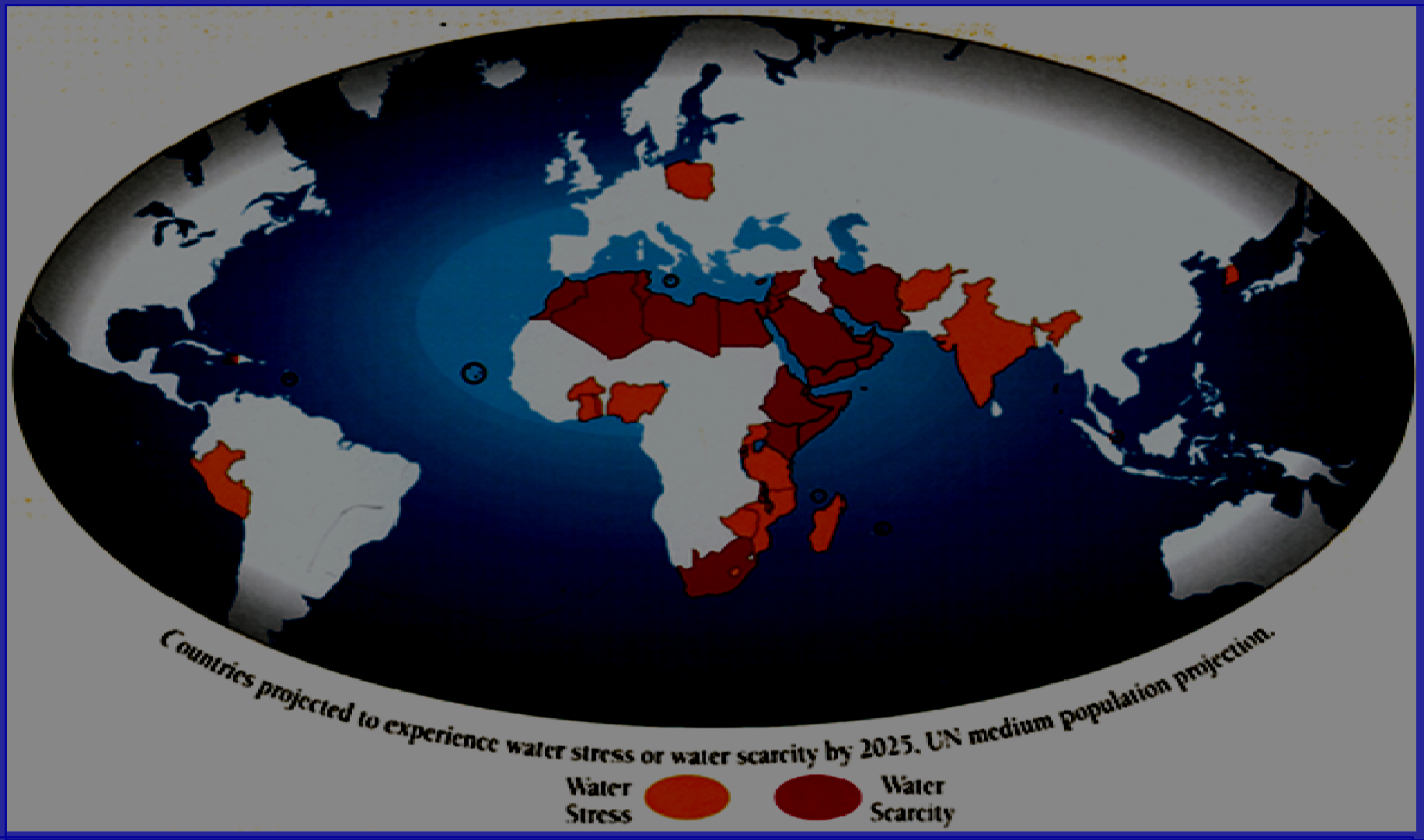
Ecosystem approach for
Conservation of urban lakes in South Asia

– Case study of lake Hussainsagar,
Hyderabad, Andhra Pradesh, India

Global water scenario by 2025



Projections indicate that Indian sub-continent will be a water stressed region by 2025 and thus there is an urgent need to conserve and manage vast freshwater resources in the form of lakes and reservoirs in the region on sustainable basis .

South Asia : Water scenario by 2025

South Asia includes seven countries [India, Nepal, Bhutan, Bangladesh, Sri Lanka, Maldives and Pakistan] constituting South Asia Association for Regional Cooperation (SAARC)..

The Indian sub-continent supports 18% of world's population crammed in to only 2% of its land mass

The region is cradle of one of the oldest human civilizations that mainly flourished around lakes and rivers.

Often described as "Water stressed" the countries in South Asia are facing water crisis on account of ever increasing demand of freshwater in all sectors of human activities.

Impounded in 1562, more than 450 year old Hussainsagar is an engineering marvel. However, in the last 60 years the lake basin has undergone extensive urbanization and industrialization resulting in to an all-round degradation of the lake ecosystem. Intensive conservation efforts in recent years have transformed the lake environment into recreational zone.

Fig. 1. HYDERABAD – DRAINAGE MAP

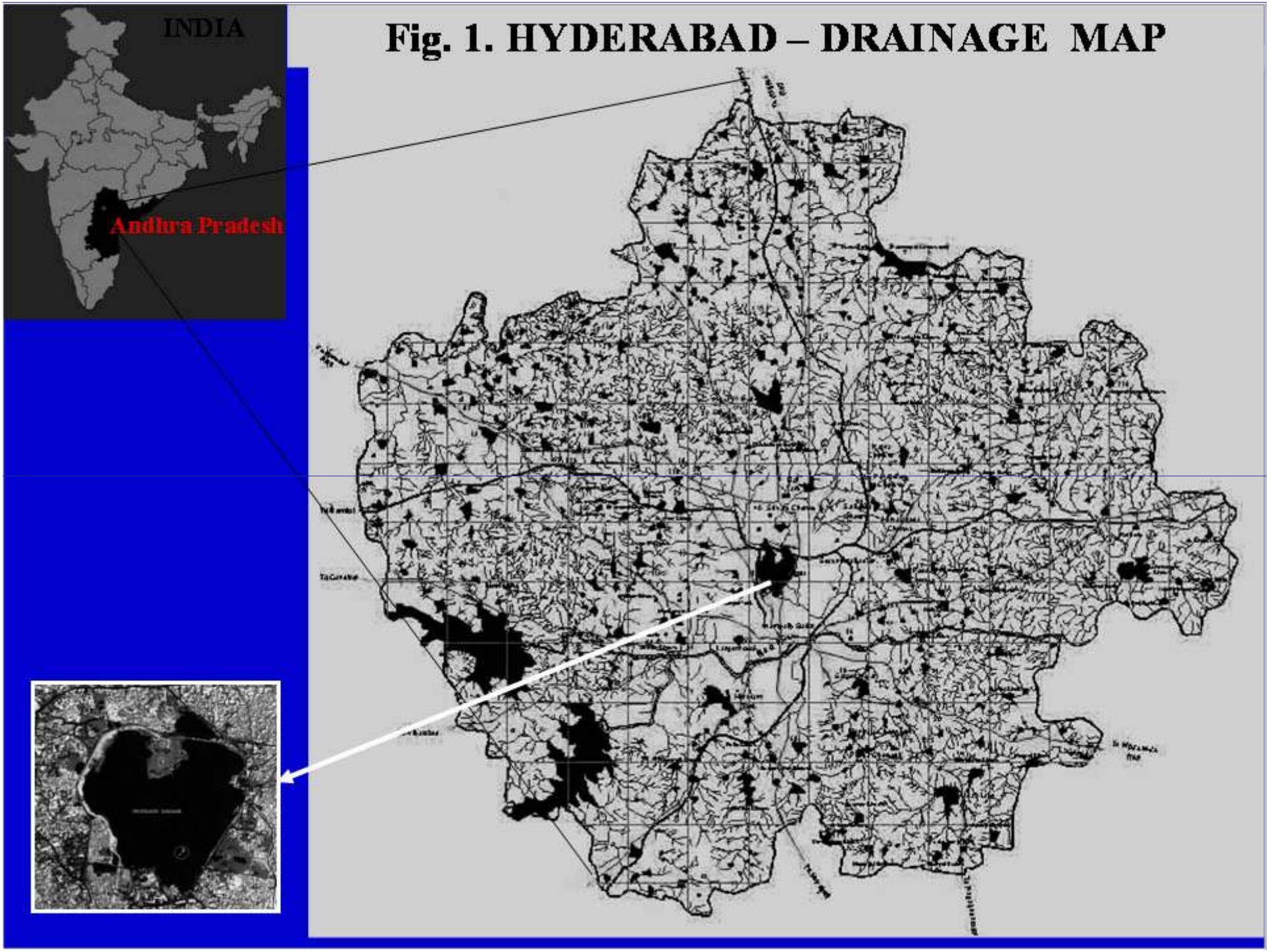
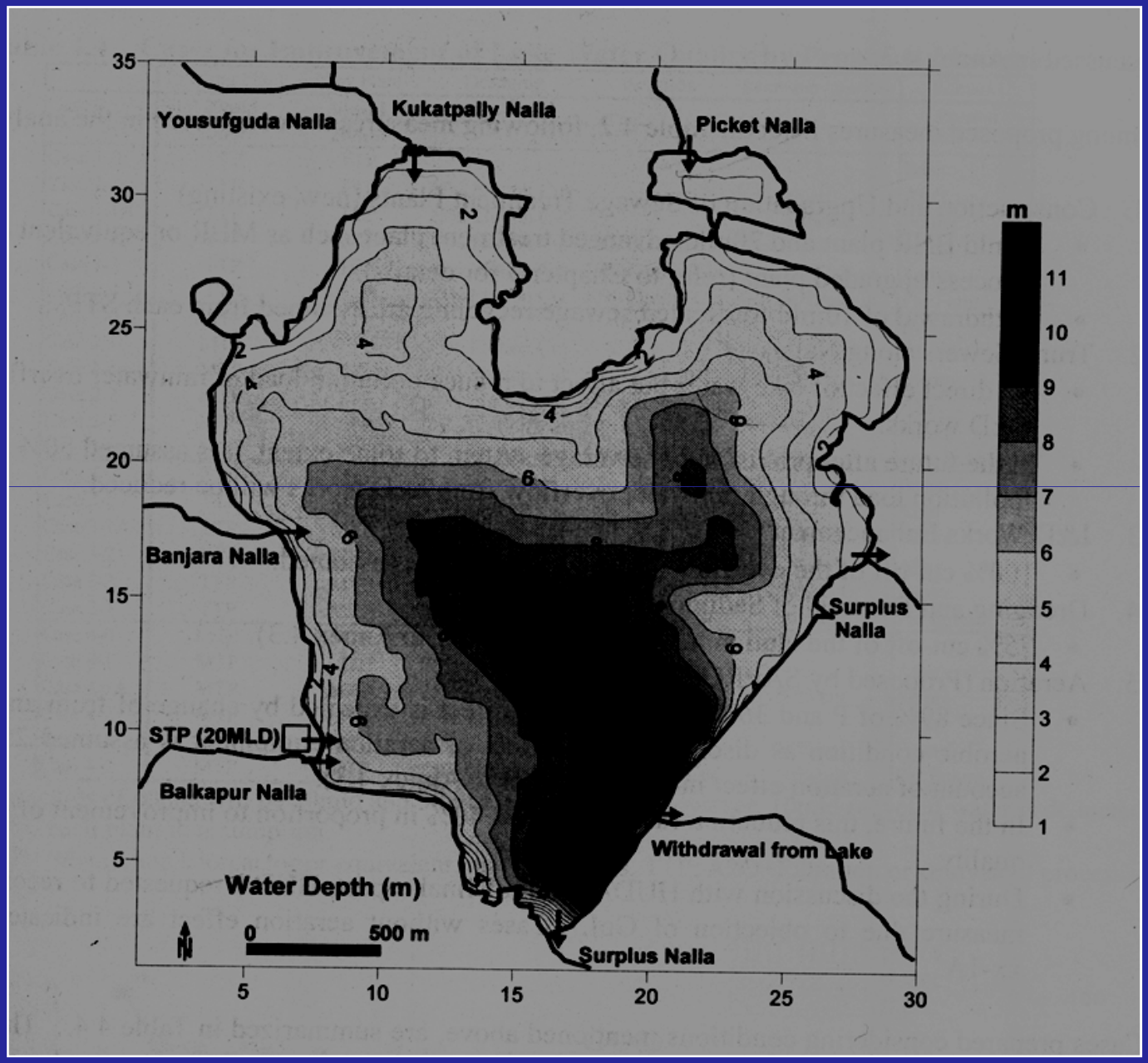


Fig. 2. In-lets and depth profile of Hussansagar lake, Hyderabad, India.



Hussainsagar, Feeding channels and dredging sites

Feeding channels :

1. Balkapur nalla (existing STP of 20 MLD capacity)
2. Banjara nalla (sewage)
3. Kukatpally nalla (sewage and Industrial effluents)
4. Picket nalla (proposed STP of 50 MLD capacity)

→ Dredging sites

Table 1. Physio-graphic features of lake Hussainsagar

Year of construction	1562
Basin area	240 km^2
Direct Catchment area	67 km^2
Shoreline length	14 km
Maximum water area	5.7 km^2
Capacity	27.1 million m^3
Average depth	5.2 m
Depth variable	1 to 12 m
Storage volume (spill)	28.6 X 10^6 m^3
Maximum operating level	514.93 m
Normal operating level	513.43 m
Road bund level	5.18.16 m

Table 2. Dry weather flows

Channel	Flow in MLD			Remarks
	Sewage	Industrial effluents	Total	
Picket	05.7	-	05.7	Interception and diversion after pumping Proposed STP (30 MLD capacity)
Kukatpally	55.0	15.0	70.0	Interception and diversion (I&D)
Banjara	06.0	-	06.0	Interception and diversion (I&D)
Balkapur	13.3	-	13.3	STP (20 MLD capacity),
Total	80.0	15.0	95.0	50 mld treatment by 2 STPs

ISSUES AND PROBLEMS :

1. Reclamation and encroachments:
2. Pollution from sewage and industrial effluents :
3. Siltation from natural and cultural factors:
4. Eutrophication:
5. Ground water pollution:
6. Breeding of vectors :
7. Loss to lake dependent communities :

Table 3. Extensive developments around the lake that have reduced its water spread.

Activity	hectors (acres)	Characteristics
NTR Garden	13.736 (34)	Greenery, Party zone, Recreation
NTR Memorial	0.81 (2)	Greenery and memorial of former Chief Minister Dr N.T.Rama Rao
Lumbini Park	2.025 (5)	Floral clock, Fountain, Toy train, Recreation, Jetty for boating on the lake, Laser show
Sanjeevaiah Park	36.45 (90)	Lung space, Sprawling garden, Palm garden, Recreational centre
P.V. Memorial	1.1745 (2.9)	Memorial of former Prime Minister of India, P.V.Narsimha Rao
Necklace road	1.1458 (3.6)	Garlanding road on rear side of the lake, recreational zone
People's plaza	1.4175 (3.5)	Promenades and areas for exhibitions
Wetland eco-conservation zone	5.0615 (12.5)	Great floral diversity, 'in situ' conservation, greenery

For want of adequate sewerage network and treatment facilities sewage from the lake basin freely flows in to the lake

1. Blue green Algal blooms

Production of Nephrotoxins (Kideneys), Hepatotoxins (Liver) Dermatotoxins (Skin)

Urban settlements in lake basin

Lack of Sewage management

Nutrient enrichment

Eutrophication

Siltation and Succession

3. Fish kills indicate extreme environmental degradation

2. Wild growth of aquatic weeds *Eichornia, Pistia, Hydrilla* etc.

4. Ground water pollution Nitrites, pesticides, heavy metals etc.

Cultural siltation

Lake receives large quantities of silt from idol immersion, an integrated aspect of regional tradition and culture. However, in recent years with growing environmental awareness steps like demarcation of immersion zone and post immersion cleaning up have significantly minimized the problem

Nephrotoxins (Kideneys)

Hepatotoxins (Liver)

Dermatotoxins (Skin)

Blooms of cyano-bacteria (blue-green algae) is a sure indication of sewage linked eutrophication. The blooms set a chain reaction manifesting in the form of anaerobia, toxicity and massive fish kills.

Fish kills were a common up to 1993.
Of late extreme pollution has virtually wiped out fishes from the lake.

6/7 May 1975	Out of 27 species in the lake, 9 species including the main ones : Clarias, Etroplus, Tilapia, Mystus etc.
24 April 1984	Species not identified
22 April 1986	3 species : Notopterus, Puntius, Channa.
24 April 1990	Notopterus sp.
6 April 1991	Notopterus sp.
23 April 1993	Notopterus sp., Channa

One of the most perceptible manifestations of eutrophication is wild growth of aquatic weeds like water hyacinth that cover entire lake affecting its water quality, biodiversity and livelihood of lake dependent communities.

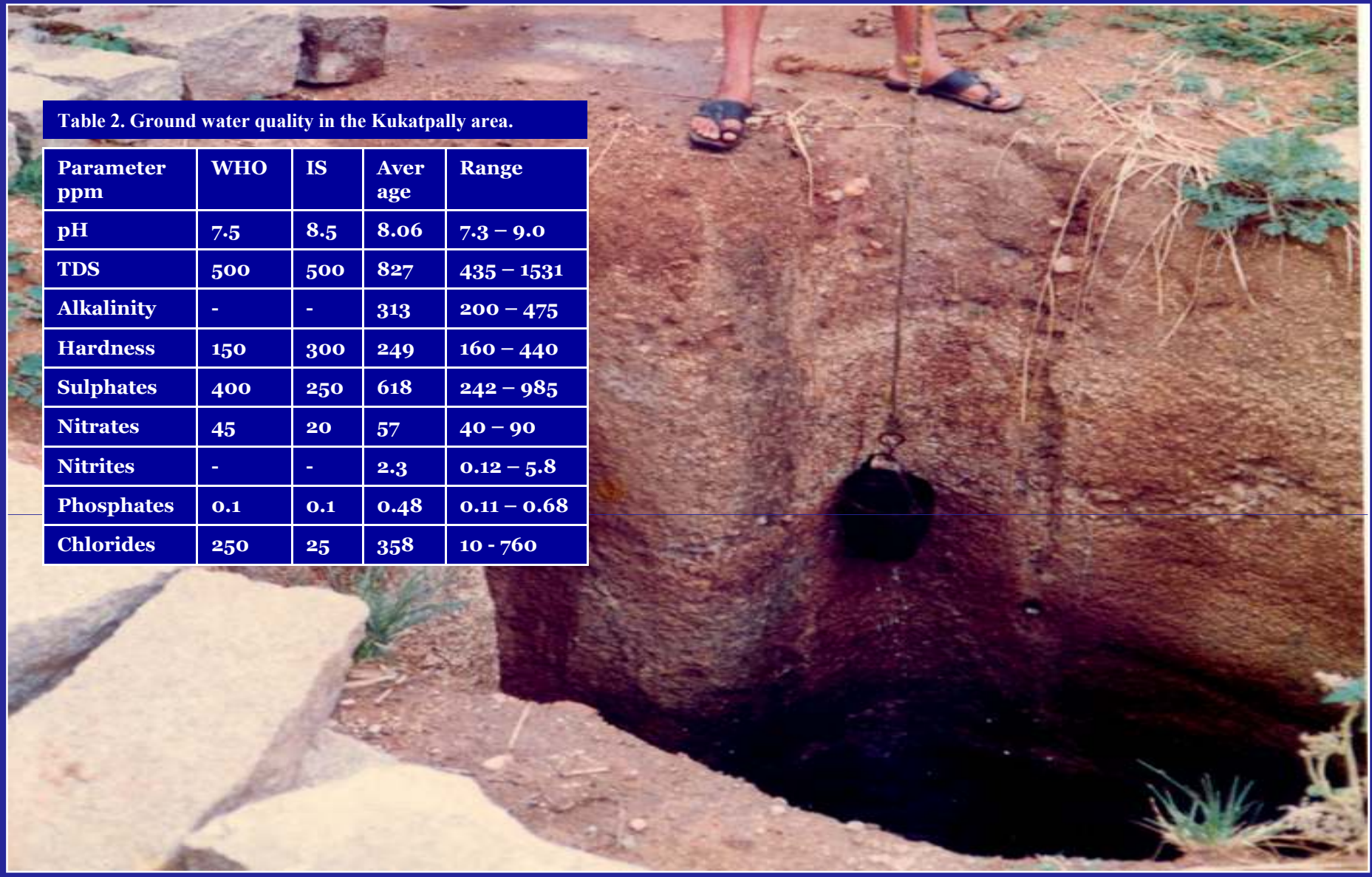


Table 2. Ground water quality in the Kukatpally area.

Parameter ppm	WHO	IS	Average	Range
pH	7.5	8.5	8.06	7.3 – 9.0
TDS	500	500	827	435 – 1531
Alkalinity	-	-	313	200 – 475
Hardness	150	300	249	160 – 440
Sulphates	400	250	618	242 – 985
Nitrates	45	20	57	40 – 90
Nitrites	-	-	2.3	0.12 – 5.8
Phosphates	0.1	0.1	0.48	0.11 – 0.68
Chlorides	250	25	358	10 - 760

Groundwater pollution : The recharging process contaminates ground water around a lake. Such pollution is severe in the case of lake Hussainsagar with large industrial areas in its catchment.

Pollution of the lake adversely affects livelihood of lake dependent communities like Fishermen, washer-men and small dairy farmers

Components of Japan International Cooperation Agency (JICA) funded - Hussainsagar lake and the catchment area improvement initiative

A. Interception and down stream diversion of sewage and industrial effluents : At 5 points I & D will be done.

B. Establishment of a 50 MLD proposed and up-gradation of existing 20 MLD Sewage Treatment Plants (STP)

C. Lake shore line improvement

D. Dredging of 1,000,000 cubic meters silt : Massive removal of sediment in the 500 m radius from 4 nalla confluence is proposed to reduce nutrient and toxic waste load on the lake.

E. Solid waste management

F. Environmental awareness and community participation

Actions proposed based on ecosystem approach :

I – Lake basin management :

A. Sewage management : Decentralization of sewage management and introduction of septic tank system could reduce sewage related problems of eutrophication. Further, wherever possible emphasis should be on recycle and reuse of sewage as a resource.

B. The catchment topography needs to be protected so that rain water flows in to the lake to sustain its hydrology. Laying of proper sewage network is necessary and separation of sewage lines from storm water drains needs priority.

C. For reducing pressure on water supply system rain water harvesting, recycle and reuse needs to be given priority.

D. Industries should be encouraged to adapt zero discharge policies through effective use of water in its processes

E. Common Effluent Treatment Plant (CETP) to treat effluents through public-private partnership should be encouraged to minimize effluent load on the lake.

F. Sewage Treatment through STP needs to be complemented through introduction of cost effective eco-technologies for restoration of the lake water quality.

Actions proposed based on ecosystem approach :

II – Water quality management :

1. Maintenance of bio-conservation zone:
2. Treatment of sewage in the course of its flow in to the lake by Green Bridge filtration system:
3. Micro habitat and feeding ground along shore line:
4. Phyto-remediation:
5. Introduction of composite fish culture:
6. Aeration:
7. Establishment of lake conservation society (*Hussainsagar Sarovar Samvardhini*) to ensure peoples participation:

1. Maintenance of bio-conservation zone:

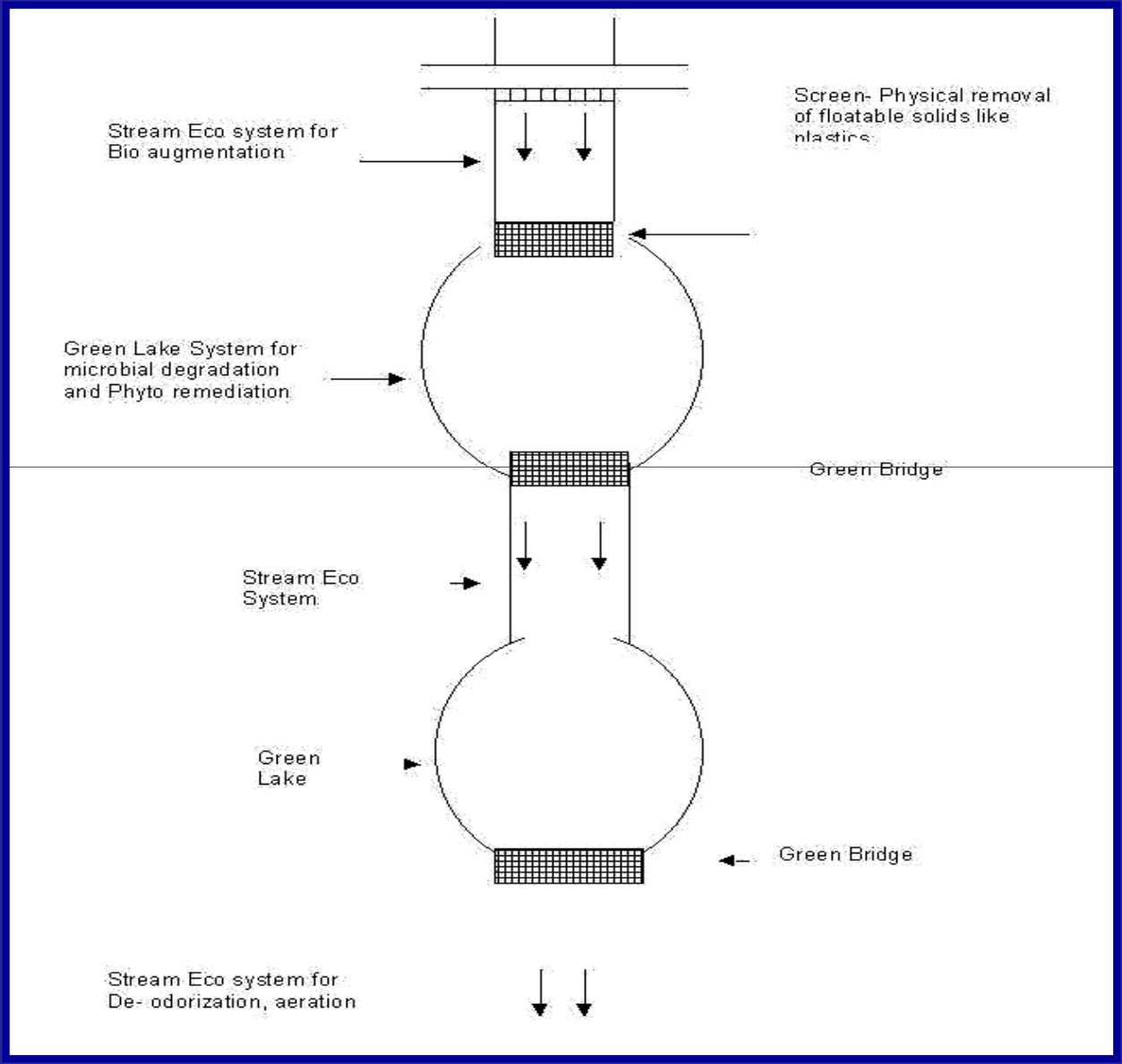
A ‘no development’ buffer zone around the lake ensures protection from negative urban impacts.

A well de-marked bio-conservation zone extending between 100 to 1000 meters in width depending on topography, will act as an effective barrier to moderate the negative impacts

In this eco-sensitive zone only plantation and other eco-friendly activities should be allowed

Greenery around lake and its catchment prevents siltation due to soil erosion.

Treatment of sewage in the course of its flow in to the lake by Green Bridge filtration system:



Step wise filtration process involves

1. Linearly arranged three stages of the fine (10mm to 40mm), course (40mm to 60mm) and large sized gravel.

2. The Green Bridge filter has layers of Coir over which a bed of floating aquatic weeds (eg. water hyacinth) is compactly woven.

3. The organic matter in sewage is degraded by microbes and algae thud reducing the nutrient load.

4. Dissolved organic matter is treated in the open lake

Micro habitat and feeding ground along shore line:

Lake shore line is rich in benthic flora and fauna and an ideal feeding ground for birds. Regeneration of shore line also helps in reducing nutrients due their harvest through benthic food chain/web.

Shoreline development along lake Hussainsagar

4. Phyto-remediation:

Aquatic macrohytes constitute an important biotic community in a lake. Un-controlled wild growth of these weeds has negative impacts. However, because of their de-polluting characteristic these components can be effectively used for conservation of a lake through phyto-remediation.

Controlled growth of macrophytes in towable flotillas is proposed for removal of nutrients and heavy metals in the case of lake Hussainsagar.

Analysis of four species of aquatic macrophytes in Hussainsagar Hyderabad,, India.

Characteristics	Hussainsagar			
	A	B	C	D
Copper (Cu) ppm	57.03	126.13	148.05	-
Zinc (Zn) ppm	311.3	847.3	0.14	-
Arsenic (As) ppm	29.02	14.30	6.18	-
Cadmium (Cd) ppm	4.04	21.30	1.00	-
Lead (Pb) ppm	8.45	3.69	9.77	-

Sample A - *Cyperus alopecuroides*; **Sample B** - *Cyperus articulatus*;
Sample C - *Alternanthera philoxeroides*; **Sample D** - *Polygonum glabrum*

5. Introduction of composite fish culture: Harvesting of organic matter

In an aquatic ecosystem the organic matter is found in two states; Dissolved Organic Matter (DOM) and Particulate Organic Matter (POM).

DOM is mainly utilized by microbes, while POM by a variety of particulate feeders like zooplankton, periphyton, micro- and macro-benthos setting in motion bio-geo-chemical cycling [food chins/webs].

Loss of biodiversity of terminal animals of food chain/web like fishes leads to accumulation of organic matter and eutrophication..

Composite fish culture is a concept that involves exploitation of all possible feeding niches and in turn harvesting of biomass generated by utilizing DOM and POM.

By introduction of fishery the organic load can be reduced thereby reversing the process of eutrophication and restoring water quality, biodiversity and cycling of energy and matter – attributes of ecologically balanced eeosystem.

6. Aeration:

Dissolved Oxygen (DO) is a critical water quality parameter. Availability of oxygen ensures cycling of energy and matter that sustains an aquatic ecosystem. Low levels of DO and resultant anaerobia leads to ecological imbalance and eutrophication

7. Establishment of lake conservation society (*Hussainsagar Sarovar Samvardhini*) to ensure peoples participation:

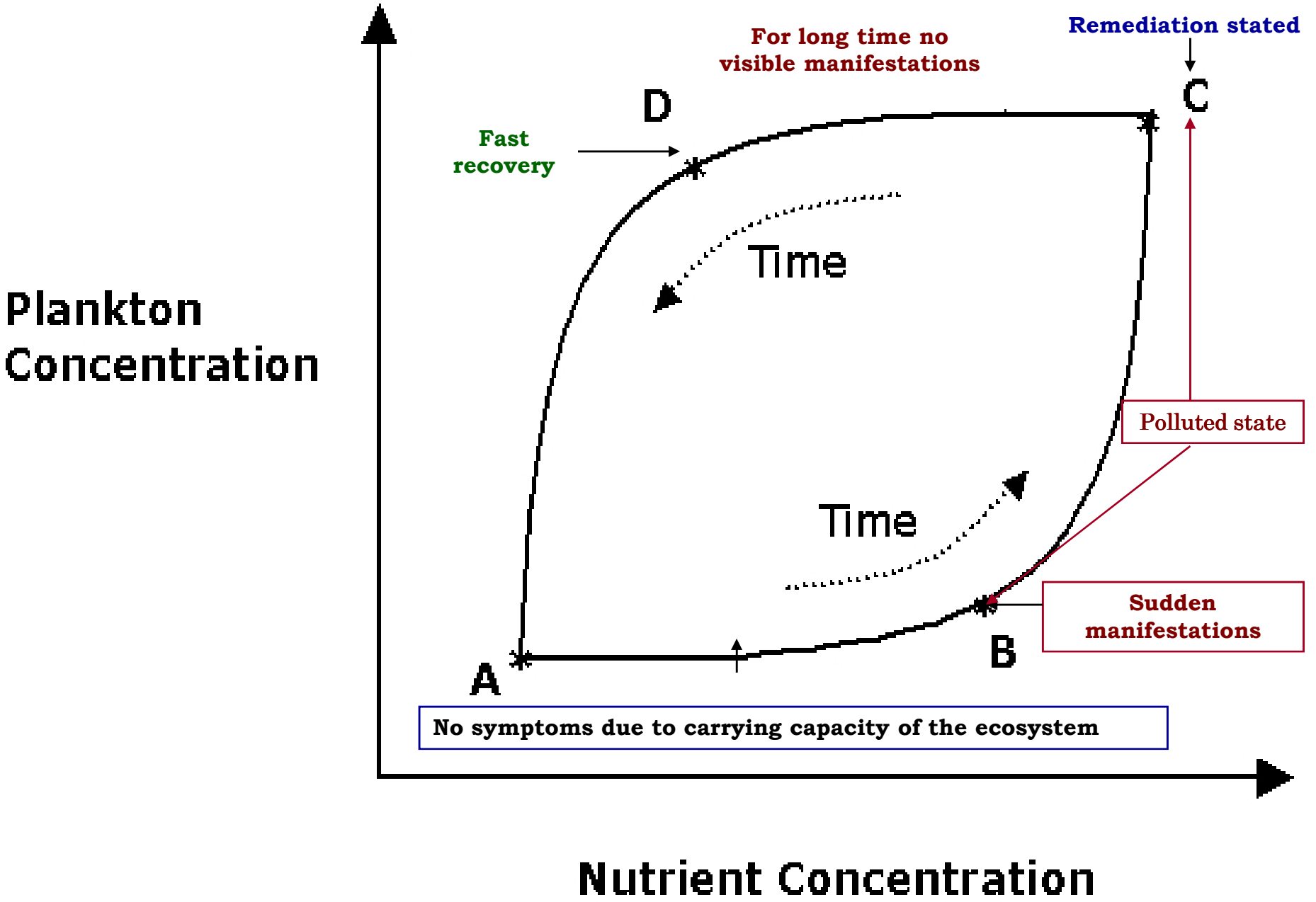
People's participation is basic pillar of good governance

The concept of Sarovar Samvardhini was developed to ensure involvement of civil society in conservation and management of lakes

The society will be a registered body with an executive council elected by general body having a wide membership of people with a wide variety of interests like irrigation, drinking water, fishery, washing and bathing to recreation and tourism.

Following are some of the suggested activities :

1. Generation of data base on geology, biodiversity, water quality etc.
2. Awareness campaigns to attract development budget, tourism etc.
3. Publication of literature/books/leaf-lets and other publicity material
4. 5. Help in organization of lake festivals/ Jatras/ Melas annually.



Restoration of ecological health to ensure sustained goods and services from a lake is a long term process

Lakes and wetlands are most important components of Global water cycle and have assumed greater significance in human survival on the background of emerging water crisis.

Innumerable natural and man-made lakes and reservoirs impound precious fresh water that is most easily accessible for human use.

In view of their large scale and wanton destruction and degradation in the last 50 years, it is time, effective actions initiated for their protection and sustainable management.

ILBM presents an opportunity for an integrated approach to solve this problem