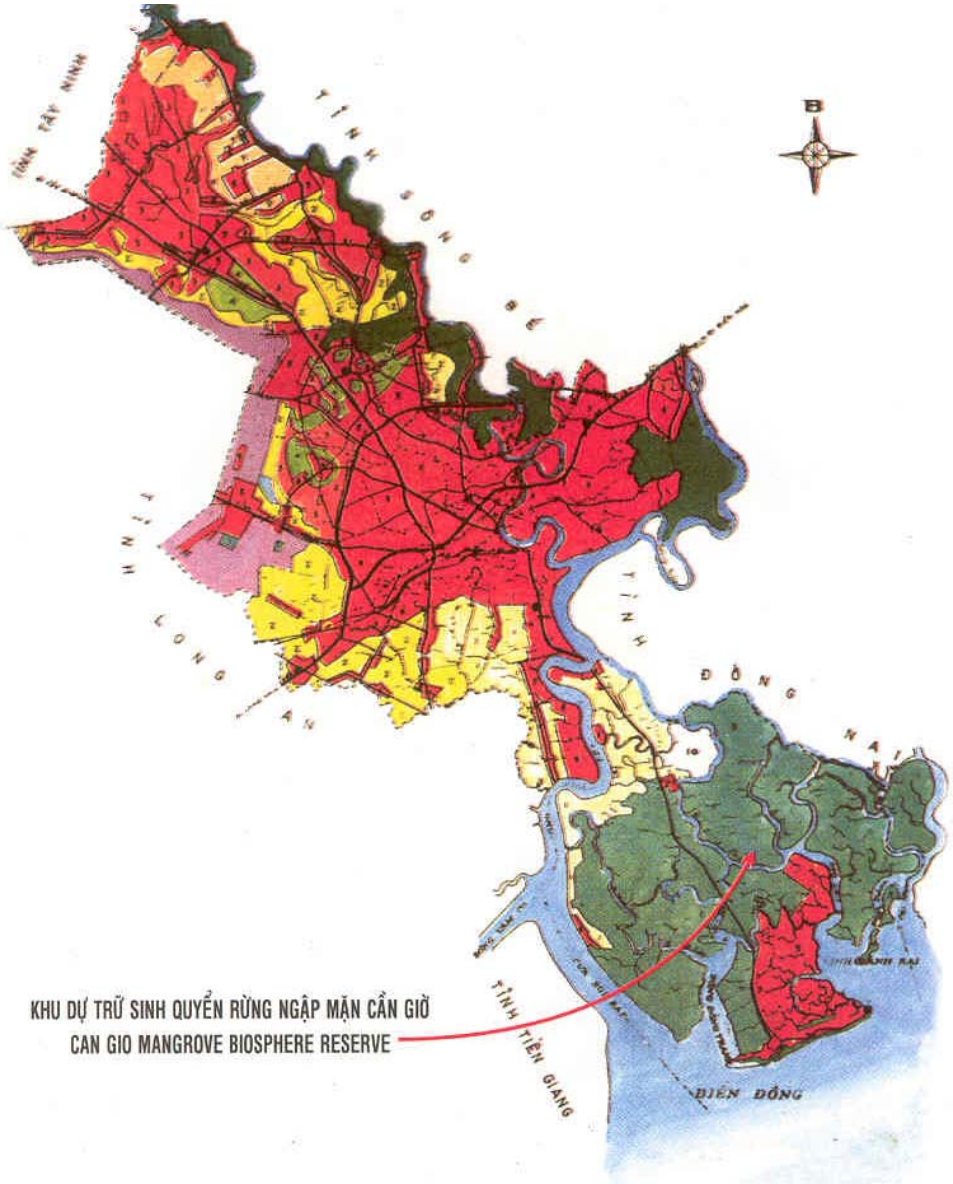
- In the world and Asian countries, the water pollution has been become an urgent problem.
- Many technologies applied for wastewater treatment with high technique but expensive for standard of life in Vietnam.
- Eco-technology is the first choice for applications in wastewater treatment.
- Wetland and constructed wetland are necessary options for semi-tropical nations such as Asian countries.

NATURAL WETLAND

Case Studies: Can Gio Mangrove Biosphere Reserve

CAN GIO BIOSPHERE RESERVE

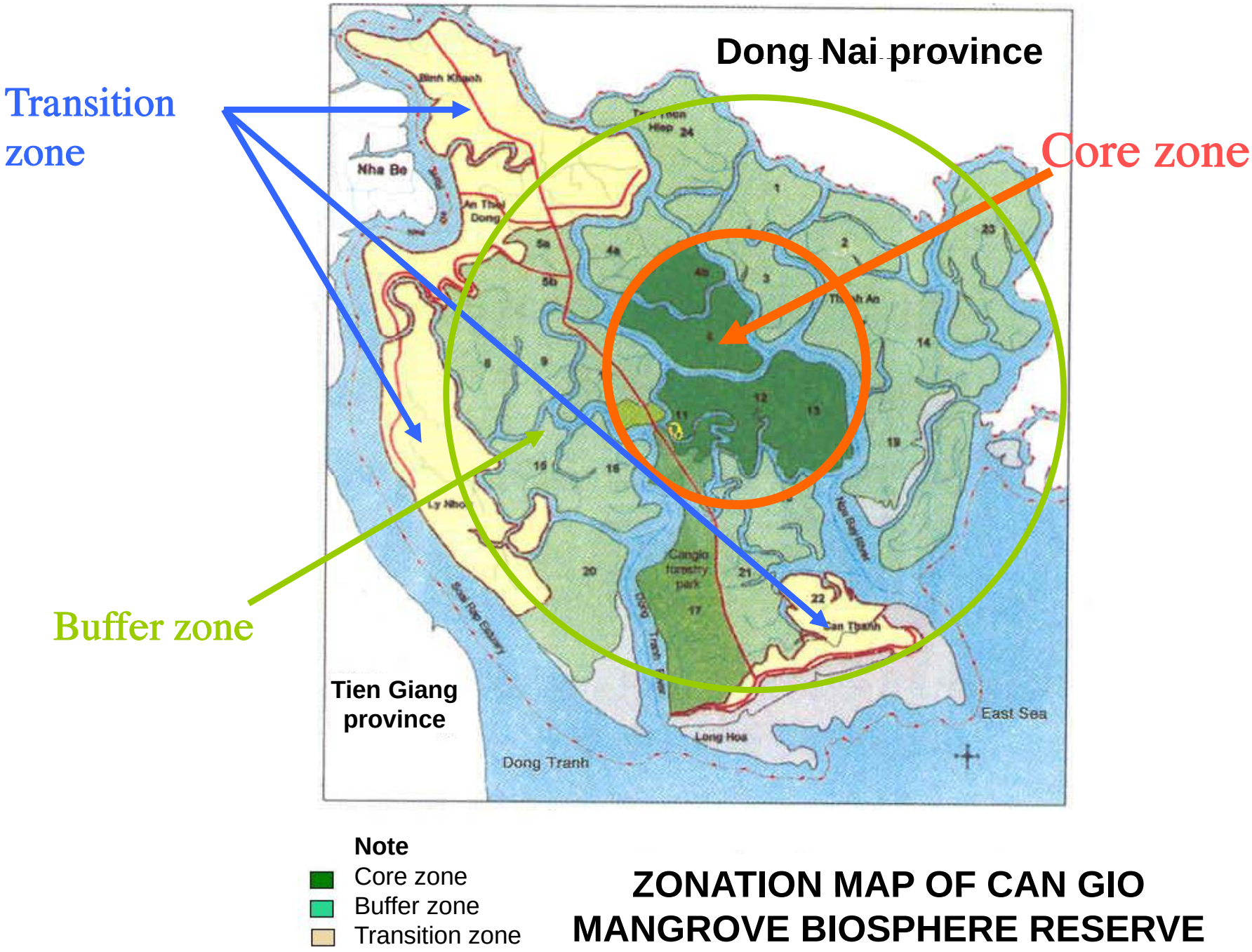
- Area: 75,740 ha.
- Biosphere Reserve of the World and Vietnam.
- Biodiversity
- Aquaculture in transition zone affected core zone.
- Problems in planning and management



OVERVIEW OF ECOLOGICAL SYSTEM AT CAN GIO

Ecological system was divided into three zones:

- ✓ **Core zone**: Conservation of landscape, ecosystem and biodiversity. **UNTOUCHABLE!**
- ✓ **Buffer zone**: Surrounding of Core zone.
- ✓ **Transition zone**: Maintenance of agriculture, aquaculture activities, resident zone and the other activity.


Transition zone
Dong Nai province
Core zone
Buffer zone
Tien Giang province
East Sea
Dong Tranh
Long Hoa
Can Thanh
Cangio forestry park
Nha Be
Note
Core zone
Buffer zone
Transition zone
ZONATION MAP OF CAN GIO MANGROVE BIOSPHERE RESERVE

PLANT BIODIVERSITY

Sonneratia Community

Back

Rhizophora Community

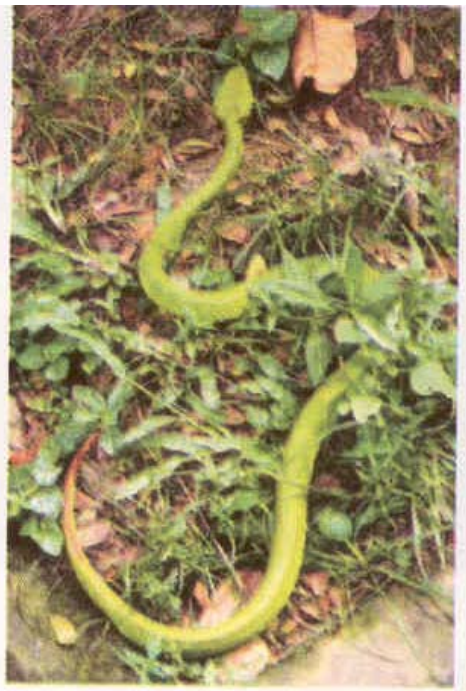
Sonneratia and Avicennia Communities

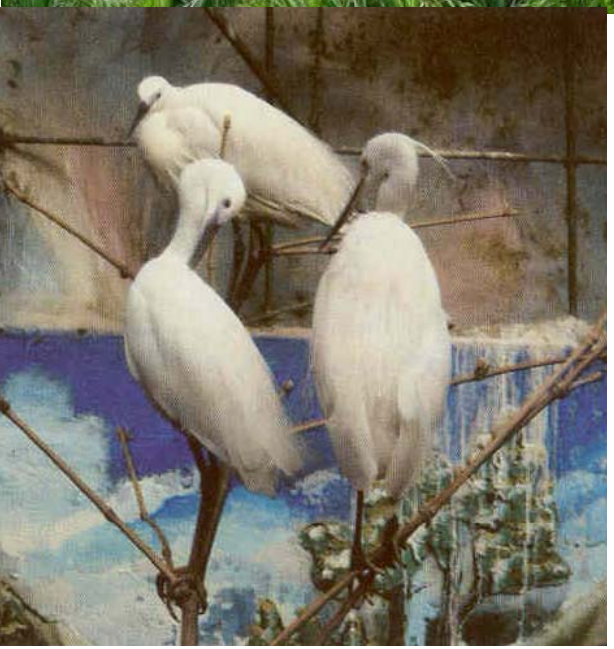

Nypa fruticans Community

Phoenix Community

Back 6

ANIMAL BIODIVERSITY





BIODIVERSITY IN ENDANGER

BECAUSE OF….?

AQUACULTURE, AGRICULTURE ACTIVITIES AND WASTERWATER FROM CITIES

- Agriculture
- Aquaculture
  - Shrimp culture in rice field
  - Alternative shrimp culture
  - Industrial and intensive shrimp culture
- Receiving a mass of wastewater from Ho Chi Minh City and Dong Nai province

Intensive shrimp culture

Polluted water from shrimp ponds

ECOLOGICAL SOLUTIONS

Proposed models and applications

APPLICATION OF ECOLOGICAL SYSTEM IN ENVRIONMENT PROTECTION

- Aquaculture management surround biosphere reserve.
- Control the effluent before discharging into ecological system.
- Create a ecosystem in shrimp culture pond.
- Using effluent from intensive shrimp culture for agricultural crop.

Ecological shrimp culture

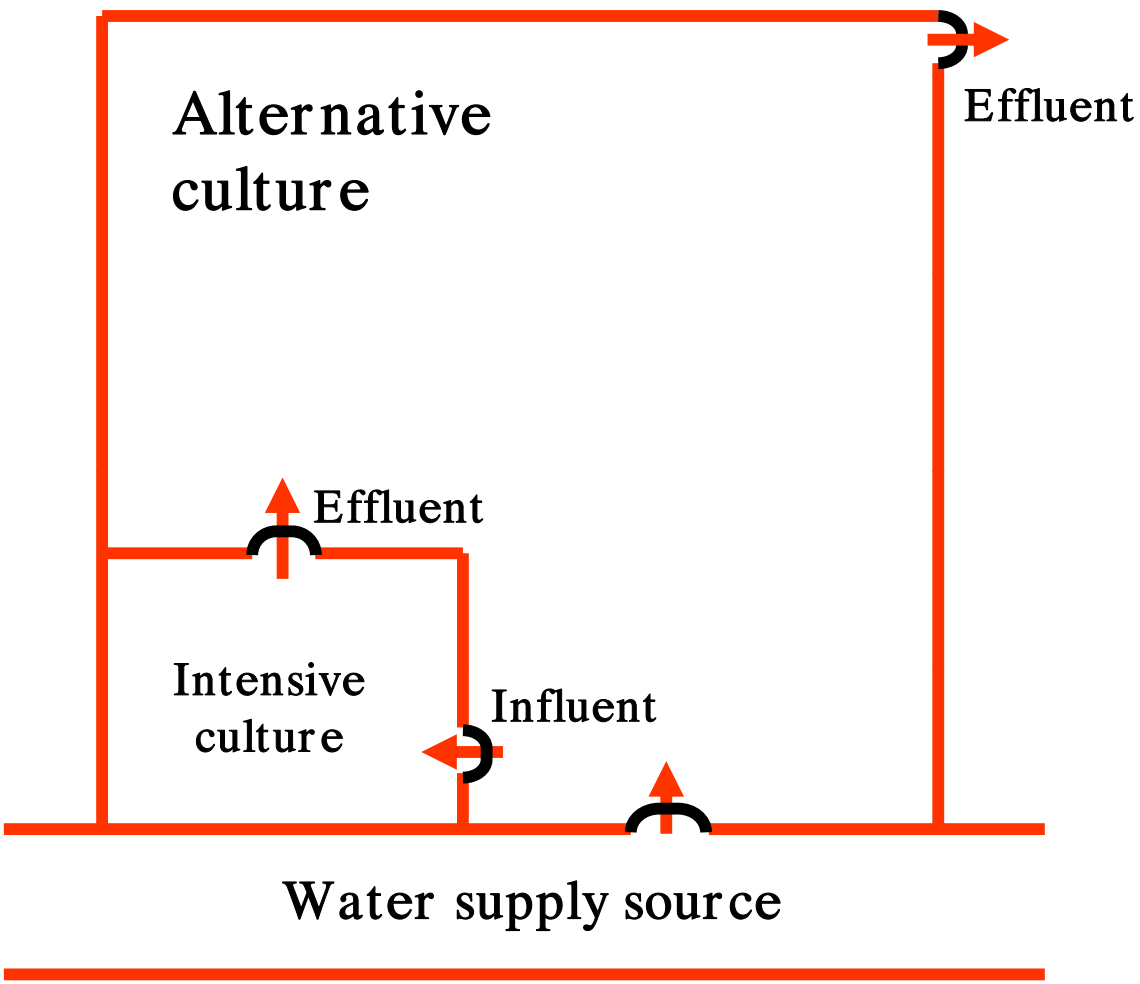
Bivalves culture along river to filtrate water

Shrimp culture and rice crop at same site

Aquaculture
from January – June

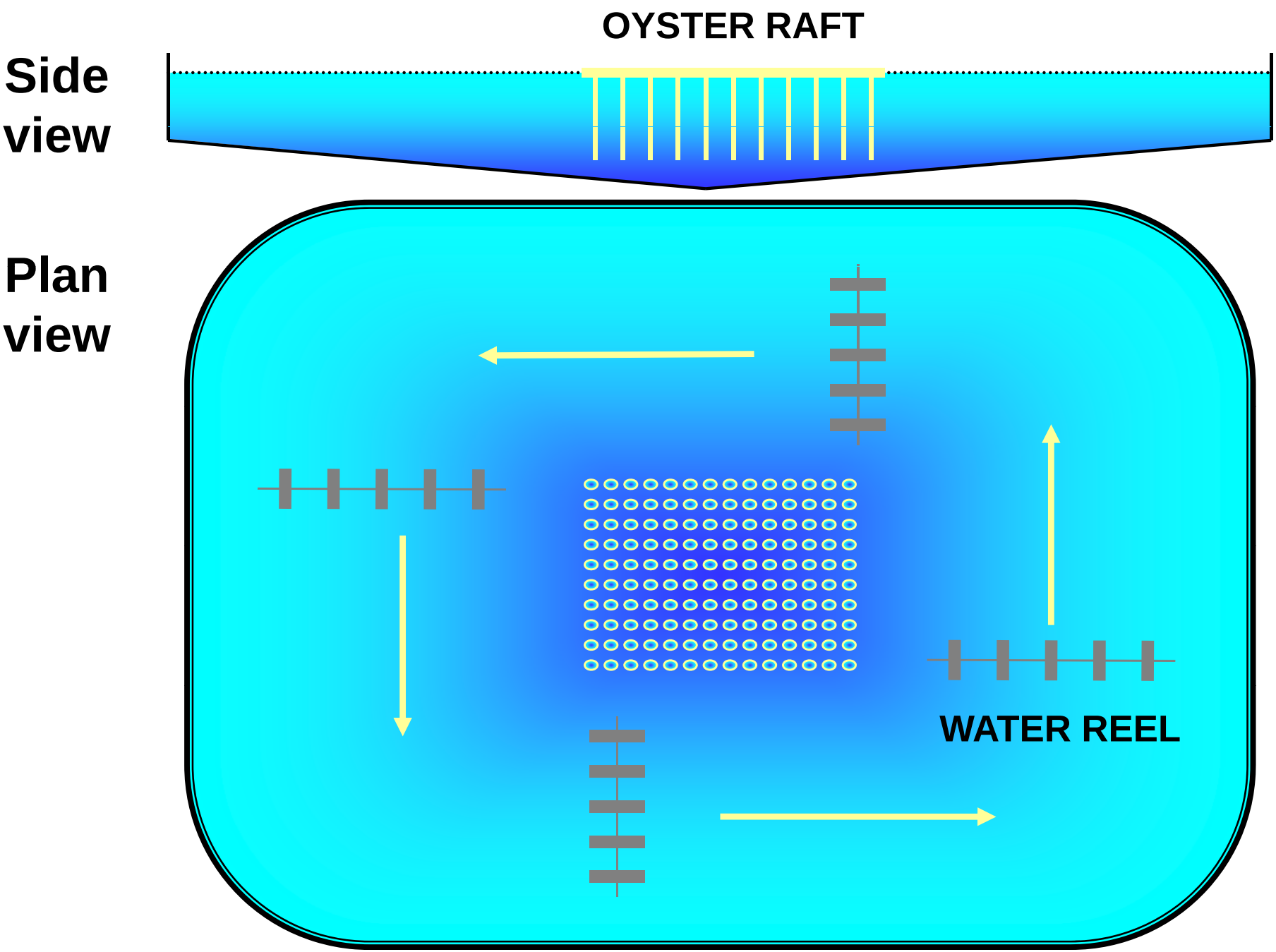
Rice crop
from July – December

Proposed models for intensive and alternative culture to reduce the pollutants



A model for sustainable culture development using ecological system.

An application of ecosystem in reality



Ecological food chain has been implicated in industrial shrimp ponds

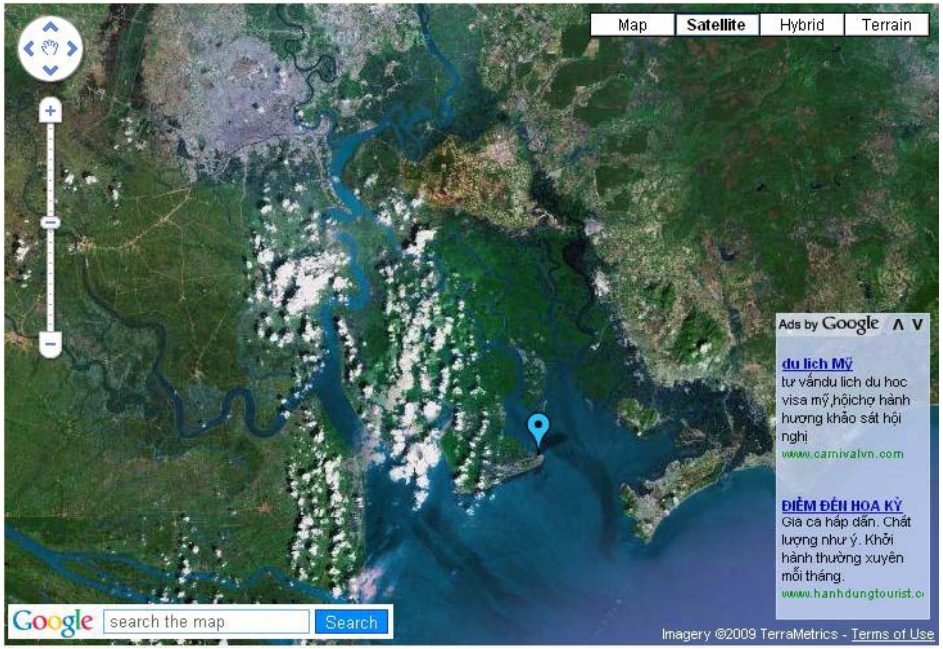
Application of effluent from shrimp culture for agriculture or natural wetland

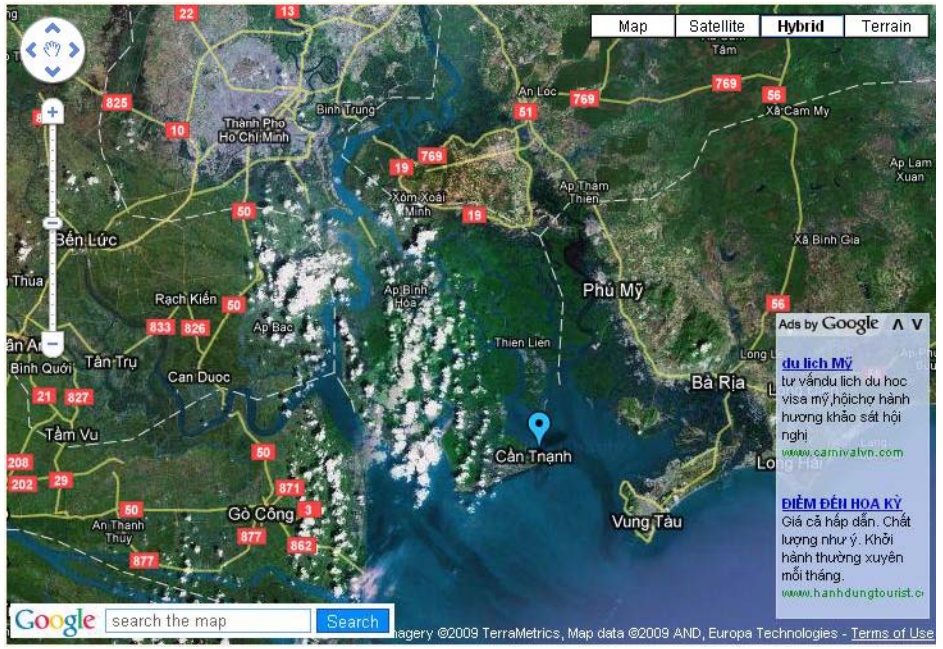
Agricultural development for a sustainable and friendly environment

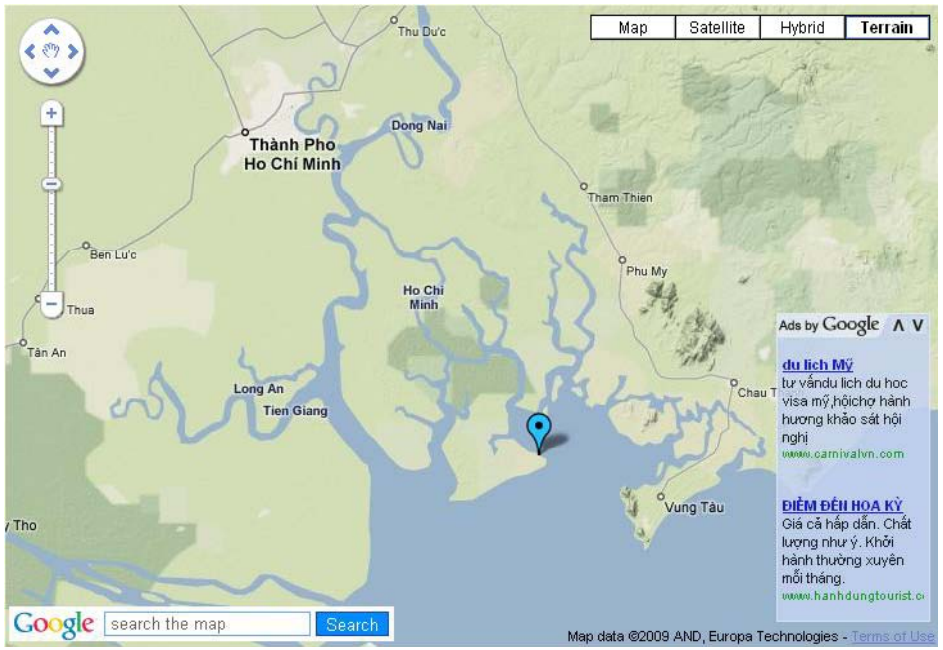
Wastewater from cities and province

DANGER for WETLAND

Receive a mass of polluted water from Dong Nai Prov. and Ho Chi Minh City.





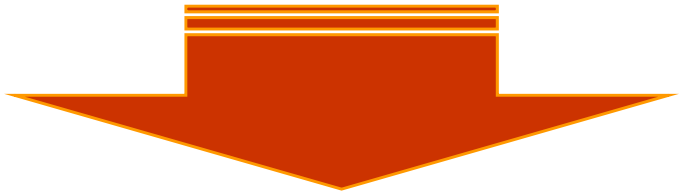


Wastewater estimated

> 1,000,000 M^3/day (Ho Chi Minh City)

> 1,500,000 M^3/day (Bien Hoa, Dong Nai Prov.)

Source: MONRE, 2008



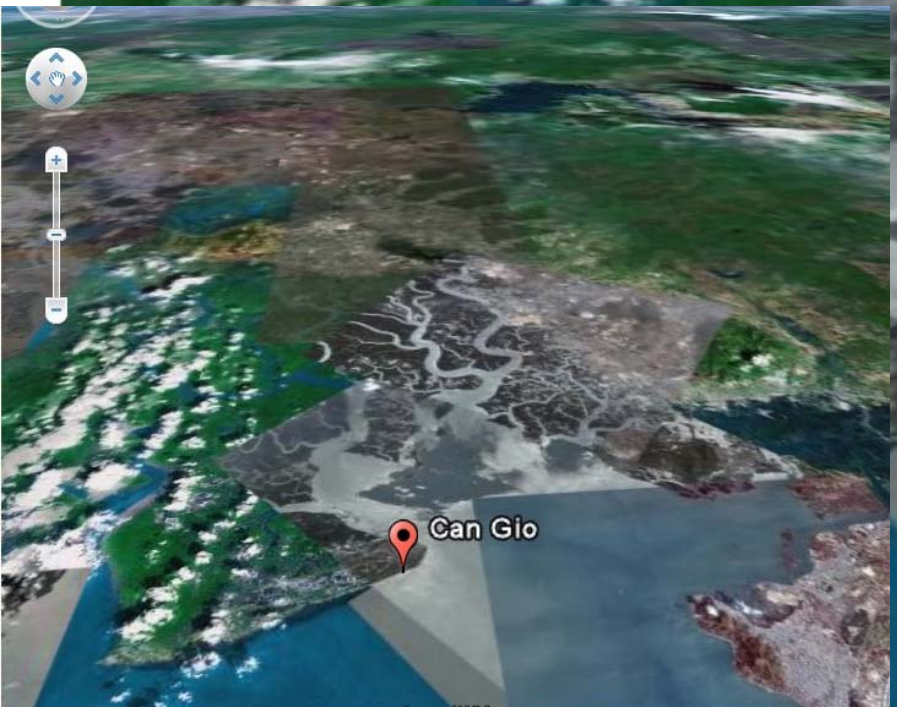
All downstream to Can Gio Wetland

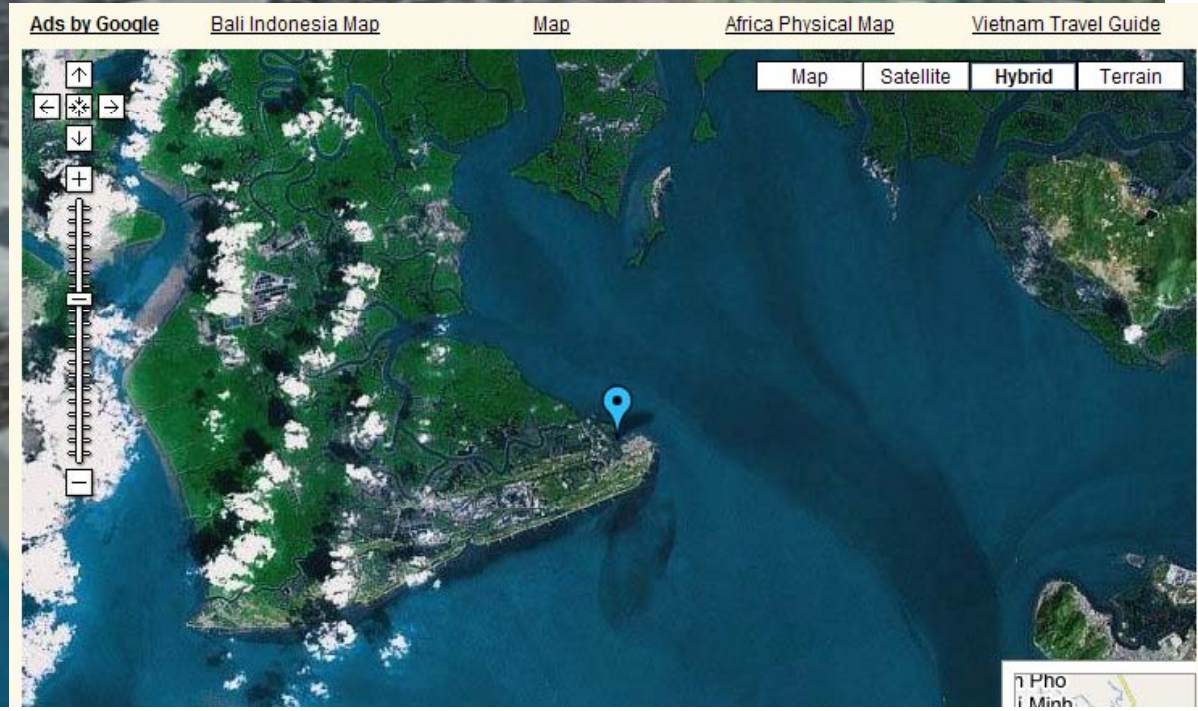
Polluted water from cities & industries

Factory

Dong Nai River

Can Gio Wetland





River network possesses 31.76% of total area at Can Gio

CALCULATIONS FOR TREATMENT WETLAND

The hydraulic loading rate

$$q = \frac{Q}{A}$$

q = inflowing hydraulic loading rate (m day^{-1} or m yr^{-1})

Q = flow rate (m^3 day^{-1} or m^3 yr^{-1})

A = Wetland surface area (m^2)

ESTIMATION FOR WETLAND POTENTIAL IN WASTEWATER TREATMENT

The hydraulic loading rate

$$q = \frac{Q}{A}$$

$Q = 38 \times 10^9\ M^3\ yr^{-1}$

$A = 240 \times 10^6\ M^2$

$\Rightarrow$ $q = 158\ M\ yr^{-1}$

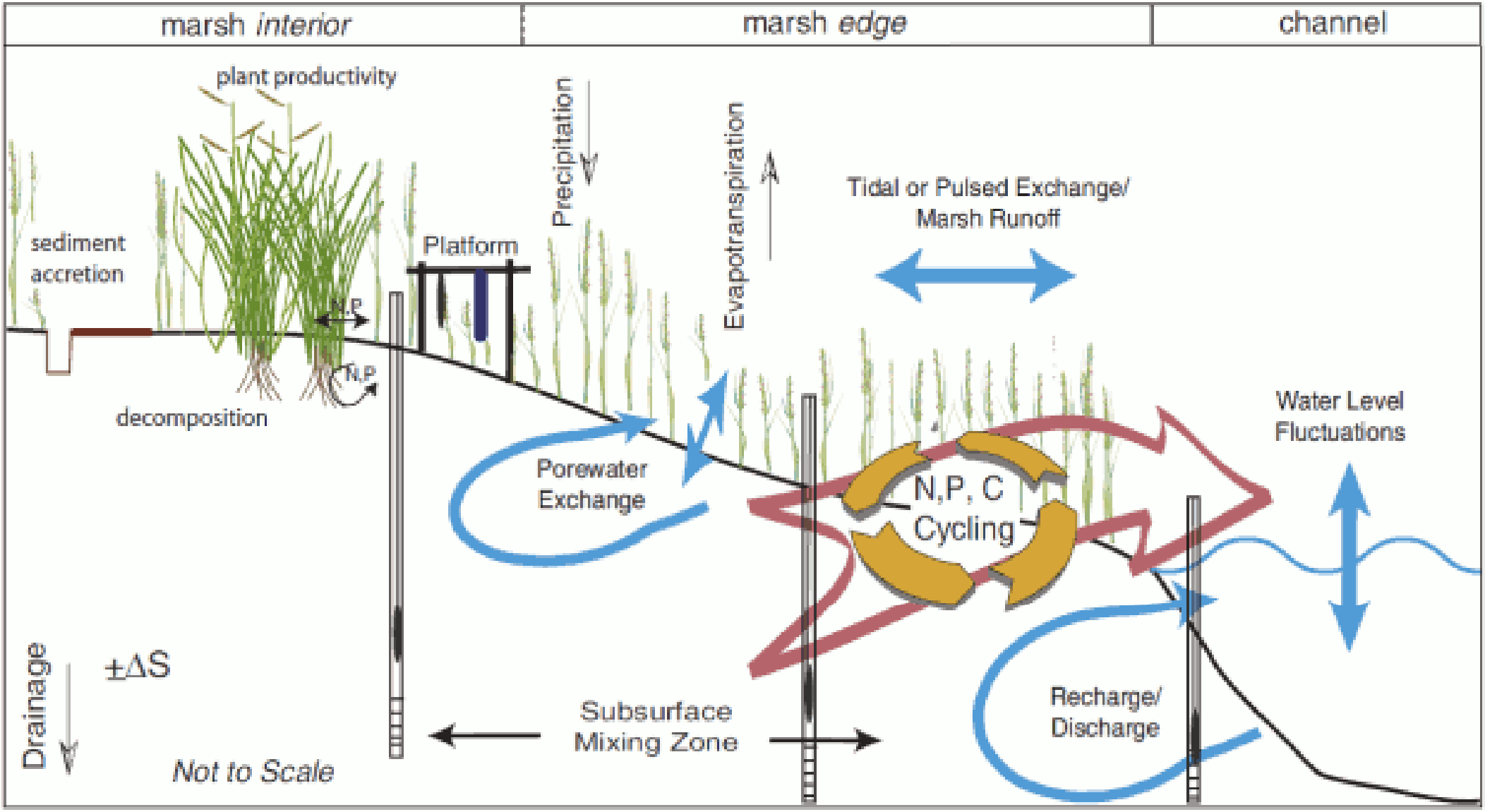
Minimum volume of wastewater Can Gio WETLAND can treat

$7{,}000{,}000\ M^3\ day^{-1}$

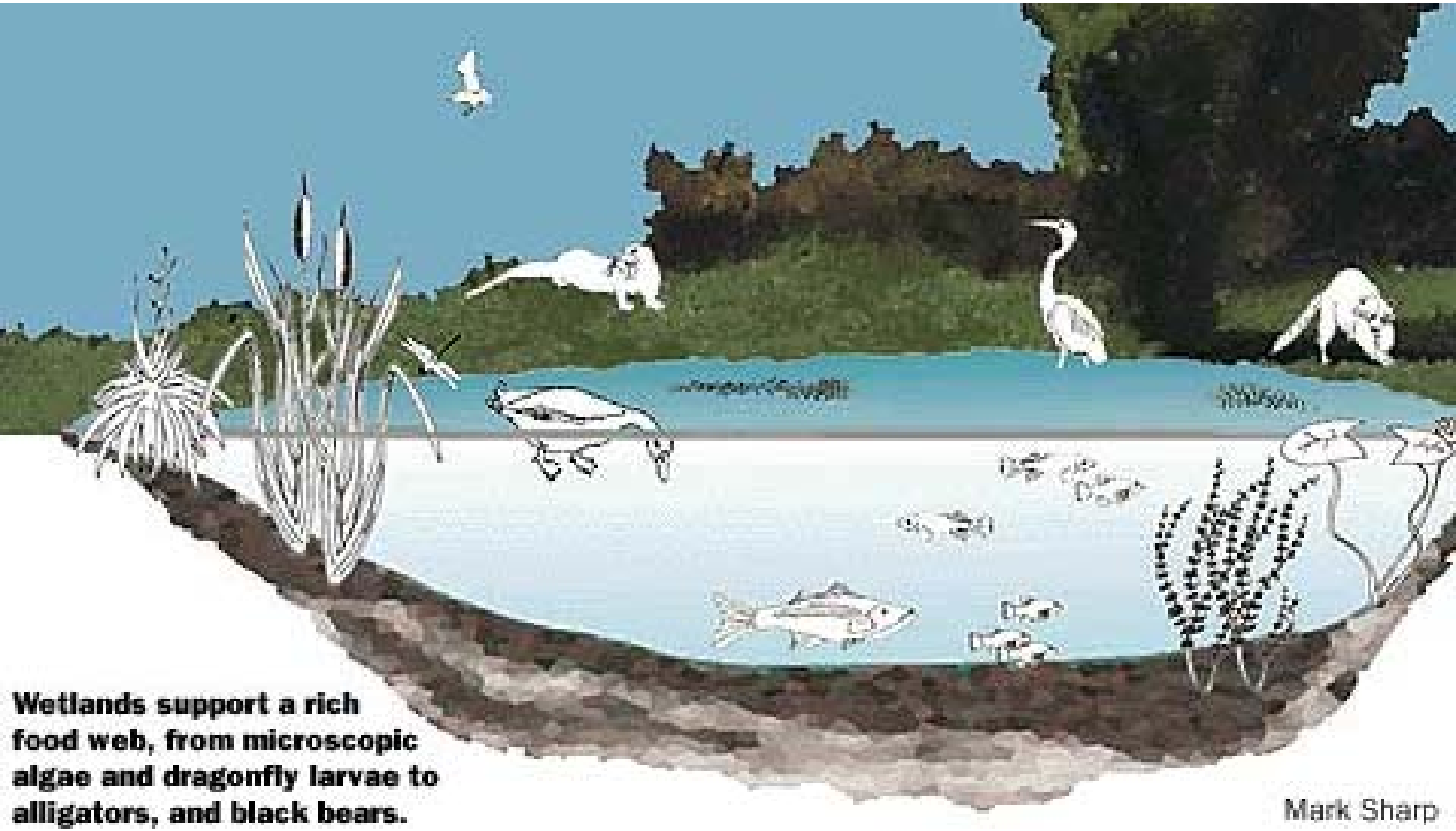
Natural wetland activities in wastewater treatment

- ✓Bioprocesses
- ✓Filtration
- ✓Remediation
- ✓Self-maintain and control
- ✓…many unknown mechanisms

Wetland Ecosystem activities for contaminant treatment



Nutrients and food web in wetland



Wetlands support a rich food web, from microscopic algae and dragonfly larvae to alligators, and black bears.

Mark Sharp

THE OTHER INDISPENSIBLE VALUES

The importance of mangrove forest for humans and ecological environment

❖ Direct values

- Fishing
- Bivalves culture
- Shrimp culture
- Research and Education
- Ecotourism

❖ Indirect values

- Storm prevention
- Soil degradation prevention
- Water and air clarification
- Biodiversity conservation

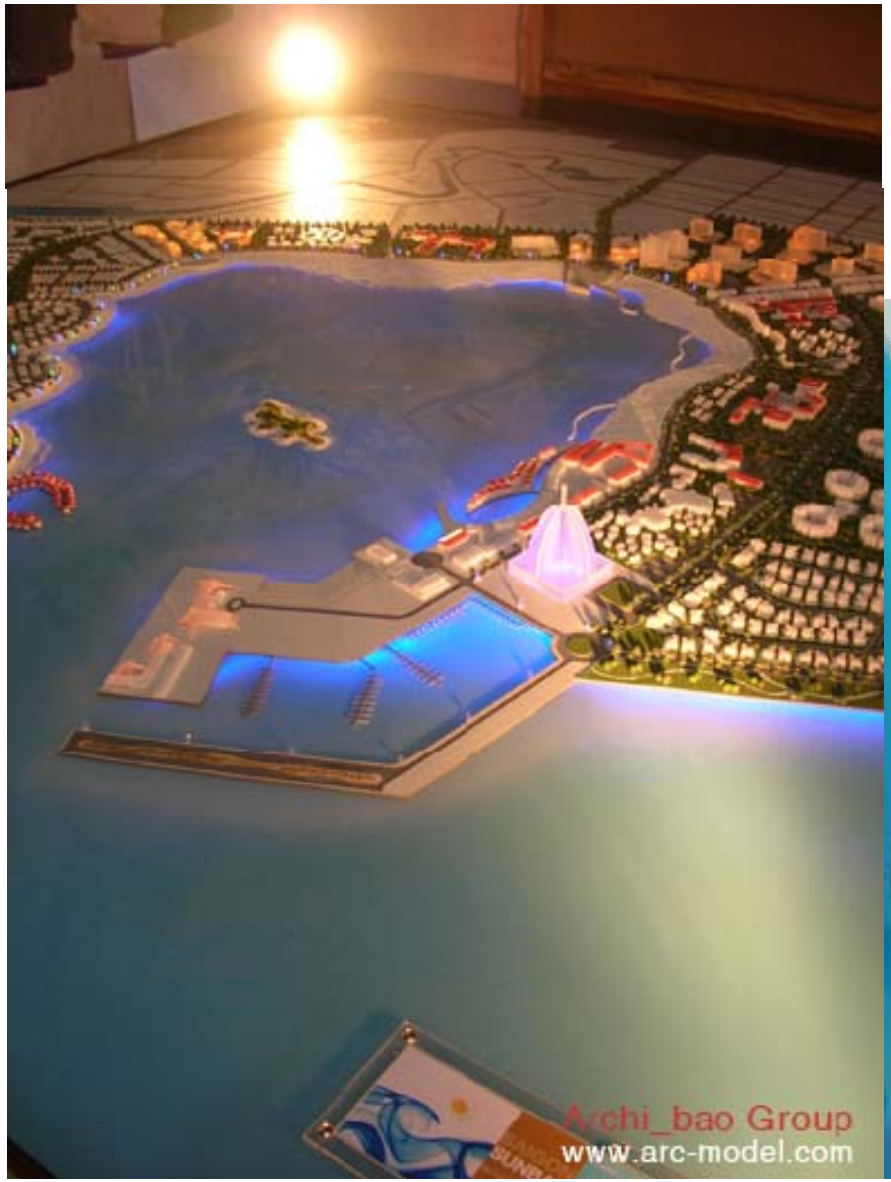
The importance of natural wetland (Education)

Ecological values

Historical values

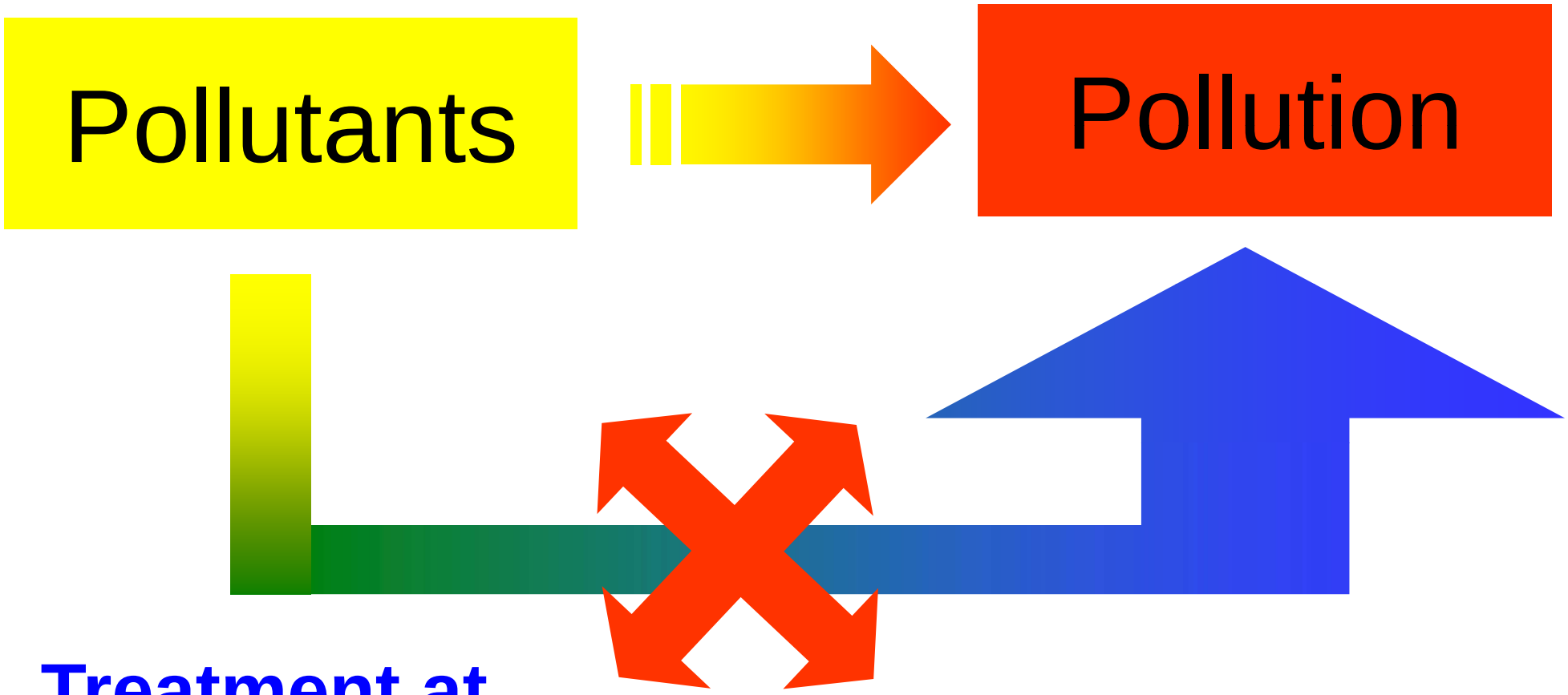
Ecotourism potentials

Planning for future development

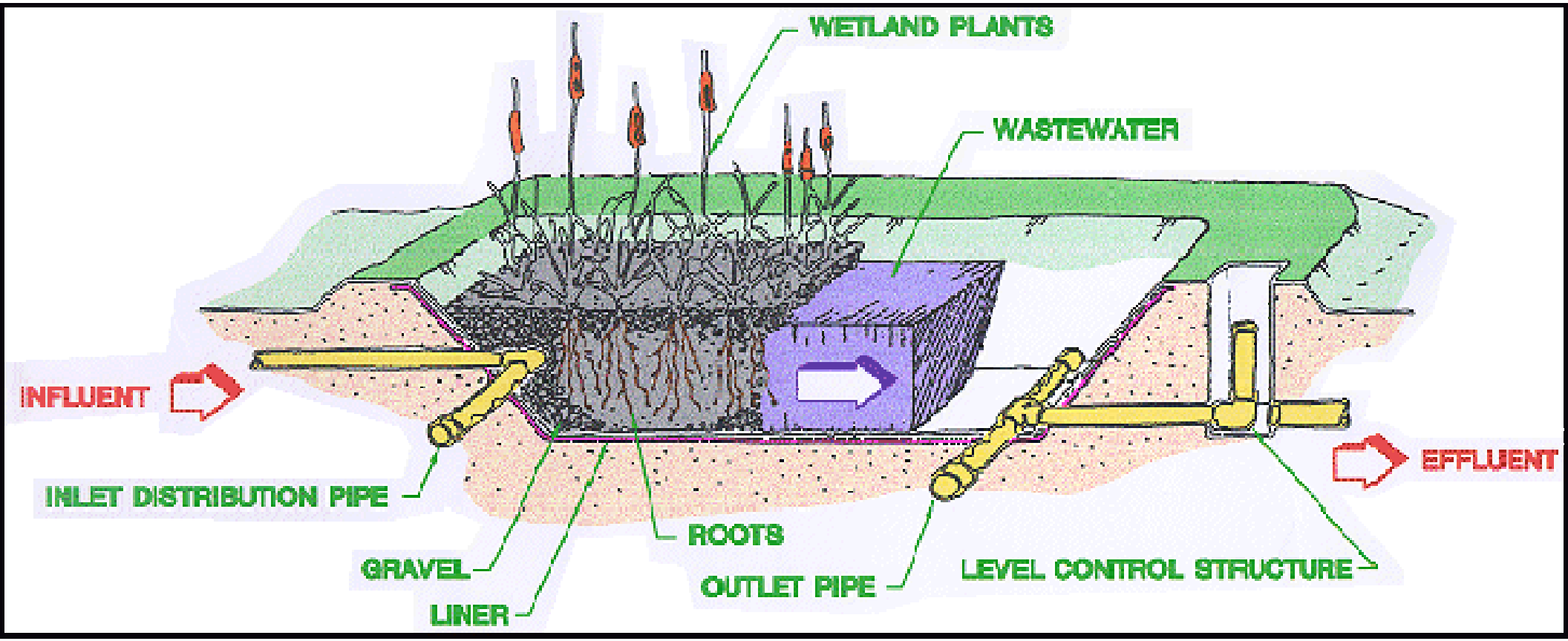


Saigon Sunbay

TREATMENT AT SOURCE

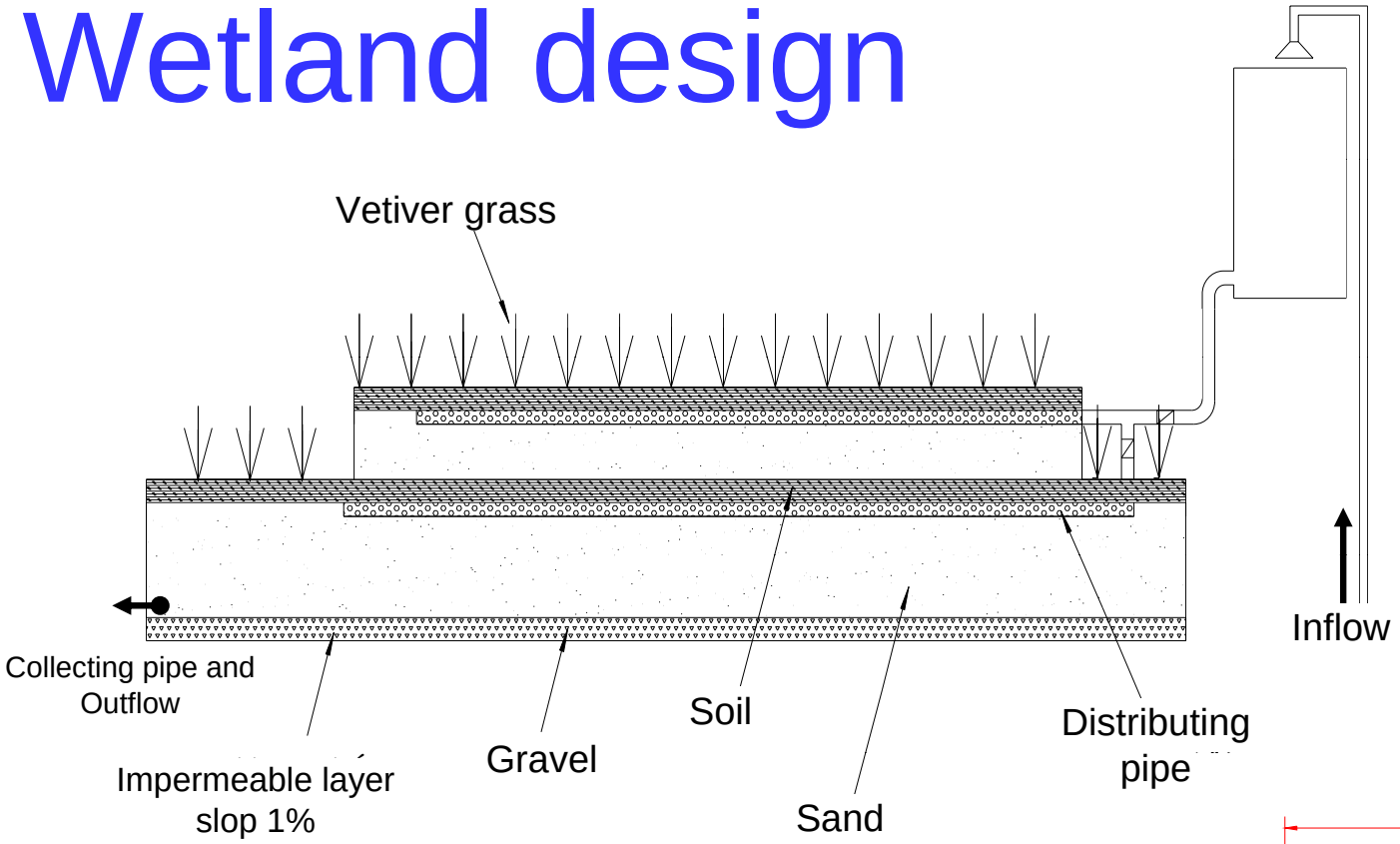


CONSTRUCTED WETLAND FOR WASTEWATER TREAMENT

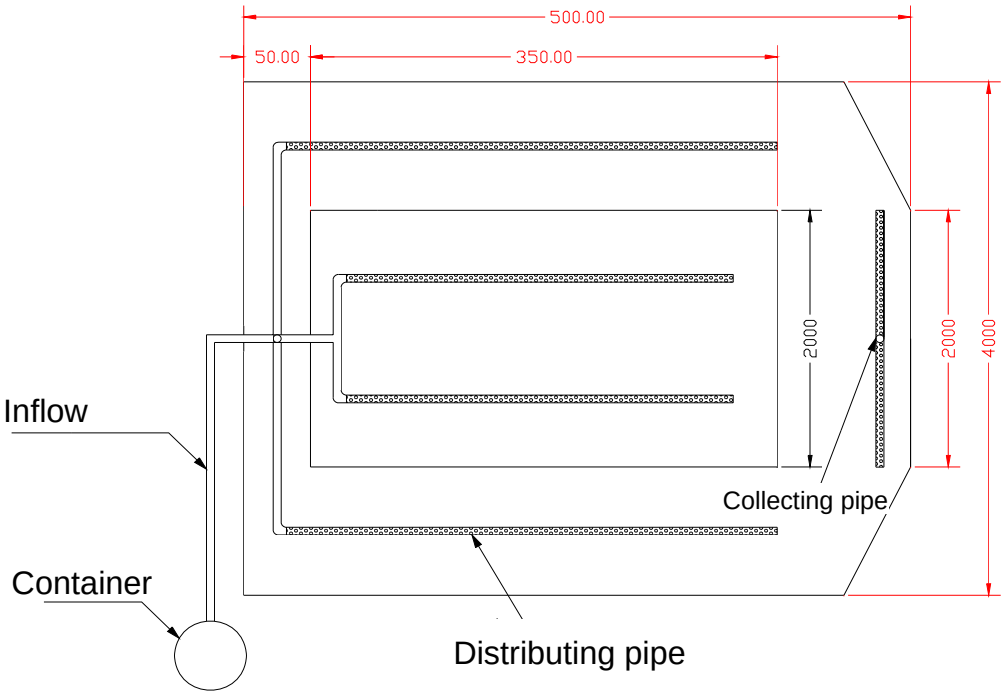


Water pollution

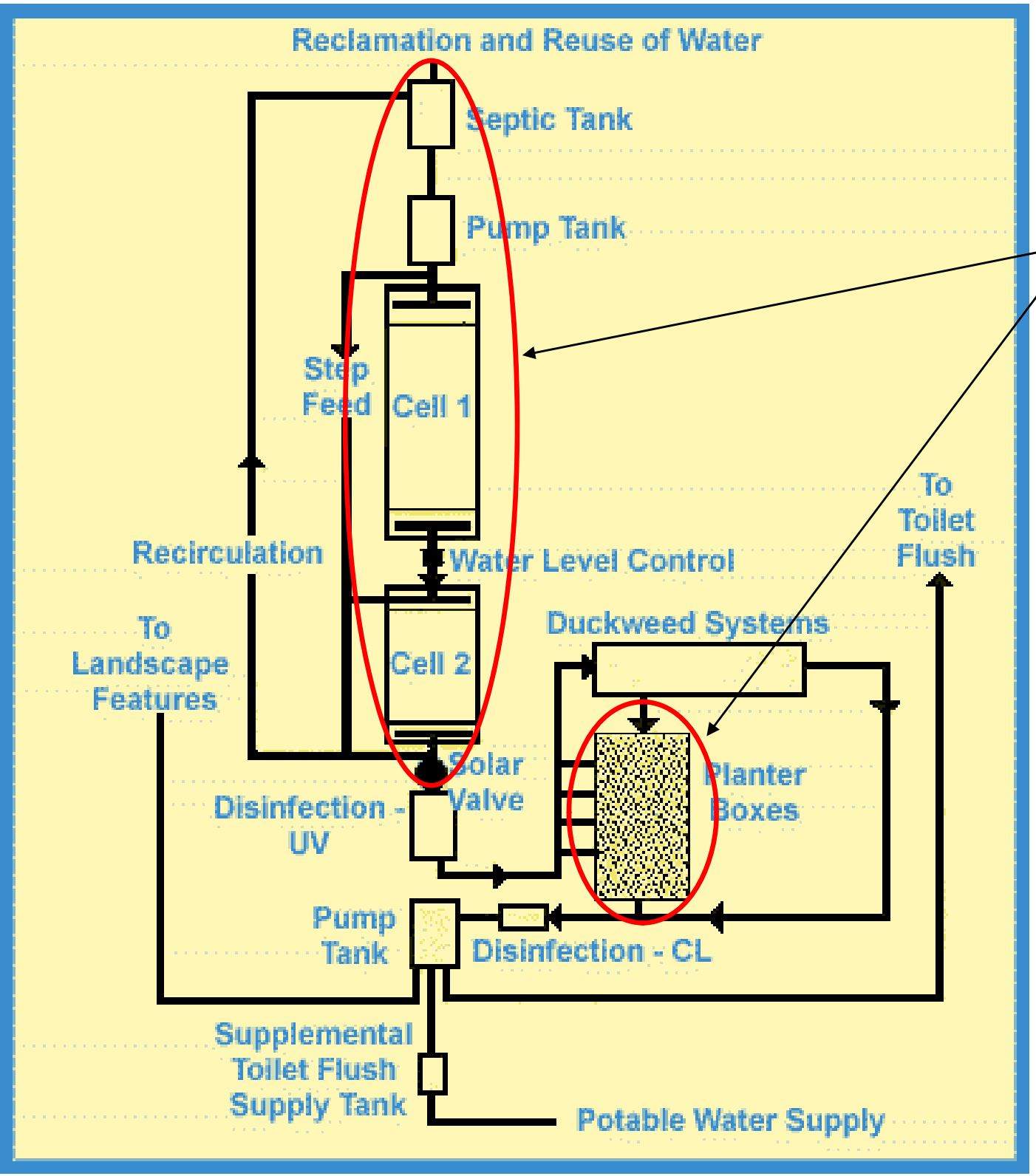
Wetland design



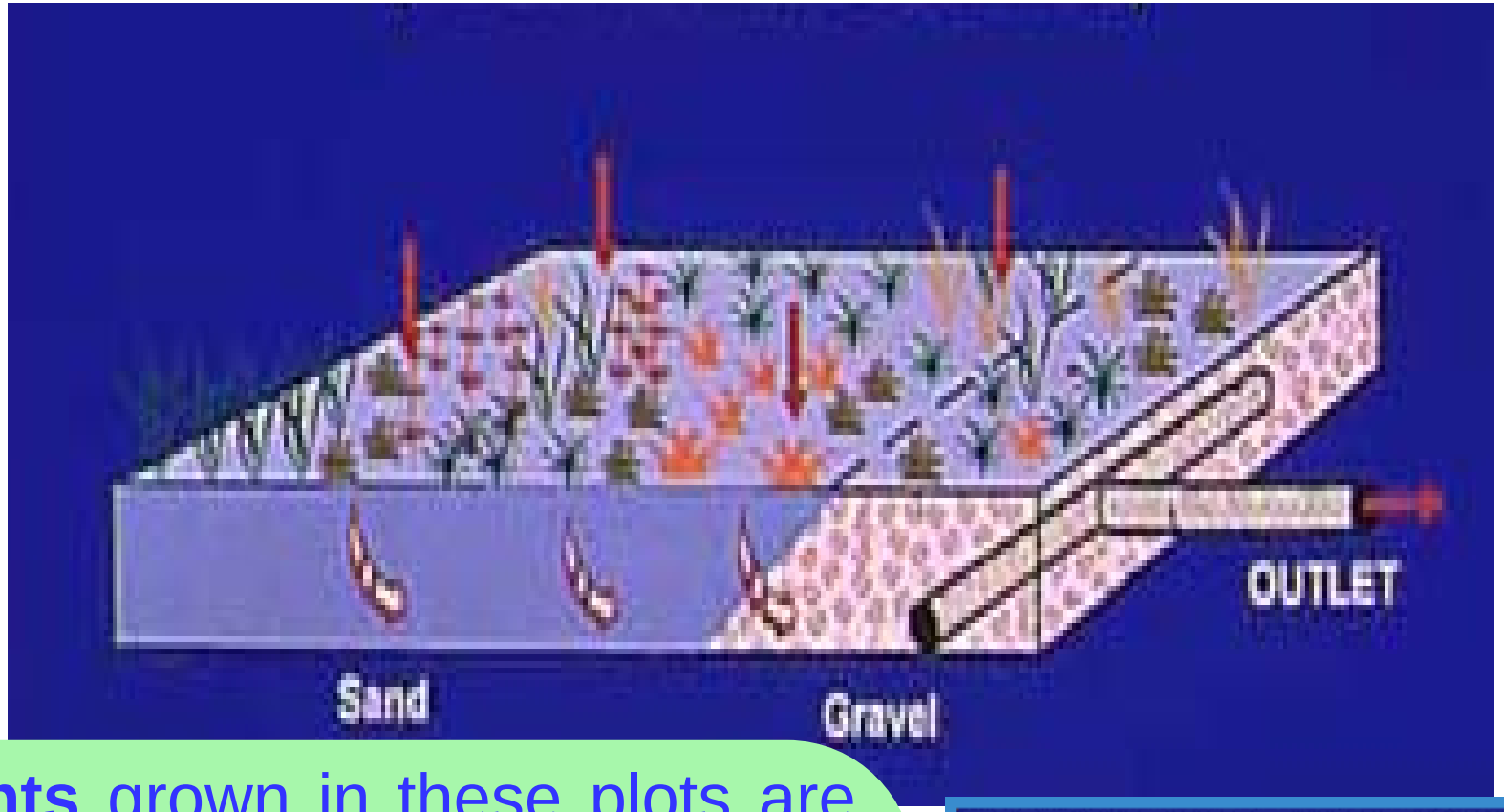
Side view



Plan view

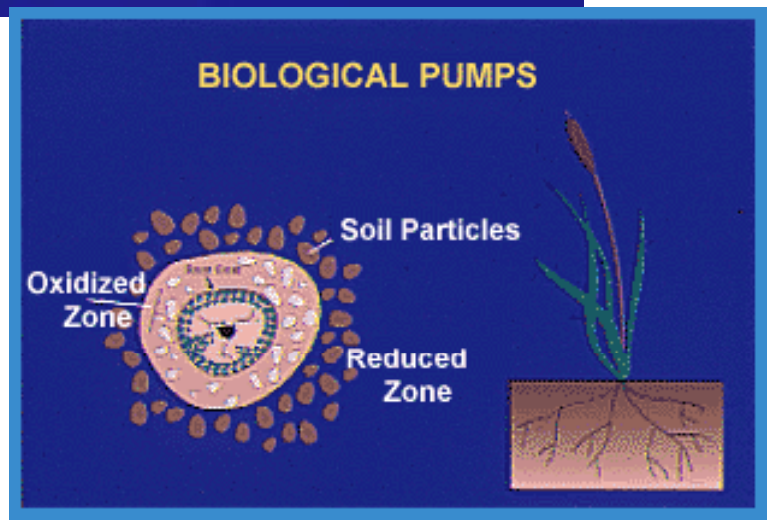


Modules applied

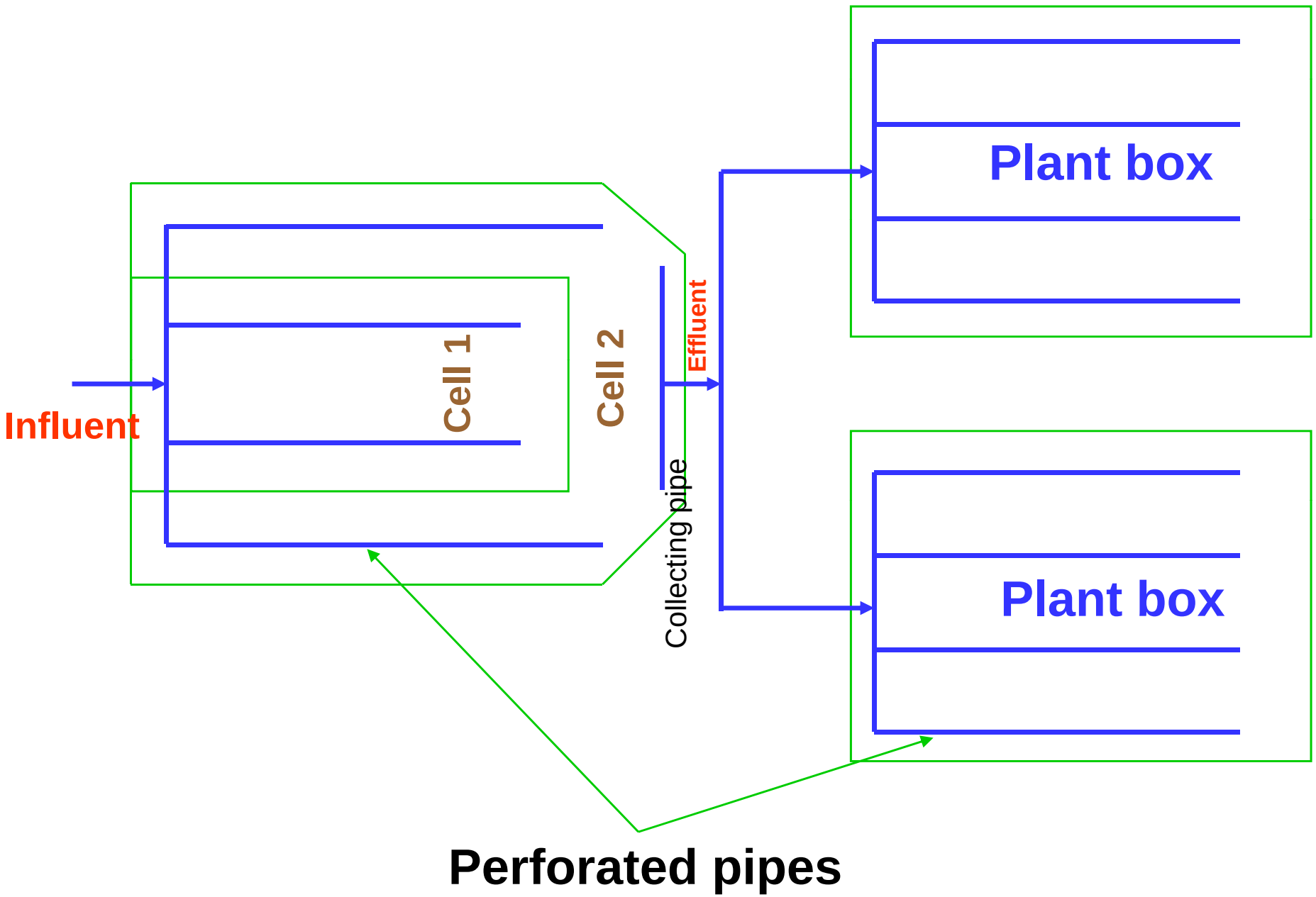


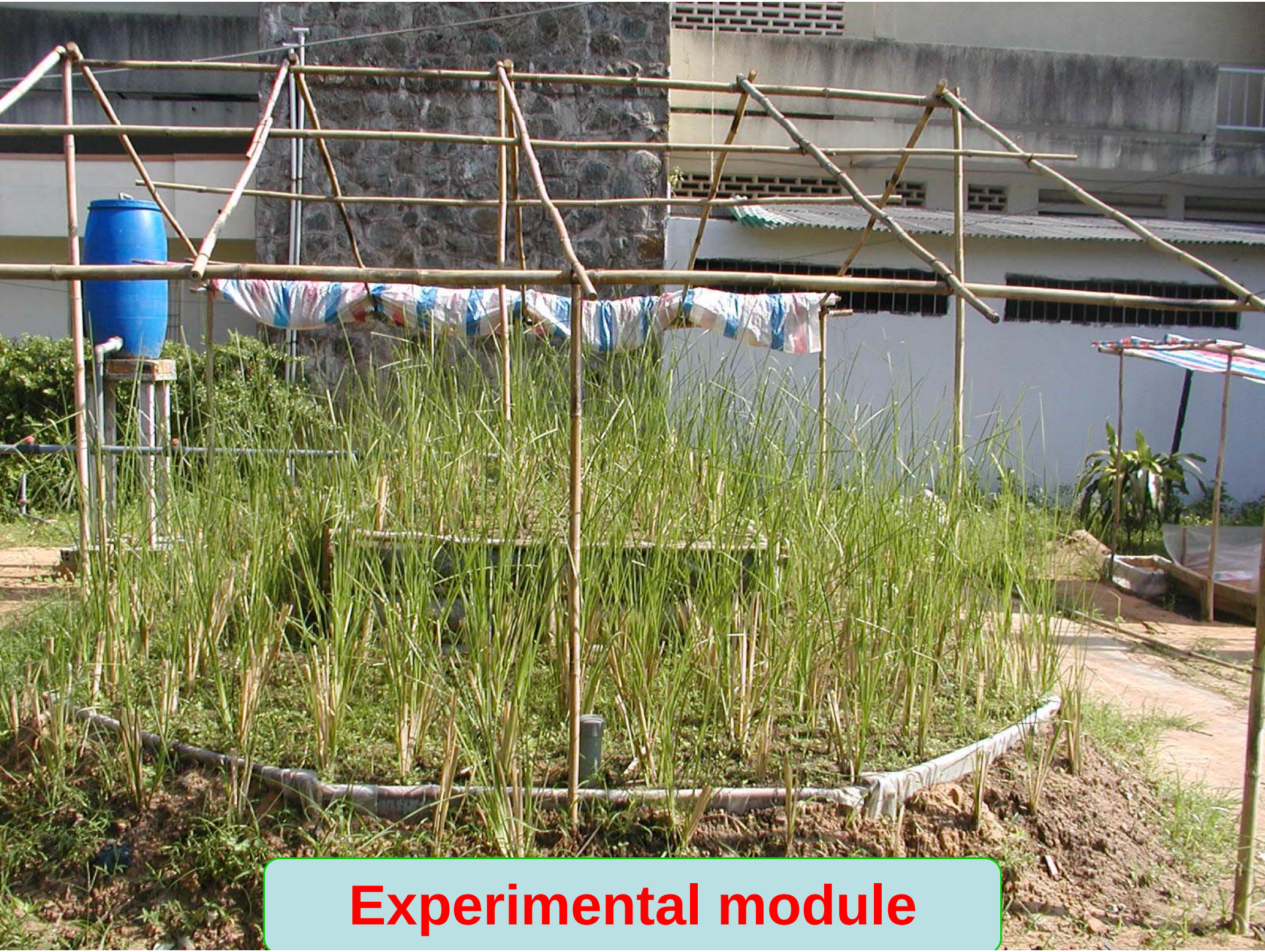
The **plants** grown in these plots are specifically chosen for their ability to assist in the biological treatment of water.

Plants act like biological pumps, converting sunlight into chemical energy and carrying oxygen from their leaves to their roots.



Water distribution system




Experimental module

Water distributing system under surface

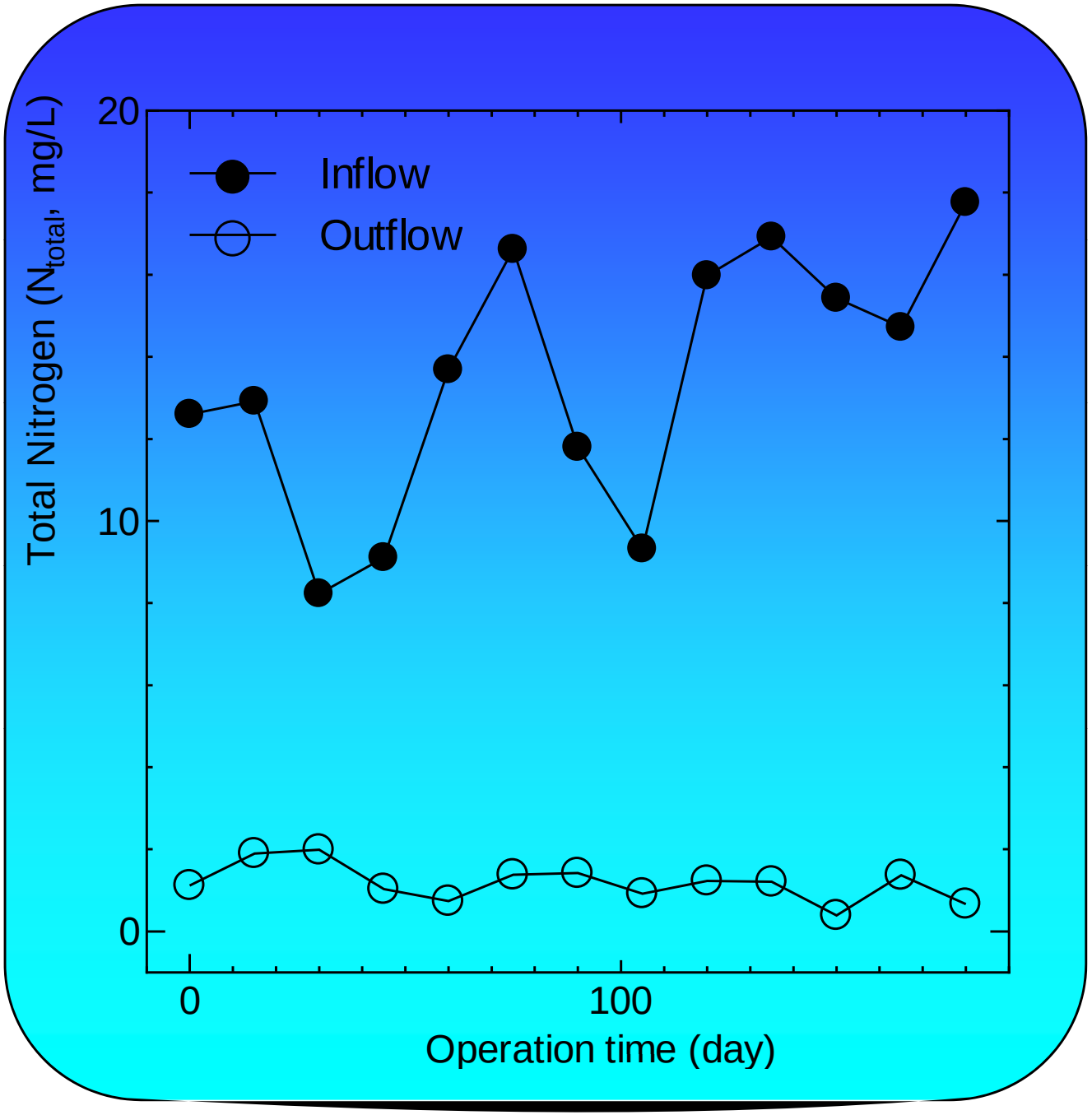
Two years of operation with cover of grass

Potential of constructed wetland

- TDS of influent ranged from 370 – 480 mg/L, but effluent only 8-14mg/L.
- Temp. of influent is normally higher than that of effluent from 1-2^{0}C. This temperature ranged from 25 – 30^{0}C.
- pH of influent normally low, ranging from 4.3 – 5.2. Otherwise, pH of effluent fluctuated in ranging 6.5 – 7.8.

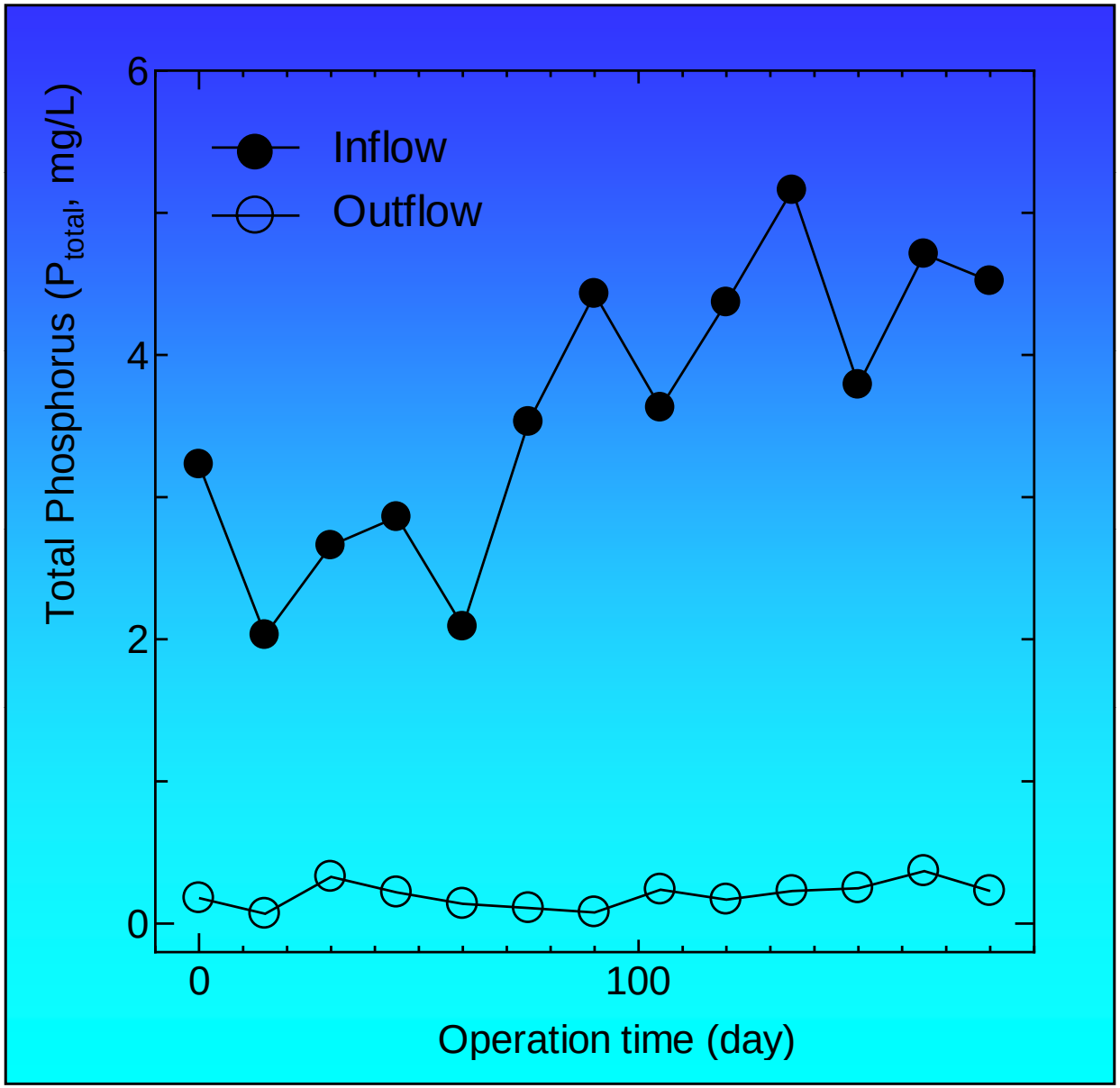
Nitrogen

Treatment efficiency of constructed wetland reached 91%.



Reduction of N by the treatment system.

Phosphorus

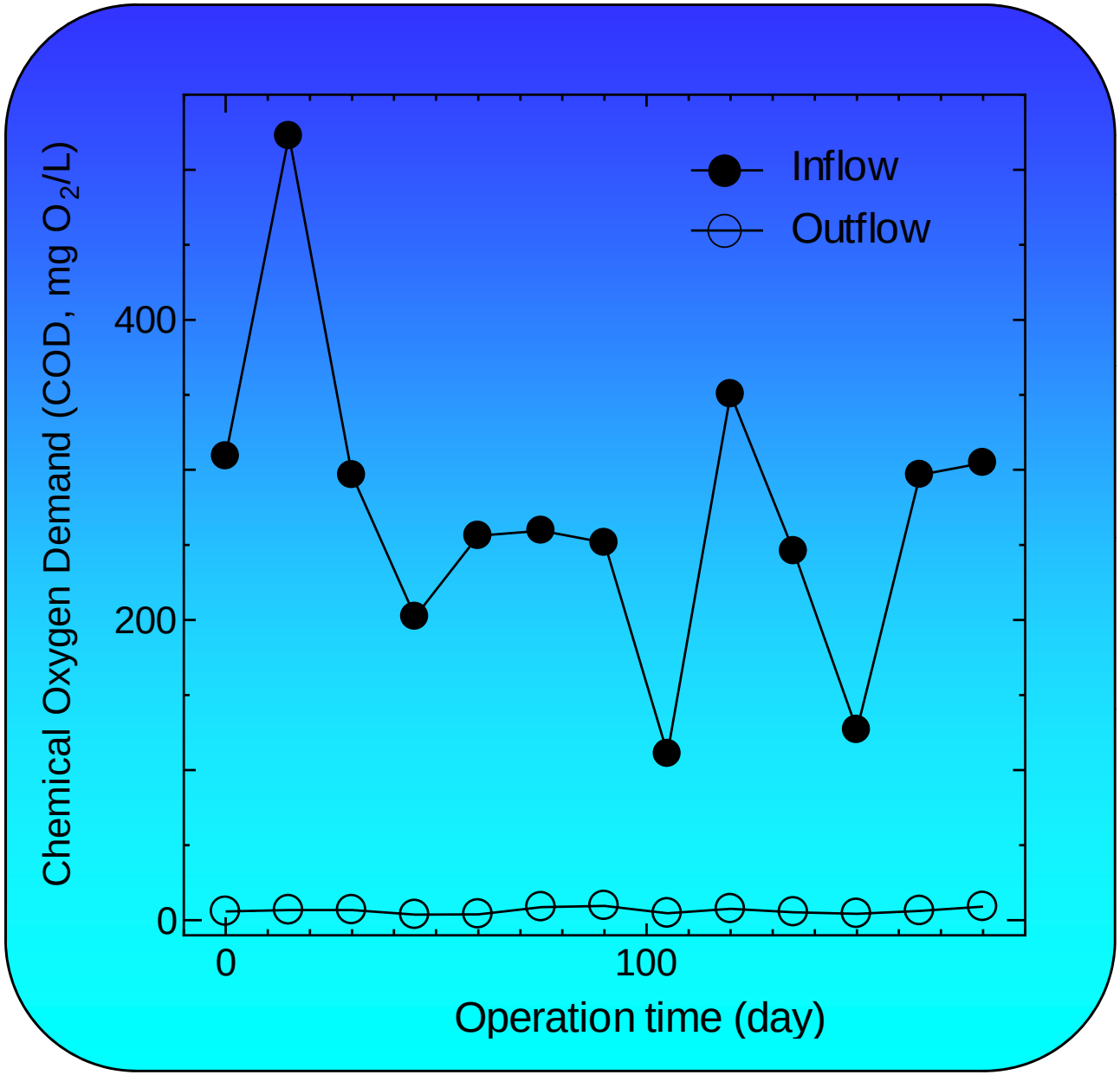


Concentration of P inflow was unstable but outflow was relatively stable.

Efficiency of that system rose up to 94%.

Fluctuation of phosphorus in operation time

COD



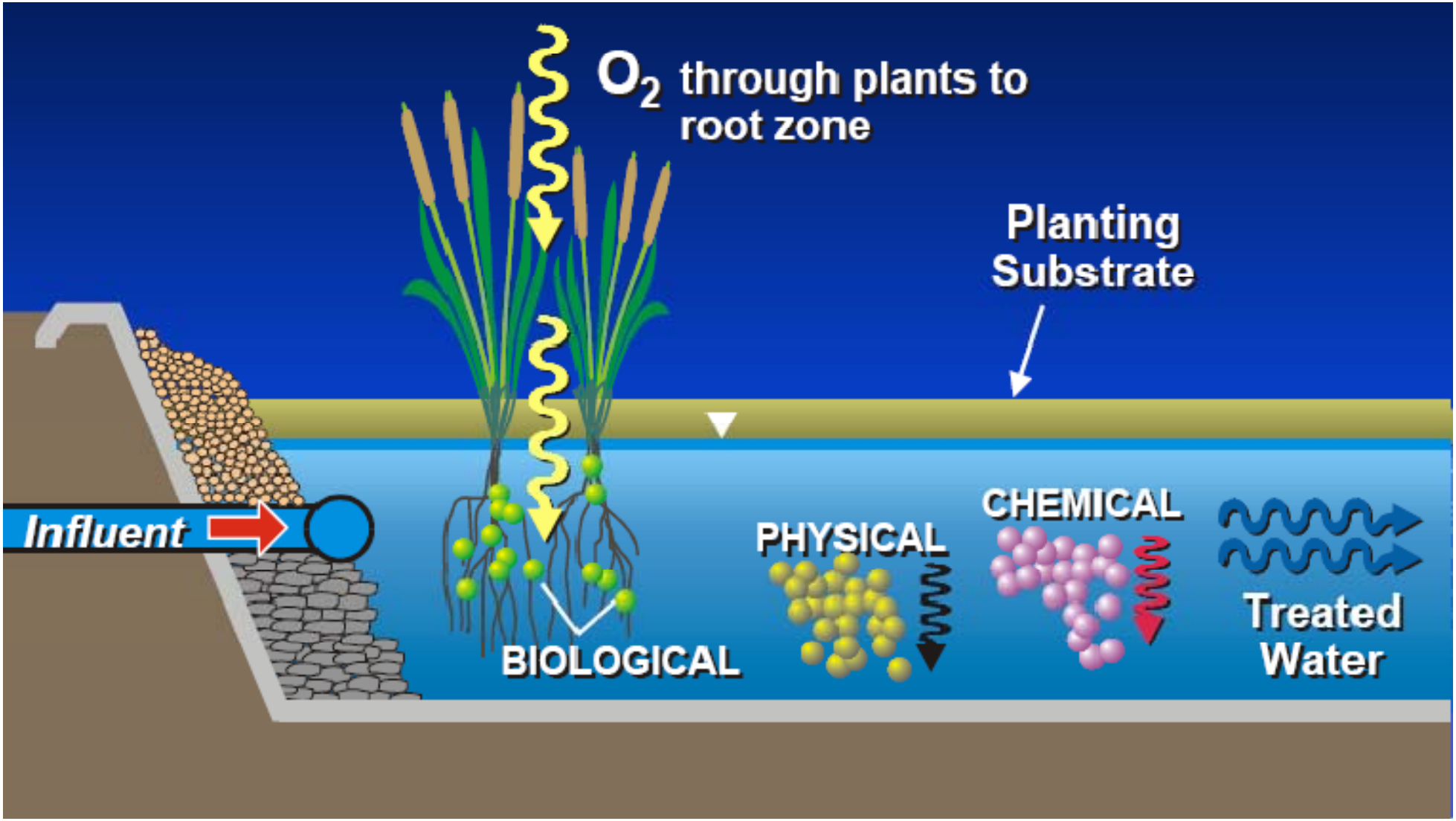
COD in outflow reached US-EPA standard (<50mg/l).

Effluent could be used for watering gardens and landscape sites.

Water outflow could be considered a source of valuable fertilizer.

Fluctuation of COD in operation time

Contaminant removal mechanism in constructed wetland



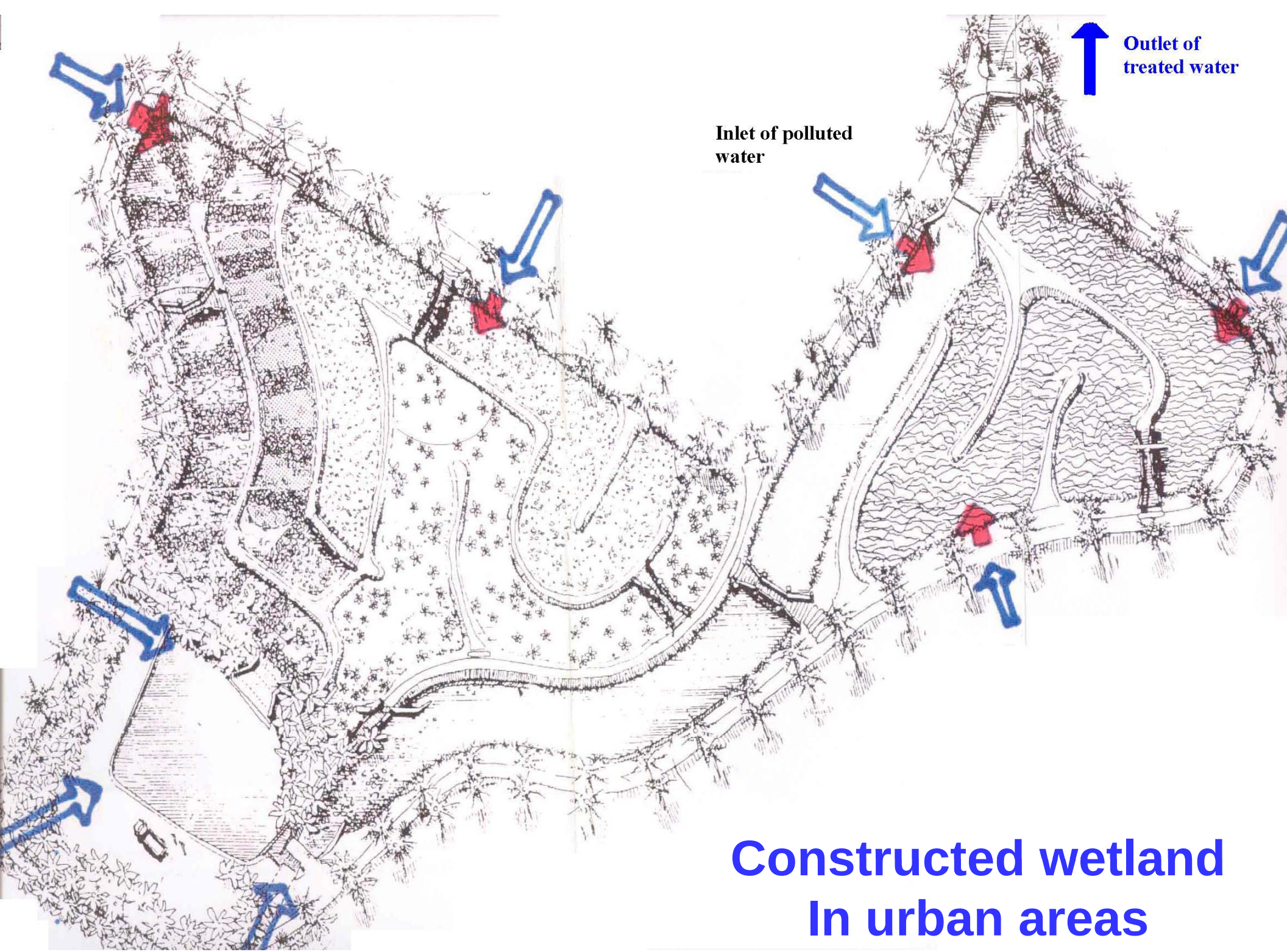
Source: **ROUX ASSOCIATES, INC.**

Concluding remarks

- Designed wetland removed a significant of contaminants (COD, N, P and pathogens) from wastewater.
- Biomass of cover vegetation considerably increased
- Easy and stable operation at low cost.
- Applicable for other kinds of wastewater so far.

Some wetland applications

Natural wetland surrounding farmland



Constructed wetland
In urban areas

In urban with high population


Combination with vegetation

….and so on

Conclusion

Natural wetland has potential in water control and treatment.

Constructed wetland removed contaminants efficiently.

Full estimation of wetland values has been under investigation by multidisciplinary researchers.

Utilities of wetland for different purposes need to be controlled and managed carefully.


Thank you
for your attention