Could the water harmonica play its role in the developing world ?

A review of practical experiences, successful, and less successful experiences

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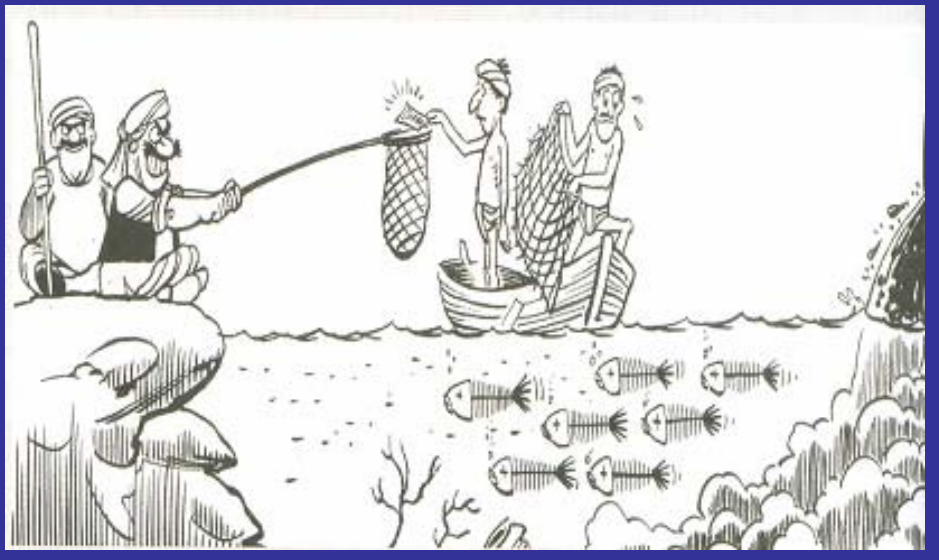
Major problems of Environmentally Sustainable Future

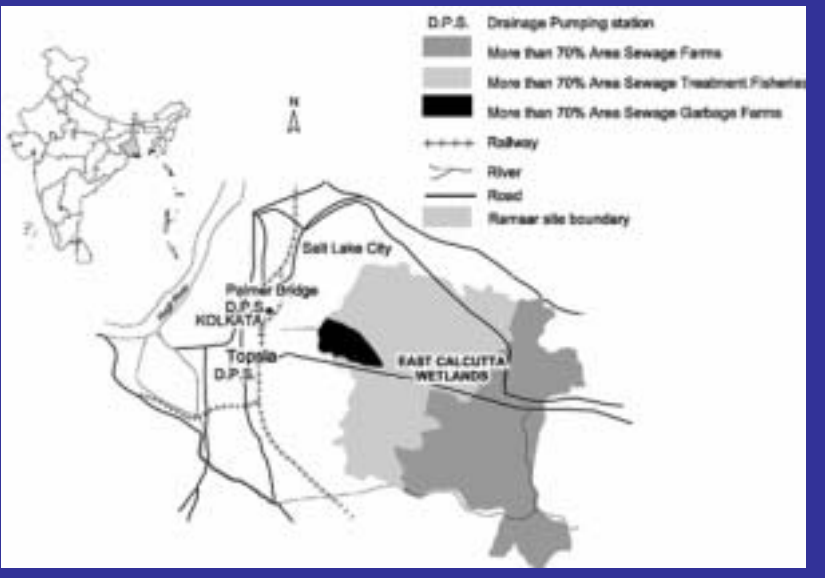
- Population Explosion
- Rapid pace of Industrialization
- Substantial rise of Urban Population
- Small population of India is served by sewers
- Sewerage system exists only in few largest Cities
- Uncontrolled spillage of Wastewater
- Acute crisis of water and clean water

Ganga Fisherfolk:

between ancient oppression and modern distruction



Because of severe surface water pollution migratory Hilsa, a much sought after delicacy is being damned to death.



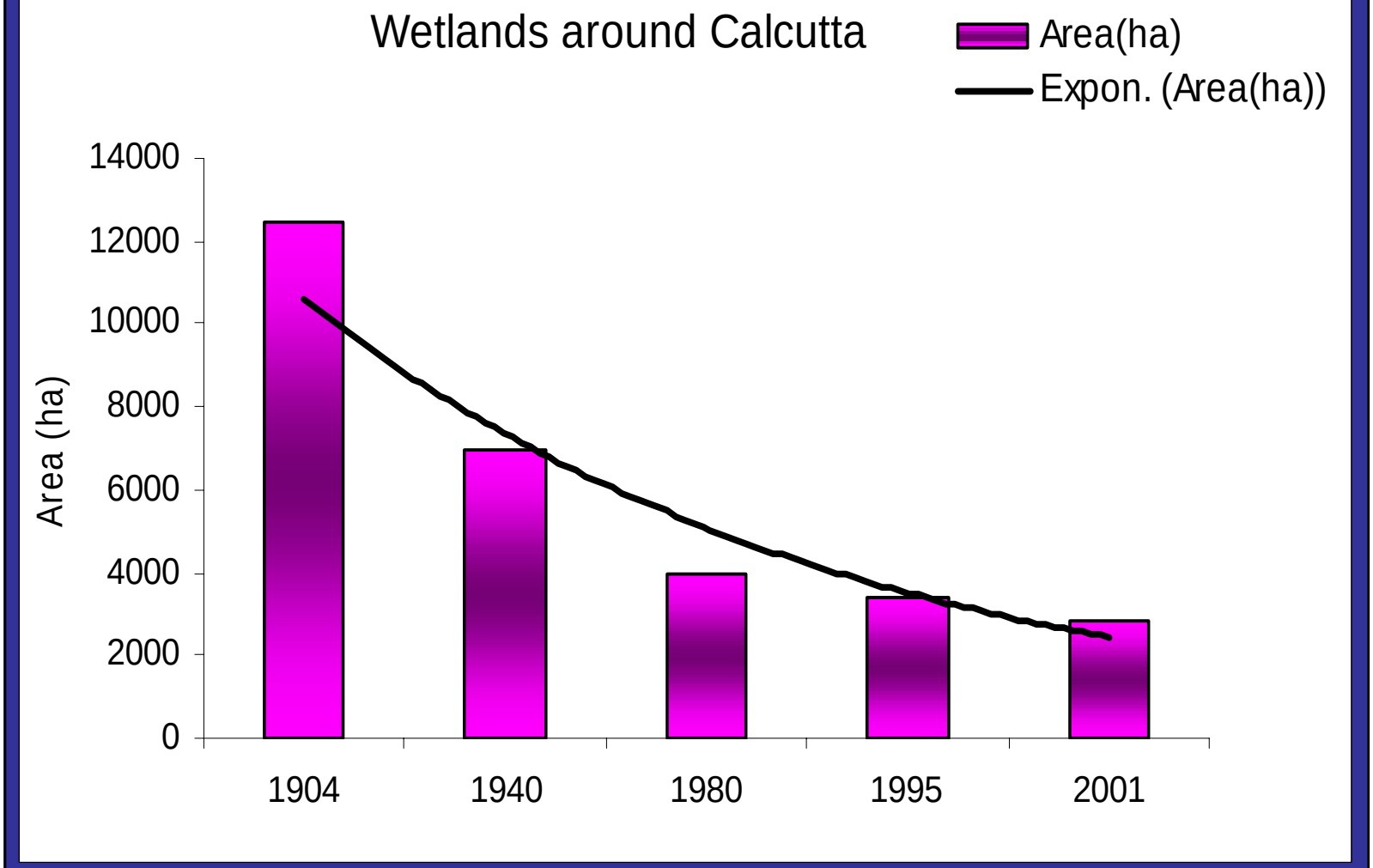
Coordinates - 22°25' – 22°40' N latitude and 88°20' – 88° 35' E longitude

Area - 12500 ha
Elevation - 2 m GTS (Global Telecommunications System

Wetlands – City's Kidney

- **Declared Ramsar site**
- **Dynamic buffer ecotones**
- **Natural Kidney of city landscape**- City's vital drainage basin
- **Unique Environmental repairer of the city**
- **Stabilize water supplies-** ameliorate both flood and drought
- **A low cost single unique ecological unit-** resource recovery,repairing
- **An unique single system based on-**Conversion of waste into bio-wealth
- **Sink to air particulates**
- **City's major source of daily edible needs-**Important source of protein
- **Biological supermarket-**valuable conservators of bio-diversity
- ***Cause celebre* for conservation minded people and organization**

WETLAND DECLINE



Sewage production in major cities of India

Total amount in sewage in India in ton per day:

N	**90**
P	**32**
K	**55**

We could recover a huge quantum of nutrients from domestic sewage

These nutrients do have a value of about 1 million Euro per day

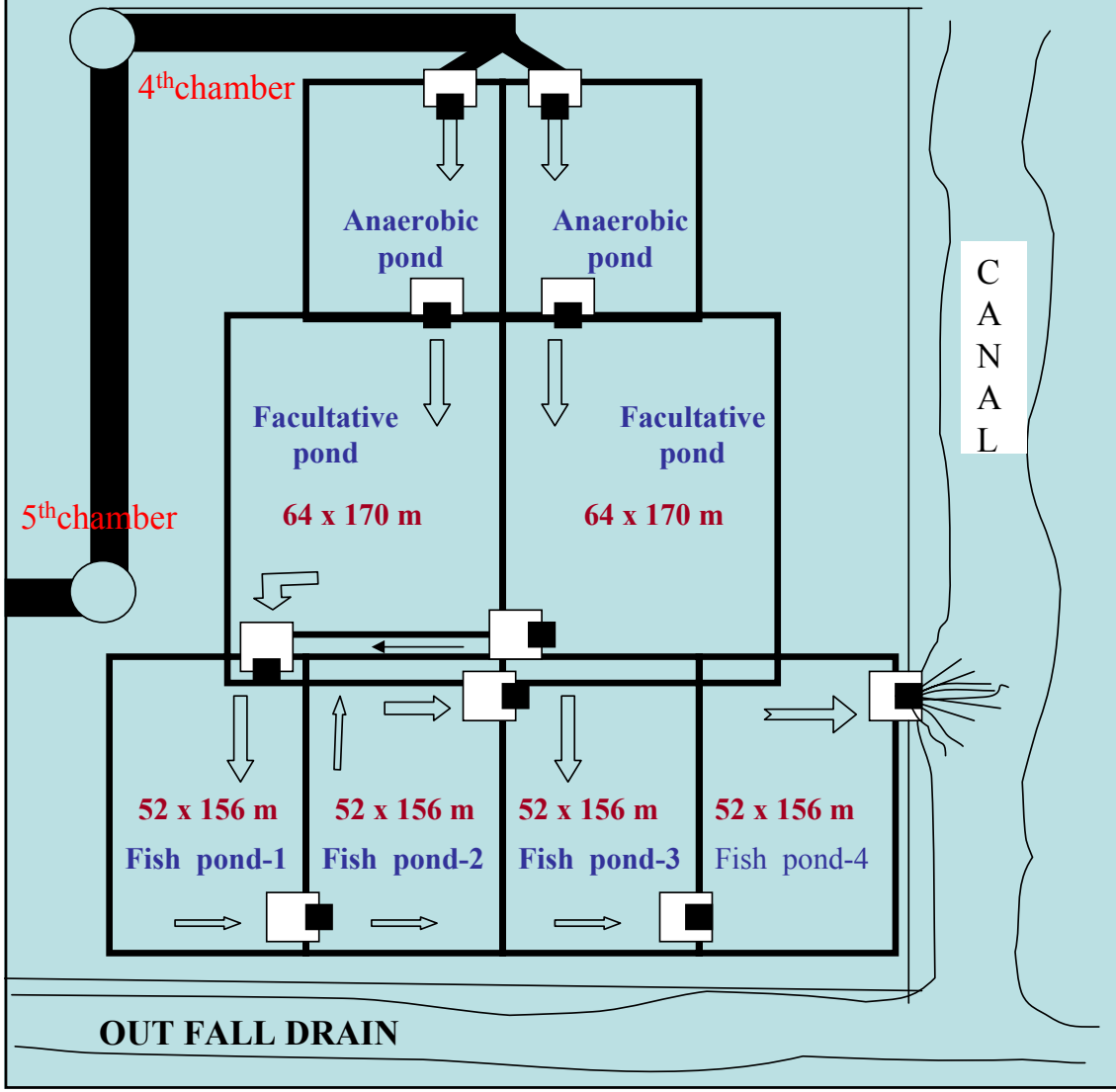
Wastes into Wealth

- Referred as resource out of place
- Should not remain unutilized, but be returned to earth
- Recycling and reuse converting wastes into wealth
- Integrated cross disciplinary approach
- Living machines

WASTEWATER - FED AQUACULTURE

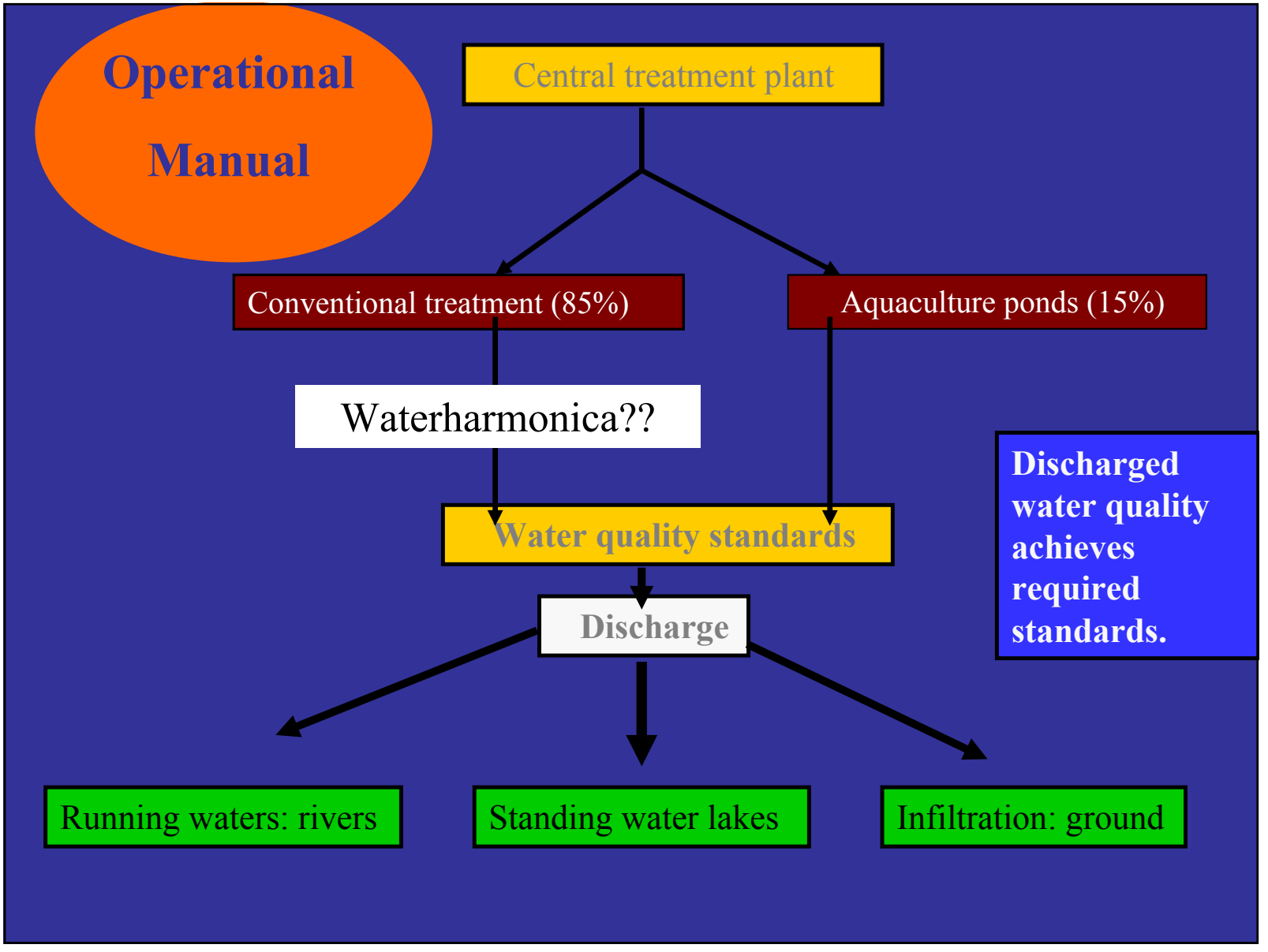
- Integrated biosystem-- at least two sub-systems, the waste from the first system used by the next sub-system producing value added products.
- An economically viable source of high protein through recycling of organic residues in the eco-friendly balanced system.
- Maximizes waste recycling and reuse, converting wastes into wealth.
- Design criteria - conducive to rapid degradation of sewage using living machines - macrophytes, algae and bacteria.
- Final effluent – environmentally risk free and permissible for discharge into the river system.

Kalyani Sewage Fed Fish Farm- A case study



Period of Study: May, 1997- 1999
Area of the farm: 82 acres or 33.2 ha
Rate of sewage Production: 17 mLD day^{-1}

Sewage fed aquaculture ponds


Operational Manual
Central treatment plant
Conventional treatment (85%)
Aquaculture ponds (15%)
Waterharmonica??
Water quality standards
Discharge
Discharged water quality achieves required standards.
Running waters: rivers
Standing water lakes
Infiltration: ground

FARMERS PROTOCOL

- **Pond management**
  - **Dry up when necessary**
  - **Lime application @ 400-500 kg/ha**
- **Species selection**
  - **Greater proportion of more tolerant and bottom grazing fish (tilapia, common carp and mrigal)**
- **Stocking density**
  - **Titagarh - 5000-7000 fingerling/ha**
  - **150-300 x 10^3 advance fry / ha/yr**
  - **Mudialy - 200-300 x 10^3/ha/ yr**
  - **Captain Bheri - 150 x 10^3 / ha/ yr**
  - **Kalyani - 30000 - 50000 fry / ha / yr**
- **Culture Period - 2-3 months**
- **Harvesting and restocking - multiple cropping patern**
  - **(2 - 3 months after fish introduction)**

One of the most advantage of wastewater aquaculture is highly cost-effective as no supplementary feeding nor pond fertilization is required. Stocking density varies according to seed availability, time of stocking and culture system

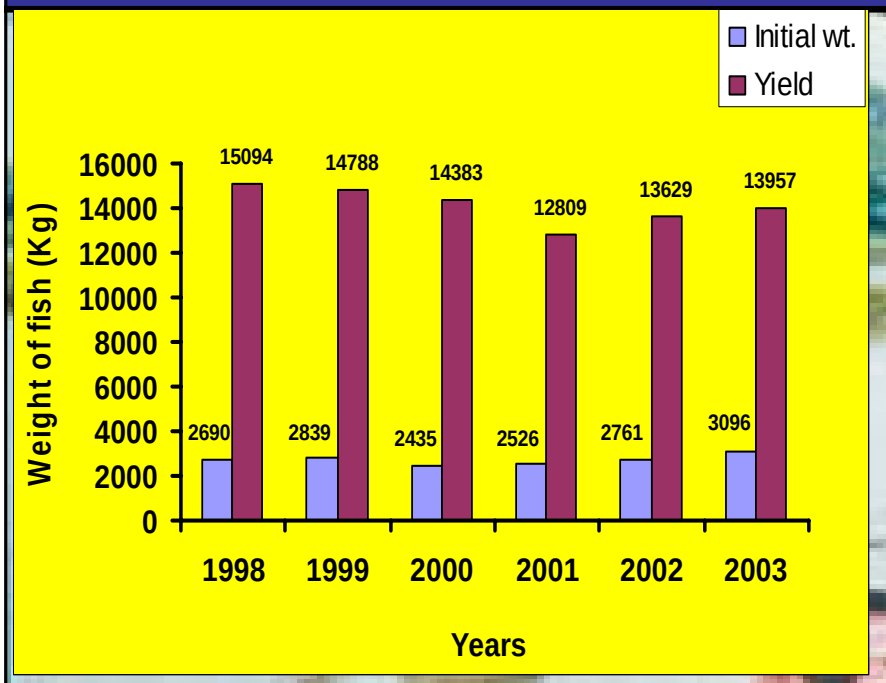
Criteria for Selection of Fish Species

- Tolerant to low DO level
- Herbivorous or omnivorous in nature to feed on waste grown phytoplankton
- Tolerant to disease and other adverse conditions
- Filter feeding herbivorous fishes with energy effective short food chain
- Hardy and market value

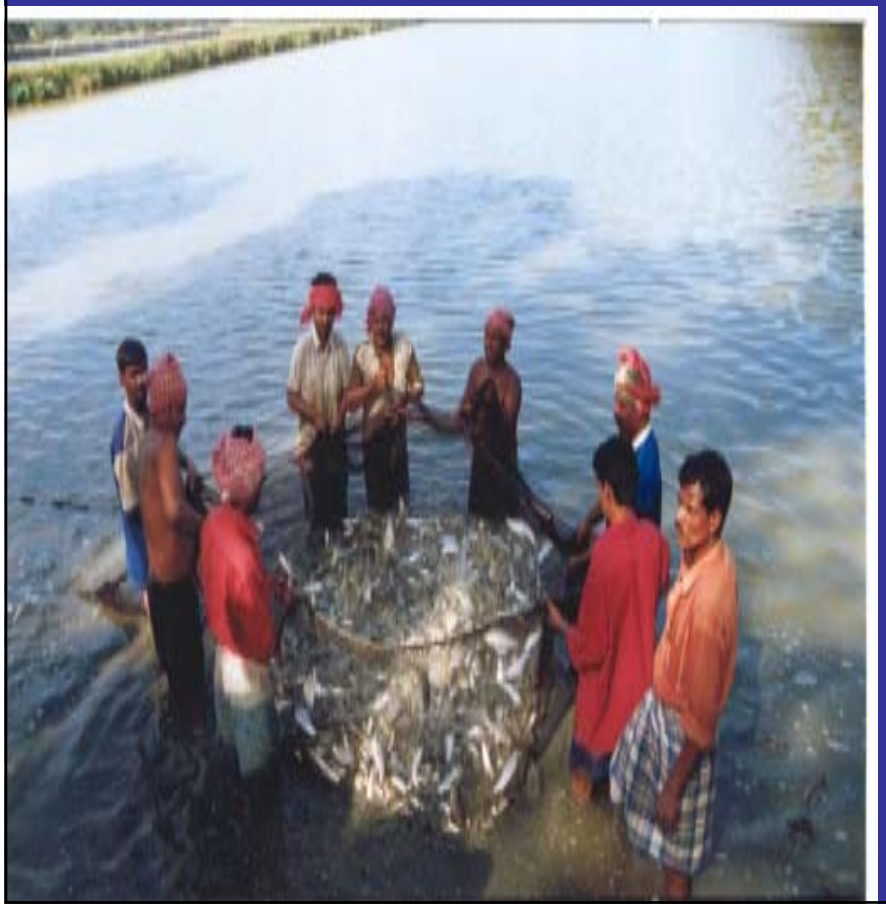
Well Adapted species of Fish for Wastewater Aquaculture

Herbivores	Carnivores	Omnivores
Catla (*Catla catla*)	Magur (Clarias batrachus)	Tilapia (Oreochromis spp.)
Grass carp (*Ctenopharyngodon idella)*	Bermuda angel fish *(Holacanthus baramudensis)*	Rohu (Labeo rohita)
Silver carp (*Hypophthalmichthys molitrix*)	Freshwater prawn *(Macrobrachium lanchesterii)*	Mrigal (Cirrhinus mrigala)
		Pangus (Pagusius sp.)
		Kissing gouramy (Helostoma temmincki)
		Giant gourami (Osphronemus goramy)

Fish Yield in Kalyani Farm



Fish catch in Calcutta sewage-fed fisheries



12.500 ha fish ponds

1991 – 1996

average 565 *kg/ha per month*

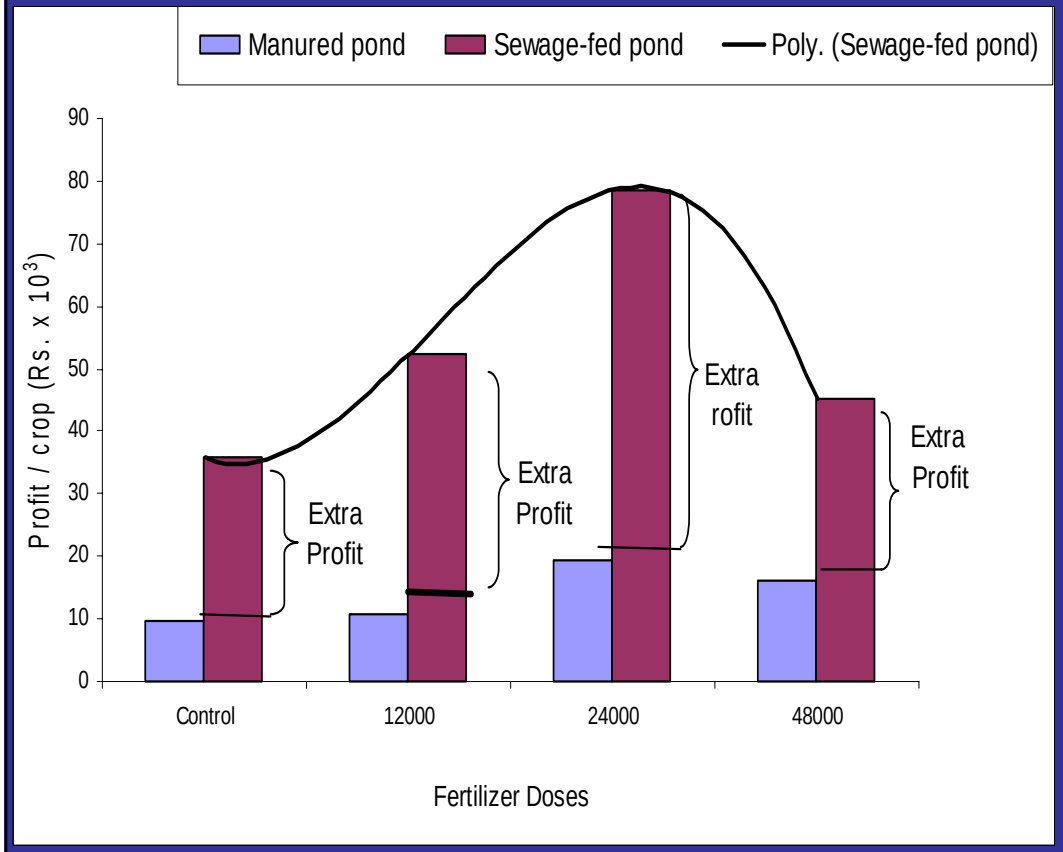
7000 – 8000 ton/month

estimated value € 0.80 per kg

Or € 5.6 million per month

Or livelihood for about a 100.000 people

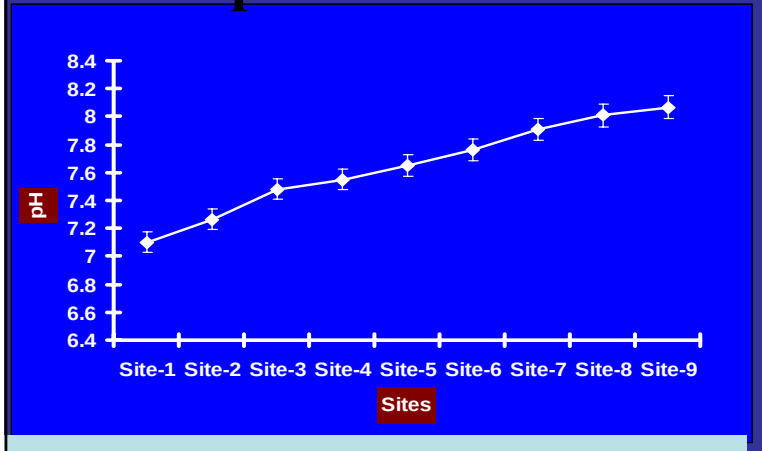
Extra profit in sewage-fed over manure ponds



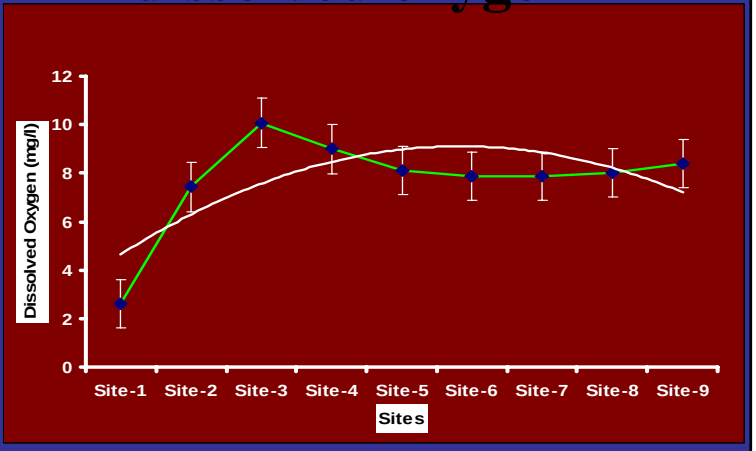
- **Within the limit of fish growth, in wastewater, additional profit was obtained in the waste water aquaculture ponds over manured ponds. Extra profit was maximum at optimum fertilizer dose (24000 kg/ha) low on either side.**

Variability in different sites from anaerobic pond to facultative pond

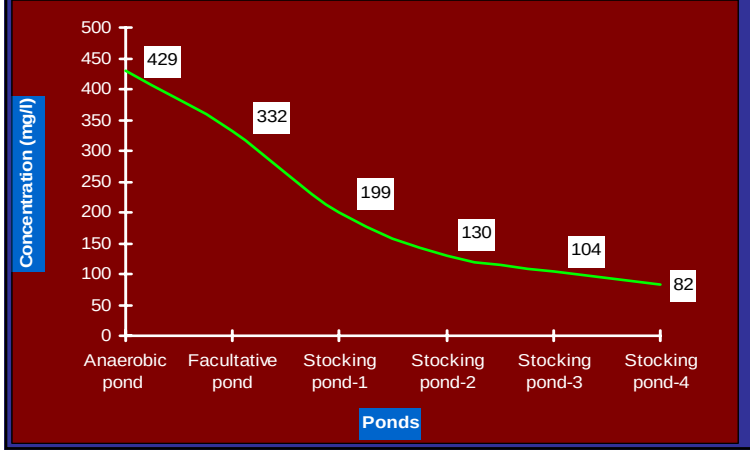
pH



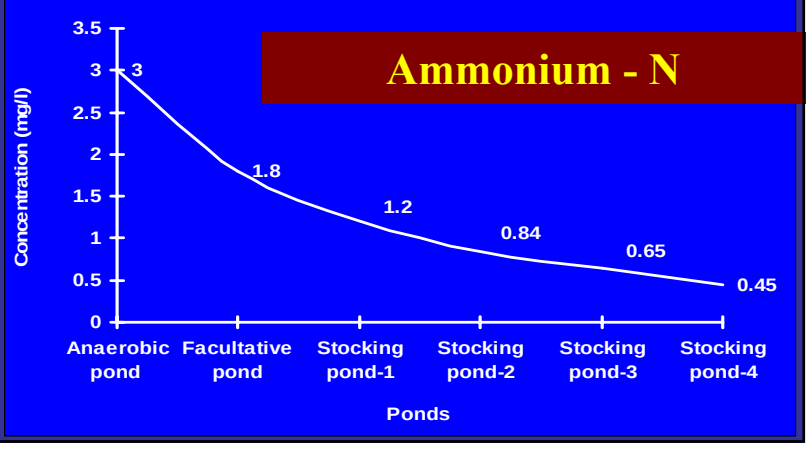
dissolved oxygen



Chemical oxygen demand



Ammonium - N



Kalyani Wastewater Aquaculture System

City sewage entering Kalyani Sewage Treatment Plant

Multiple Benefits that accrue in India

The concept of Waterharmonica has been based on integration of food chain management

- through recycling of nutrients that otherwise cause not only eutrophication of the water bodies,
- loss of biodiversity but also causes loss of nutrient resource
-

This is particularly applicable to developing countries like India where a millions of people used to get their bread and butter from the wastewater fed aquaculture system.

The conventional expensive STP is hardly affordable in many economically developing countries, including India.

The Waterharmonica could act as:

1. **Safe guard to human Health and minimize health risk**
2. **Money recovery and employment generation system**
3. **Food Security through production of cash crop**
4. **Energy saving system**
5. **Economic security through integrated activites**
6. **Solution towards sustainable development**

1. Safe guard to human Health and minimize health risk

- Only a small fraction of Indian population is served by sewer system resulting in direct discharge of untreated sewage into open water systems which in turn promote the breeding ground for mosquitoes causing malaria and other water borne diseases.
- Water harmonica, on the other hand, would reduce /minimize the human health risk through prevention of disease outbreak caused water by borne vectors.

2. Money recovery and employment generation system

- Even though the STP can purify the domestic sewage, huge amount of nutrients that remain in the raw sewage has not been recovered and remain unutilized. This is a situation simulating drainage of huge money.
- As the domestic sewage is a store house of fertilizer and enormous amount of wastewater generated from different cities of India every day, the India is loosing an amount of approximately 1 million Euro daily because of lack of holistic and integrated approach towards economy driven activities for sustainable development.

3. Food Security through production of cash crop

- Waterharmonica practiced in India for the production of commercial fish. As fish is the output of the end of pipe system through food chain management, this is most significant for India because of favourable tropical conditions for fast growth of commercial fish serving as poverty alleviation as millions are involved directly or indirectly for their bread and butter.
- Because of shorter food chain, herbivorous fishes are more preferred than carnivorous fish.

4. Energy saving system

- Because of algal photosynthetic oxidation, the WSP is energetically more efficient and can replace the mechanically operated energy intensive oxidation system.

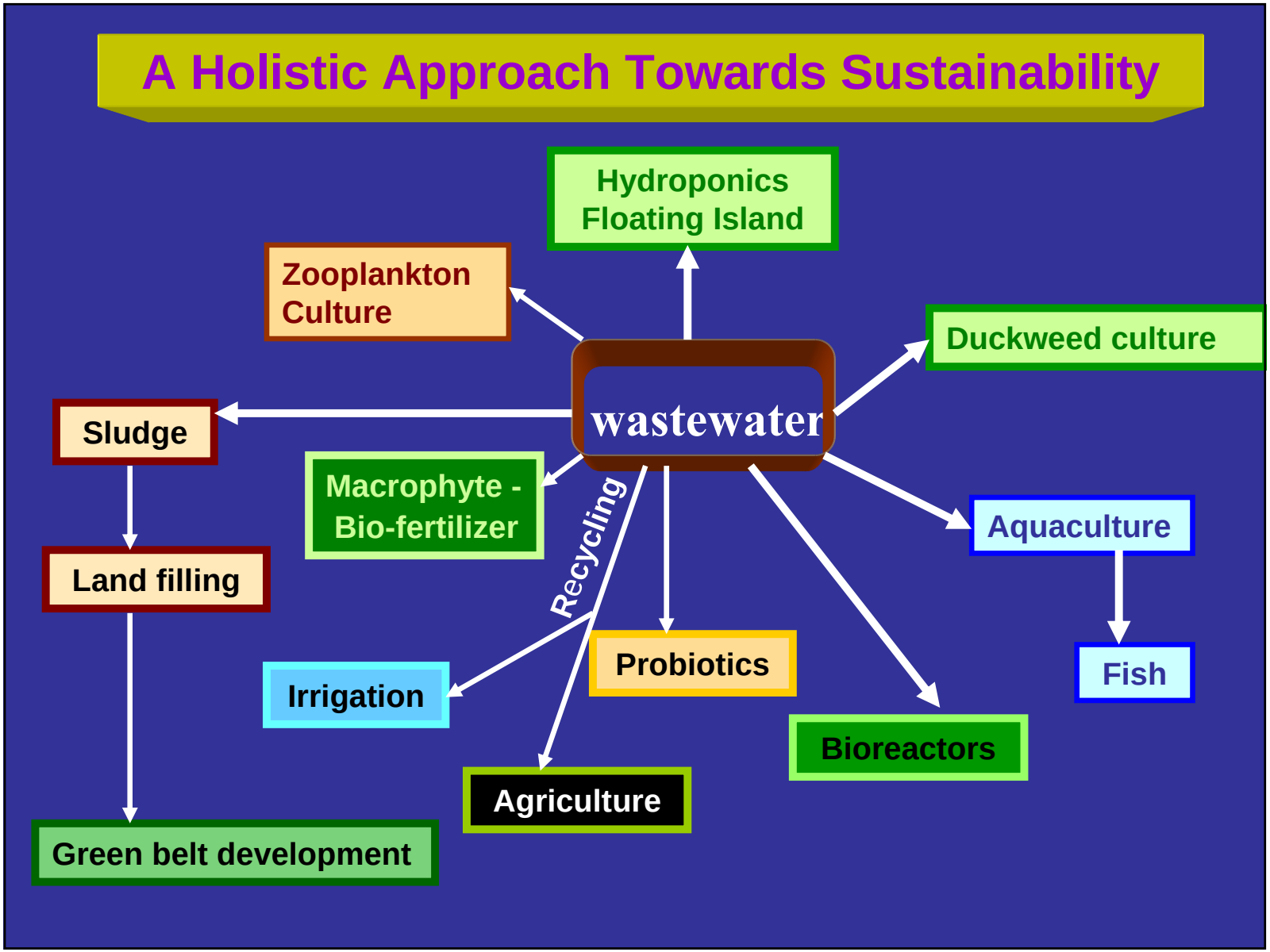
5. Economic security through integrated activities

- Waterharmonica may well be linked with production of economy driven value added products such as hydroponics, duck weed culture, mass production of live food, irrigation and nutrient supply in agriculture production, horticulture, floriculture, etc.

6. Solution towards sustainable development

- Waterharmonica may have several benefits. Such a practice helps not only to recover money through nutrient recovery, but also helps to combat environmental pollution . Thirdly, it helps to reduce the production cost by avoiding the application of supplementary feed and fertilizers.

A Holistic Approach Towards Sustainability



Conclusion

- the system would promote the development of eco friendly ecosystem free from pollution that preserves the biodiversity and maintains standard water quality for further use.


THANK YOU