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PRESERVATION OF MYSORE URBAN WATERBODIES

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ABSTRACT

Mysore urban development over a period of 100 years is unique from ecological planning and development. Shri Nalwadi Krishna Raja Wodeyar formed the City Improvement Trust Board (CITB) in 1903. Innovative planning combined with a humanitarian approach had been cited as the hallmark of CITB. Mysore development authority was constituted in 1988 .Now, environs of Mysore – Nanjungud local planning area cover about 495 sq km. Over 120 water bodies are now endangered in this area. The Mysore Urban Development Authority (MUDA) has the onus to carry the specific ecological features and to provide the city world-class infrastructure so that Mysore becomes a center of Tourism, education and industries.

Study on Mysore Urban development from the EIA and ESTs perspective reveals serious shortcoming leading to loss of valuable resources and irreversible economical and ecological damages. (V.Jagannatha, UNEP/IETC,1999). During 2002 under ADB support five lakes were earmarked for conservation with Rs 6 crores. However, for lack of pro-activeness only two lakes got conserved. For the first time, International Lake Environment Committee (ILEC,) format for lake status was prepared for all these five lakes. In this presentation the SENCLE model in the preservation and management of lakes including socio technical aspects of water bodies is presented.

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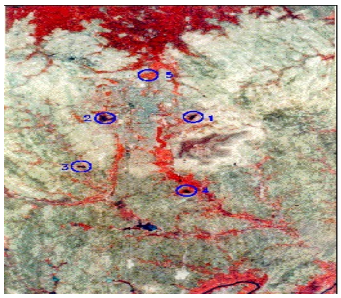
" A Lake is the landscape's most beautiful and expressive feature. It is earth's eye: looking in to which the beholder measures the depth of his own nature. The fluviatile trees next to the shores are slender eyelashes which fringe it, and the wooded hills and cliffs are its overhanging brows"

- Henry David Thoreau

1.0 INTRODUCTION

Lakes in urban regions are ecological security zones and true indicators of sustainable urban development. Karanji, Kukkarahally, Lingambudhi, Dalvoy and Devanoor lakes are five man made Lakes at Mysore taken up for restoration around during 2002 under the Asian Development Bank through Karnataka Urban Infrastructure and Finance Corporation(KUIDFC).



1. Karanji
2. Kukkarahalli
3. Lingambudi
4. Dalvoy
5. Devanoor

Fig 1.1 IRS Satellite imagery of Mysore showing the location of five lakes.
(Source: NNRMS, ISRO Hq Bangalore)

ISSUE # 01 : ECOLOGICALLY BENIGN URBAN LAND USE VITAL FOR LAKES

As a result of increasing land use conflicts fertile agricultural lands, water bodies and their catchments in the urban regions have been the real casualties. The multiple land use patterns have been used effectively to convert erstwhile water bodies in to commercial complexes, housing colonies, exhibition and playgrounds. Mysore urban region is no exception in India for lowered ecological planning strategies. At Mysore, the famous Doddakere lake is now an exhibition and football playground, Subbarayana kere lake is a park now. There are many lake beds which are such casualty examples at Mysore urban. As per the G.O No. UDD 337-DTP 96 dated 16.05.97, the land use pattern for Mysore urban development area has been approved in the revised Comprehensive Development Plan (CDP- 2011 AD). **The projected land use pattern is at Table 1.1**. It can be seen that 178.95 hectares to the extent of 1.27 percent of 154 sq.km land has been identified as water sheet at Mysore. A significant land other than these identified water sheets constitutes the buffer, feeder canal and low-lying areas around the lakes. These different land pieces need to be brought under the ecological land uses compatible with lakes now proposed for restoration at Mysore. Existing water bodies and related land do have real estate pressures and also other developmental priorities. Monitoring is by the age-old approach of revenue records without any validation by advanced techniques such as remote sensing and community participation

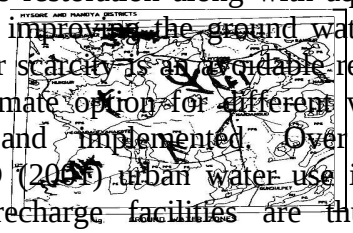
Table 1.1: Land use Pattern in Mysore City (CDP, 2011)

Type of land use	Area (ha)	Percentage
Residential area	6097.87	43.5
Commercial area	344.07	2.45
Industrial area	1655.06	13.22
Public and semi public	1180.76	8.41
Park and open spaces	2689.87*	7.52
Transportation and Communication	2380.56	16.96
Public utility	43.45	0.31
Water sheet	178.95	1.27
Agriculture	898.99	6.41
Total	15469.58	100.00

(Source : RCDP, Mysore,1999) Note : 1) * Includes Nehru Loka (1634.82 ha.)

ISSUE : # 02 : COMPREHENSIVE WATER MANAGEMENT POLICY REQUIRED

Hydro-geological aspects of Mysore **Fig 1.2 Ground water zones for Mysore** reveal mixed water utilization potentials. As such there are over 7000 bore wells of which over 2000 are private and about 5000 owned by the Corporation. Even though ground water is an important and dependable source at Mysore there is no specific legal rain water harvesting strategies deployed in domestic, industrial and service sectors. Households, industries and service utilities have got in few rain water harvesting structures. Reuse and recycling are yet to become fully operational except for secondary treatment for fishiculture by the Corporation. Dept. of Mines and Geology studies reveal that a depletion of ground water to about 36 m in industrial and 18 m in residential areas in the past two decades (Chandrashekara Mutt, 2000).The depth of Ground water sources has reached a maximum of 250 to 300 feet below ground level. Lakes restoration along with aquifer recharge are most crucial in improving the ground water at Mysore. Every year water scarcity is an avoidable reality at Mysore. Lakes as an ultimate option for different water uses has to be planned and implemented. Over 7.3 percent of the total 190 MLD (2001) urban water use is by Ground water. Aquifer recharge facilities are thus a necessity.



(Source: Hydro geological Map, NRSA, 1988)

ISSUE : # 03 : ROUTINE MONITORING BY ADVANCED TECHNIQUES CRUCIAL

As of date, endangerment of the five urban water bodies in Mysore were well known. There was hardly any scientific and routine monitoring of other threatened water bodies

before the restoration plans. Legal sampling by Pollution Control Board have been regularly conducted for the lakes. There is an urgent need to take up the status documentation of lakes in Mysore Urban region as done at Bangalore under the chairmanship of Former Administrator Mr. Lakhman Rao during the 1980's. **Table 1.2 furnishes the conditions of urban water bodies using remote sensing techniques**.

Table 1.2: Conditions of Urban Water Bodies using Remote Sensing Techniques

Sl. No.	Name of water body	Area (Sq. Km)	Water spread Area (Sq. Km)	Marshy Area (Sq. Km)	Dry Area (Sq.Km)
1	Kukkarahalli Tank	0.620	0.3925	0.0425	0.180
2	Karanji Kere	0.3475	-	0.0675	0.28.0
3	Lingambudi Tank	0.84125	-	0.1375	0.70375
4	Behind RCE	0.075	-	-	0.075
5	Basavana Katte	0.0325	-	-	0.0325
6	Devanoor Kere	0.0425	-	0.0425	-
7	Kyathamaranahalli tank	0.040	-	-	0.040
8	Gobli Tank	0.030	-	-	0.030
9	Nachanhalli Palya Tank	0.029	-	0.029	-
10	Uttanahalli Tank	0.0375	-	-	0.0375
11	Dalvoy Tank	0.527	0.1675	0.3595	-
12	Kamakare Hundi	0.070	-	-	0.070
13	Jayanagar Tank	0.1375	-	0.1375	-
14	Mandakalli Tank	0.1175	0.0875	0.030	-

(Source: P. Dinesh, Computation from IRS Imageries - June 1995)

ISSUE : # 04 : ECOLOGICAL SUCEESSION & POLLUTION LOADS QUANTIFIED

Summary of physical features of five lakes are at Table 1.3, details of the catchment area, water spread area, foreshore area and silt depth are available at Table 1.4 and water levels at Table 1.5. **Table 1.6 gives distribution pattern of planktonic** forms in the lakes for the period 1981-2001. The ecological successions to these water bodies are evident in the prevalence of specific biological species. **Table 1.7 documents pollution loads to five water bodies** based on WHO standards. Bio-accumulation of the macro and micro nutrients has triggered the ecological succession over two decades. Table 1.3:

Table : 1.3 : Summary of Physical Features of Lakes in Mysore City.

Sl. No.	Parameter	Karanji	Kukkarahalli	Lingambudi	Dalvoy	Devnoor
1	Geographic location :					
	Latitude	12º 18’ N	12º 18’ N	12º 17’ N	12º 15’ N	12º 19’45” N
	Longitude	76º40’30” E	76º38’ E	75º27’E	76º39’E	76º40’30” E
3.	Owned / monitored by	Forest Dept/ Zoo	University of Mysore	Minor Irrigation Dept.	Minor Irrigation Dept.	Minor Irrigation Dept.
4	Aquatic weeds growth	Yes	Yes	Yes	Yes	Yes
5	Fishery	Yes	Yes	Yes	Yes	Nil
6	Public entry	Yes (restricted)	Yes	Yes (controlled)	Yes	Yes

Table 1.4: Details of Catchment Area, Water Spread Area, Foreshore Area and Silt Depth in Five Lakes of Mysore City.

Sl. No.	Lake	Catchment Area (ha)	Water Spread Area (ha)	Foreshore Area (ha)	Average Silt Depth (m)	Total Silt Deposition 10^3 (m^3)	Lake Capacity (ML)
1	Kukkarahalli	414	49	55	0.45	220.0	2533.3
2	Karanji	745	22	13	0.23	50.0	629.2
3	Dalvoy	1379	54	66	0.89	479.0	1771.2
4	Devanoor	458	5.3	3.2	0.30	15.9	15.9
5	Lingambudhi	2189	36	60	0.21	74.5	1507.7

Table 1.5: Water Levels of Lakes in Mysore City.

Sl. No.	Lake	Present Water Level* (m)	Highest Flood Level (m)
1	Kukkarahalli	755.40	755.73
2	Karanji	743.20	744.14
3	Dalvoy	704.45	705.15
4	Devanoor	-	720.33
5	Lingambudhi	722.15	727.09

Note: * Indicates the water level during the second fortnight of December 2001

Table 1.6: Distribution pattern of planktonic forms in the lake of Mysore and surrounding areas for the period from 1981 to 2001.

Lake	Karanji Lake			Kukkarahalli Lake			Lingambudi Lake			Dalvoy Lake		
Year / Group	*1981*	*1991*	*2001*	*1981*	*1991*	*2001*	*1981*	*1991*	*2001*	*1981*	*1991*	*2001*
Chlorococcales	19320	27180	35837	353251	542210	438342	129350	299850	51320	1032	14360	21131
Desmids	9321	4255	130	150	Nil	7	832	312	Nil	1322	980	Nil
Diatoms	31171	37320	21250	5822	5132	6173	20384	19650	12180	55430	35580	27260
Blue-greens	94680	133450	142544	24325	23420	20719	154319	180210	210382	22150	45201	570102
Euglenoids	11355	15421	18150	8321	3251	6577	24680	128125	35640	8343	8437	11215
Dinoflagellates	180	560	480	210	622	174	21	180	310	856	937	315

(Source: ET Puttiah, et. al., 2000) Note: Number are represented as organisms / litre

1. **Table 1.7: Pollution Loads of wastewater Contribution to Lakes as source of Eutrophication**

Sl. No	Name of the Lake	Population	Waste volume at 34 Cu.m/c/yr 80% of 115 lpcd	BOD_5 at 19.7 kg/c/yr	COD at 4.4 kg/c/yr	Suspended solids at 20 kg/c/yr	Dissolved Solids at 36.5 kg/c/yr	Nitrogen as Nitrate at 3.3 kg/c/yr	Phosphorous as Phosphate at 0.4 kg/c/yr
			MLD	t/day	t/day	t/day	t/day	t/day	t/day
1	Dalvoy	258145	24.05	13.9328	0.00029	0.000763	2.9E-08	6.9E-09	3.1767E-14
2	Devanoor	95239	8.87	5.1403	0.00011	0.000282	1.07E-08	2.55E-09	1.172E-14
3	Karaji	15020	1.40	0.81067	1.7E-05	4.44E-05	1.69E-09	4.02E-10	1.84834E-15
4	Kukkarahalli	35813	3.34	1.93292	4E-05	0.000106	4.02E-09	9.58E-10	4.40711E-15
5	Lingambudhi	26450	2.46	1.42758	3E-05	7.82E-05	2.97E-09	7.07E-10	3.25491E-15

(Source : Waste load as per WHO guidelines for quantification of pollutants, 1982).

ISSUE # 05 : NATURAL MANAGEMENT OF SILT

Table 1.8 furnishes silt management for the five lakes. The characterization of silt in the lakes have been analyzed in approved laboratories. The test results reveal that the silt parameters qualify for use as Compost as per the Municipal Solid Waste Management Rules 2000

Table 1.8: Silt and its management in Five Lakes

Sl.	Lake (Capacity ML)	Total Silt, CumX1000	Silt % with Lake capacity	Depth, M (Average)	Proposed % of the Total	Quantity Cum
01	Kukkarahalli (2533)	220	0.008	0.45	40 %	88000
02	Karanji (629)	50	0.007	0.23	25 %	12500
03	Dalvoy (1721)	479	0.020	0.89	50 %	239500
04	Devanoor (458)	16	0.003	0.30	100 %	16000
05	Lingambudhi (1508)	75	0.005	0.21	40 %	30000
	6849	840	0.043	0.414	51 %	386000

(Source: Field Survey conducted, 2001)

ISSUE # 06 : CONSTRUCTED WETLANDS FOR RESTORATION OF WATER BODY

Further, with regard to treatment of waste water, the ectones between lakes and terrestrial ecosystems are crucial for protection of the lake eco-system against anthropogenic impacts. The denitrification potential of wetlands is often surprisingly high. As much as 2,000 to 3,000 kgs of nitrate-nitrogen can be denitrified per hectare of wetlands per year depending on the hydraulic conditions. Since the denitrification is accompanied by stoichiometric oxidation of organic matter, this process also removes a significant amount of organic matter. The phosphorous bound in organic matter or absorbed to the organic matter, may however be released by these processes. Wet lands provide cost effective option for prevention of pollution and reduction of nutrients at the water body. Table 1.9 below furnishes different types of wetlands commonly found adjacent to lakes.

Table 1.9: Characteristic of Wetlands Adjacent to Lakes

Type of Wetland	Characteristics	Ability to Retain Non-pollutants
Wet meadows	Grassland with waterlogged soil. Standing water for a part of the year.	Denitrification only in standing water. Removal of nitrogen and phosphorus by harvest.
Forest wetlands	Dominated by trees, shrubs. Standing water not always for the entire year	High potential for denitrification and accumulation of pollutants, provided that standing water is present.
Fresh water marshes	Reed-grass dominated, often with peat accumulation.	High potential for denitrification and accumulation of pollutants, provided there standing water is present.
Shore line wetlands	Littoral vegetation, often of great importance for the lake.	High potential for denitrification and accumulation of pollutants, but area coverage.

(Source : IETC/UNEP, Conservation and Management of lakes & reservoirs,1997)

Ten wetlands proposed at the five lakes and the details are at Table-1.10

Table 1.10: Constructed wetland in Five Lakes

Sl.	Lake Volume, ML	Constructed Wetlands size and Locations	Number of Wetland
01	Kukkarahalli (2533)	20m X 5m X 20m X 1.5m at North, West and Southwestern side of the lake	03
02	Karanji (629)	20m X 5m X 20m X 1.5m at North and Eastern of the lake	02
03	Dalvoy (1721)	20m X 5m X 20m X 1.5m at Eastern side of the lake	01
04	Devanoor (458)	20m X 5m X 20m X 1.5m at North and Western side of the lake	02
05	Lingambudhi (1508)	20m X 5m X 20m X 1.5m at East and Western side of the lake	02
	6849 ML	Total number of Constructed Wetlands	10

2.0 CONCEPTS DEPLOYED IN THE RESTORATION OF LAKES

Restoration Plan is based on field studies and its analysis. *Ecological succession status* for each lake has been considered for its restoration. In the proposed restoration plan, established basis for solving the problems facing endangered lakes namely Socio-Economic-Natural Complex- Lake Ecosystems (SENCLEs) are used as guidelines. Further, the State of Art Techniques elucidated in the IETC/UNEP guideline document is followed.

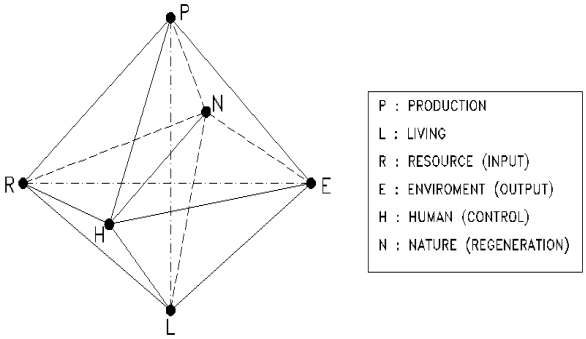
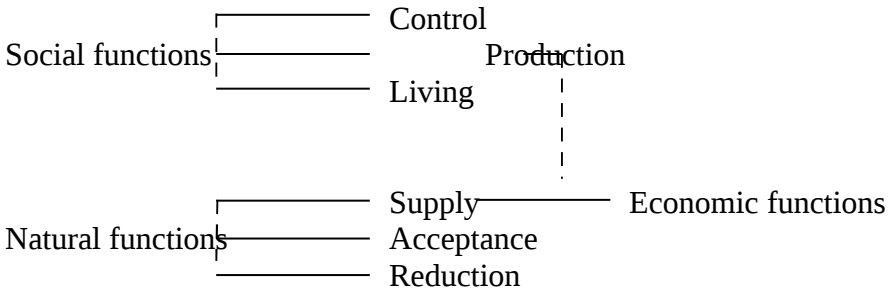


Fig.2.1 Structure of SENCLE

Fig. 2.2 Functions of SENCLE



In the SENCLEs approach **Fig.2.1** ***the core is human beings***, including the organization, technology, and culture, comprising laws, strategies, customs and traditions for management and utilization of lakes. This is the controlling part of SENCLEs, and may be called the ***Eco-core***. The second layer is the direct environment of human activities within a SENCLE, including the geographic, biological and artificial environment, which is the fundamental medium activities and is called the ***Eco-base***. The third layer is the external environment of SENCLEs, including source, store, and sink, which is the external supporting system of SENCLEs and called the ***Eco-pool***. These three layers are interacting upon one other.

Further, in the SENCLEs functions Fig 2.**2 the succession is a result of interaction of natura, social and human exploitation**. There are two kinds of effective factors: one is the leading factor: the other is the limiting factor. When the leading factor prevails, various human activities lose no time in making use of the favorable ecological niche and the system grows in an exponential way.

Considering the major functional priorities of five lakes, namely Karanji – Wild life and recreational : Kukkarahally- Recreational and Fisheries : Lingabudhi - Recreational and Irrigation : Dalvoy- Irrigation and Recreation : Devanoor – Open Space and Park. SENCLEs model is also a very useful tool for conflict resolution amongst multiple functional priorities for each lake.

3.0 IDENTIFIED ENVIRONMENTAL SOUND TECHNIQUES FOR LAKES

Environmentally Sound Planning Strategies for restoration of urban lakes is challenging, based on complexities of the ecosystems. Planning for restoration of five urban lakes at Mysore under the Asian Development Bank, Infrastructure Development Plan through KUIDFC revealed over 23 unique environmentally sound practices such as

1) SENCLE model for management of lakes involving socio-economical and cultural aspects of the lakes,
2) ILEC/UNEP formats for documenting status of lakes,
3) Functional utilisation of water bodies based on quality standards such as for drinking, bathing, wild life, ecologically sensitive, fishing and aesthetic uses,
4) Both water shed and water body restoration approach identified,

5) Lakes planned as ecological security zones to improve urban eco-system,
6) Conventional and remote sensing data identified for planning status of lakes,
7) Effective indigenous cultural heritage found necessary,
8) A strong monitoring system with laboratory support identified,
9) Silt from the lake is used for bund strengthening, island formation and road development,
10) Weed and other organic waste used for composting,
11) Each lake given a priority in its utilization and networked,
12) Wet Land technology used for restoration of lake body and reduction of loads,
13) Solar lighting and environment friendly techniques and methods proposed,
14) Aquifer recharge planned for surplus water recharge to augment ground water,
15) Recreational and aesthetic landscaping for each lake incorporated,
16) Urine segregating toilets and bio-gas plants for demonstration plants identified,
17) Each lake with ecological road indications with education hoarding proposed,
18) Feeder canals for each lake and their constraints quantified,
19) Sewage, waste water and trade effluents sources identified and scheme evolved,
20) Effective community participation of villagers and stake holders proposed,
21) Development of lakes planned keeping in mind the requirement of all visitors /users like children, aged, physically challenged people,
22) Environment friendly and low cost construction involved which merge with the natural surroundings,
23) Planning done in consultation with the owners of the lakes and their functional requirements.

Based on the priority fixed by the owners of the Lake, as many as possible Environmental Sound Technologies were taken up under the phase – 1 for execution.

4.0 INTERVENTIONS ADOPTED

There were are good number of ecological engineering interventions proposed for restoration and development of five lakes at Mysore. They can be clustered are as follows:

A. Restoration Works

i. Removal and disposal of weeds from the lake,
ii. De-silting of the lake in the selected areas,
iii. Construction of silt traps and constructed wetlands at the entry of incoming drains and sewage
iv. Strengthening/ formation of bund.
v. Providing chain link fencing for protection of lake,
vi. Aquifer Recharge Works

B. Conservation Measures

i. Landscaping, plantation and improvement of park with fountains & walk ways,
ii. Zoning of land uses to protect the wild life, recreational and other uses
iii. Formation of bird enclosure with ecological aspects simulated.

C. Development Works

i. Providing drinking water facilities,
ii. Construction of dust bins,
iii. Providing lighting fixtures,
iv. Providing parking facilities for vehicles,
v. Providing children play amenities,
vi. Providing pre-cast benches for visitors,
vii. Providing mild steel gates for entry,
viii. Construction of public toilets, separate for children and physically challenged.
Ix Construction of boating jetty
x. Construction of watch tower
xi. Construction of small bridge

5.0 NEED FOR PARTICIPATION FOR SUSTAINABILITY

There are many individuals, community based and voluntary groups who have been active in lakes conservation since a decade now at Mysore. These groups are basically wild life activists, environmental education activists and popular science groups. During the year 1999 – 2000 civic and environmental groups were active in protecting Lingambudhi lake from a ring road passing over it. An EIA was got prepared under the ADB project to safeguard Lingambudhi Lake from a ring road. Mysore Jala Samrakshana Okkutta (MJSO) has been registered as a Society during July 2001.

In the recent past, People Science Forum (PSF) www.psf.4t.com a unit of Karnataka Rajya Vigyana Parishat is one very unique group with pro-active initiatives. For over two years now adjacent to Kukkarahally Lake 1000 houses have been visited by the PSF volunteers on a weekly basis propagating the need for segregation of domestic waste and emphasizing the need of abuse free plastic use and water literacy. Over 4000 man hours have been pooled by youths, students , professionals for eco-literacy on week end voluntary community service. PSF. Dhvanya Loka and Mysore Environment Trust® with the help of villagers and civic groups and individuals have been able to actively facilitate this voluntary efforts in the cleaning of the Kukkarahally Lake and environs.

Since September 2001, People Science Forum, Mysore Environment Trust® and Dhvanya Loka have sponsored Kukkarahally Lake-Environs Preservation activities with Villagers & Citizens by conducting Cultural, Literary and Creative Programme. A Field survey report/action proposal based on A FIELD SURVEY status of Feeder Canal (Diwan purnayya canal) to Kukkarahallay lake Mysore for about 1200 metre from the lake water body was taken up by the volunteers and members of PSF during Sep'02. Over 19 specific problems have been identified in the PSF field survey. Base flow channel in the feeder canal for a length of 6000 m has been now considered under the restoration plan.

Also, in a workshop during Jan 2001 on Vision and Agenda for the Conservation and Management of Lakes at Mysore participation administration, people representatives, experts, NGOs, CBOs took place. In the work shop many case studies on the lakes covered many issues ranging from public participation, applications of remote sensing, ground water harnessing, economical utilization such as fisheries and so on were focused.

6.0 INFERENCES

- The lakes restore plans must start from generation of basic field data
- SENCLEs model for restoration of lakes is a very useful tool
- ILEC/UNEP Lake status format provides vital data(Aneexe-01)
- EST validation provides useful tools for lakes restoration
- Stake holders participation amongst villagers and volunteer groups vital
- Controlled private participation provides strengths to the sustainability
- Deprived groups need space in the form of economical activity
- A sustained monitoring of Aquatic Ecosystem Health is crucial
- A vision and agenda among the various local authorities is vital
- More democratic participation by way of dialogues is necessary.

7.0 REFERENCES

- Chandala D N and et al., A field survey report/action plan on the restoration of feeder canal to Kukkarahally lake, Mysore, People Science Forum, Nov 2002
- NNRMS, 1996, Indian Remote Sensing Satellite Imagery of Mysore, 1996
- MUDA 1997, Revised Comprehensive Development Plan-2011, Mysore
- NRSA, 1986 Ground Water Zones for Mysore
- Chandrashekar Mutt, Ground Water Status at Mysore, Vision and Agenda for Lakes Workshop, Mysore, 2001
- Dinesh P, Conditions of urban water bodies using remote sensing techniques,1995
- Puttaiah E T, Distribution pattern of planktonic forms in the lakes of Mysore, 2002
- Jagannatha V, Urban Waste Water Contributions as Source of Eutrophications,1982
- International Lake Environment Committee, Data Book on the World Lake-Environs, Oceania and Asia, Oct 1995
- International Environmental Technology Centre, Planning and Management of Lakes and Reservoirs : An Integrated Approach to Eutrophication UNEP-IETC, 1999