Conservation & Management of Urban Wetlands: Strategies and Challenges

Acknowledgement*:*

We thank the following members for taking part in the Brainstorming session towards finalizing the strategies for conservation and management of wetlands.

Stakeholders	**Representatives**	**Organisation**
Environmentalists	Dr. Yellappa Reddy	Bangalore Environment Trust
	Harish Bhat	CES, IISc
	Shyamal	
Researchers	Dr. Ramachandra T.V.	CES and CiSTUP, IISc
	Dr. T G Sitharam	CiE and CiSTUP, IISc
	Dr. Mohan Kumar	CiE and CiSTUP, IISc
	Dr. Chanakya H N	CST and CiSTUP, IISc
	Dr. Chakrapani	CES, IISc
	Dr. Gururaja K V	CiSTUP, IISc
	Mr.Karthick B	CES, IISc
	Ms. Supriya G	CES, IISc
	Ms. Alakananda	CES, IISc
	Dr. Nandini	Bangalore University
	Mr.Shivashaktivel	Bangalore University
	Durgesh R	Bangalore University
	Harshavardhan	UVCE
	Harish. M	SVCE
	Ms.Ananya	CST, IISc
	Supreeth	Bangalore University

Members of the SEAC	Dr. Raghavendra Rao	Chairman, SEAC
	Dr. Ramachandra T.V.	Member, SEAC
Government Officials	Dr. Ramakrishna N R	JD, Department of Fisheries
	Jagadeesh B R	Department of Fisheries
	Dr. Vikas S J	AD Department of Fisheries
	Dr. Basappa	Director General, EMPRI
	Uzra Sultana	EMPRI
	Dr. U V Singh	CCF, Lake Development Authority
	J R Gopalakrishna Rao	Cauvery Niravari Nigam Limited
	Dr. K S R Shankar Reddy	Bangalore Development Authority
	Dr. Ramakantha	CCF, Karnataka Forest Department
	Mr. Suresh	ACF, Bruhat Bangalore Mahanagara Palike
	Dr. Syed Aajiz Ahmed, Mr Narahari S	Secretary, Bangalore Water Supply and Sewerage Board (BWSSB)
	Dr. Mohan Kumar M S Mr Shiva Kumar A R	Karnataka State Council for Science and Technology (KSCST)
School	Mr Khan M A, Ms Ali Rani	K K English School, Varthur
College	Mr.Yathiraju	Kalidasa Junior College
	Dr. B K Chakrapani	Vijaya College, Jayanagar
	Mr Amit Yadav	Mumbai

Media personnel	Mr. R Manjunath	Vijay Karnataka
	Ms.Bosky Khanna	DNA
	Mr.Amit Upadhye	Deccan Chronicle
Non Governmental Organisation's representatives	Praveena Sreedhar	Argyam Foundation
	Abby Brown	Argyam Foundation
	Sanjay Vijayraghavan	Praja.in

Participants of the Workshop on urban lake monitoring (23-25th Sept 2009)

1	Aditi Kashinath Kale, Abasaheb Garware College, Pune - 411004
2	Saravanan. M, Bharathiar University, Coimbatore
3	Debayan Bose, Vellore Institute of Technology, Vellore.
4	Deepthi .S, Department of Studies in Zoology, University of Mysore, Mysore.
5	Divya .K, Vellore Institute of Technology (Vit University), Vellore.
6	Gitanjali Kanwar, Wildlife Institute of India, Dehradun, Uttarkhand.
7	Hariharan .T, Department of Environmental Sciences, Bishop Heber College, Trichy - 17.
8	Joseph Salve, Abasaheb Garware College, Pune – 4.
9	Kavitha. C, Bharathiar University, Coimbatore
10	Mridula B. Ram, North Maharashtra University, Jalgaon, Maharashtra.
11	Muralidharan .G, Kongunadu Arts and Science College, Coimbatore.
12	Nita Shashidharan, Institute of Science, Mumbai.
13	Ramkumar. V, Kongunadu Arts and Science College, Coimbatore

14	Sangeetha .M, Bharathiar University, Coimbatore.
15	Santhiya .M, Bharthidasan University, Trichy.
16	Satyavati, Allahabad University, Allahabad – 211015, UP.
17	Savitha .N, University of Mysore, Mysore.
18	Shruti R. Bhargava, The Institute of Science, Mumbai.
19	Smitha R.B, Department of Botany, University of Calicut, Calicut
20	Vidyagurkar, Yuvaraja College, Mysore.
21	Arivoli .A, Bharathidasan University, Trichy.
22	Jomet Sebastian .K, University of Mysore, Mysore.
23	Dindegave Nagnath Annarao, D.B.F.Dayanand College of Art and Science, Solapur – 413002.
24	Prajapati Sujit Kumar Ramanlal, Bio Science Department, S.P. University, Vallabh Vidyanagar– 388120.
25	Pramod A.F, Kuvempu University, Shankaraghatta, Shimoga.
26	Santosh Pingale, IIT Roorkee, Haridwar – 246667, UA.
27	Sudip banerjee, Maulana Azad College, University of Calcutta, Calcutta.
28	Shravanakumar S, Department of PG Studies and Research in Applied Botany, Kuvempu University, Shankaraghatta, Shimoga
29	Priyadarshini J Shetty, Bangalore University, Bangalore
30	Dr.Preetha Panikkar, Central Inland Fisheries Research Institute, Regional Centre of CIFRI, Bangalore
31	Rohini. J, CDD Society, Bangalore
32	Shashikala. V, Bangalore University, Bangalore
33	Lakshmi T Kumar, Indian Institute of Ecology & Environment, New Delhi

Conservation & Management of Urban Wetlands: Strategies and Challenges

Preamble

Wetlands are vital parts of the hydrological cycle, highly productive, support exceptionally large biological diversity and provide a wide range of ecosystem services, such as food and fibre; waste assimilation; water purification; flood mitigation; erosion control; groundwater recharge; microclimate regulation; enhance aesthetics of the landscape; support many significant recreational, social and cultural activities, besides being a part of our cultural heritage. In this context, the Brain Storming Session focused on the current trends in aquatic ecosystem conservation, restoration and management including the hydrological and the biophysical aspects, peoples' participation and the role of non-governmental, educational and governmental organisations and future research needs for the restoration, conservation and management. It was acknowledged that most of urban wetlands are seriously threatened by conversion to non wetland purposes, encroachment of drainage, through landfill, pollution (discharge of domestic and industrial effluents, disposal of solid wastes), hydrological alterations (water withdrawal and inflow changes), and over-exploitation of their natural resources resulting in loss of biodiversity and disruption in goods and services provided by wetlands. This report compiles the strategies for conservation and sustainable management of urban wetlands based on the discussions during the Brain storming session (26th September 2009). We hope that the strategies suggested in this report based on the interactions with all stakeholders will play a *catalytic role in activating the Policy Makers* of this country towards appropriate policy framework to conserve, restore and manage our fragile ecosystems.

Brainstorming Session on Conservation & Management of Urban Lakes

26th Sept 09

Conference Hall, Centre for Infrastructure, Sustainable Transport and Urban Planning [CiSTUP], Indian Institute of Science

Brainstorming session for evolving the strategies for the conservation and management of urban lakes was organized on 26th Sept 2009 at Centre for Infrastructure, Sustainable Transport and Urban Planning [CiSTUP], Indian Institute of Science. This Brainstorming session was organized jointly by The Energy and wetlands Research Group at Centre for Ecological Sciences, Centre for Sustainable Technologies and Centre for Infrastructure, Sustainable Transport and Urban Planning [CiSTUP], Indian Institute of Science. Participants of the brainstorming session included **Environmentalists** (Dr. Yellappa Reddy, Harish Bhat, Shyamal, Dr. B K Chakrapani), **Researchers** (Dr. Ramachandra T.V., Dr. Sitharam T G, Dr. Mohan Kumar M S, Dr. Chanakya H N, Dr. Gururaja K V, Mr.Karthick B, Ms. Supriya G, Ms. Alakananda, Dr. Nandini, Mr.Shivashaktivel, Durgesh R (Bangalore University), Harshavardhan (UVCE), Harish (SVCE), Ms.Ananya (CST, IISc)), **members of the State level Environment Appraisal Committee** (Dr. Raghavendra Rao, Chairman, SEAC, Dr. Ramachandra T.V., Member, SEAC), **Government Officials** (Dr. Ramakrishna N R (Joint Director, Department of Fisheries), Jagadish B R, Dr. Vikas J J (Asst Director, Department of Fisheries), Dr. Basappa (Director General, Environmental Management Policy Research Institute), Uzra Sultana (EMPRI), Dr. U V Singh (CCF, Lake Development Authority), J R Gopalakrishna Rao (Cauvery Niravari Nigam Limited), Dr. K S R Shankar Reddy (Bangalore Development Authority), Dr. Ramakantha (CCF, Karnataka Forest Department), Mr. Suresh (ACF, Bruhat Bangalore Mahanagara Palike) Dr. Syed Aajiz Ahmed and Narahari S (Bangalore Water Supply and Sewerage Board), Dr. Mohan Kumar M S and Shiva Kumar A R (Karnataka State Council for Science and Technology)), **School** (Khan M A, Ali Rani (K K English School, Varthur)), **College** (Mr.Yathiraju, Kalidas Junior College; Dr. B K Chakrapani, BHS College of Science, Amit Yadav, Mumbai), **Media personnel** (Mr. R Manjunath (Vijay Karnataka), Ms.Bosky Khanna (DNA), Mr.Amit Upadhye (Deccan Chronicle)), **Non Governmental Organisation's representatives** (Paveena Sreedhar and Abby Brown (Argyam Foundation), Sanjay Vijayraghavan (Praja.in)) and **32 participants of workshop on urban lake monitoring** (this workshop was conducted during 23-25th Sept 2009; participants list is provided in Annexure I).

The main objective of the Brain storming session was to evolve appropriate strategies for conservation and sustainable management of urban lakes. The August forum discussed the strategies to be adopted for protection of Waterbodies in urban areas apart from discussing the draft notification of the Regulatory Framework for Wetlands Conservation of The Ministry of Environment and Forests, Government of India. As a part of the Brain storming session a panel discussion was held and the key recommendations are:

1. **Carrying capacity studies for all macro cities:** Unplanned concentrated urbanisation in many cities has telling impacts on local ecology and biodiversity, evident from decline of waterbodies, vegetation, enhanced pollution levels (land, water and air), traffic bottlenecks, lack of appropriate infrastructure, etc. There is a need to adopt holistic approaches in regional planning considering all components (ecology, economic, social aspects). In this regard, this forum recommends carrying capacity studies before implementing any major projects in rapidly urbanizing macro cities such as Greater Bangalore, etc.

2. **Demarcation of the boundary of water bodies:** The existing regulations pertaining to boundary demarcations within different states need to be reviewed according to updated norms and based on geomorphology and other scientific aspects pertaining to individual water bodies. Maximum Water Level mark should form the boundary line of the water body. In addition, a specified width, based on historical records/ survey records etc. may be considered for marking a buffer zone around the water body. In case such records are not available, the buffer zones may be marked afresh considering the flood plain level and also maximum water levels. The width of the buffer zone should be set considering the geomorphology of the water body, the original legal boundaries, etc. The buffer zone should be treated as inviolable in the long term interests of the water body and its biodiversity.
    - The existing regulations pertaining to boundary demarcations within different states need to be reviewed according to updated norms and based on geomorphology and other scientific aspects pertaining to individual water bodies.
    - Maximum Water Level mark should form the boundary line of the water body.
    - In addition, a specified width, based on historical records/ survey records etc. may be considered for marking a buffer zone around the water body. In case such records are not available, the buffer zones may be marked afresh considering the flood plain level and also maximum water levels.

- The width of the buffer zone should be set considering the geomorphology of the water body, the original legal boundaries, etc.
- The buffer zone should be treated as inviolable in the long term interests of the water body and its biodiversity.
- Declare and maintain floodplains and valley zones of lakes as no activity regions
- Remove all encroachments – free flood plains, valley zones, storm water drains, etc. of encroachments of any kind.
- Ban conversion of lake, lake bed for any other purposes.
- Urban wetlands, mostly lakes to be regulated from any type of encroachments.
- Regulate the activity which interferes with the normal run-off and related ecological processes – in the buffer zone (200 m from lake boundary / flood plains is to be considered as buffer zone)

3. **Mapping of water-bodies:** The mapping of water bodies should also include smaller wetlands, particularly hill streams, Myristica swamps of the Western Ghats, springs etc. The neglect of these hydrological systems could cause considerable impoverishment of water flow in the river systems as well as turn out to be threats to rare kinds of biodiversity. As most of the streams originate in forest areas they come under the legal authority of the forest departments. At the same time the waters of many of these streams are being diverted for private uses. This causes diminished water flow especially in the non Himalayan Rivers during the summer months. A judicious water sharing mechanism has to be worked out at the local level taking into account also the broader national interest as well as conservation of dependent biodiversity. The mapping of these smaller water-bodies, along with their catchments needs to be conducted involving also the local Biodiversity Management Committees. The jurisdictional agreements on the water usage and watershed protection need to be arrived at on a case to case basis involving all the stakeholders.
    - Spatial Extent of Water bodies
    - Spatial extent of its catchment (watershed/basin)
    - Demarcate Flood plains
    - Demarcate buffer zone – with a list of regulated activities
    - Land cover in the catchment
    - Ensure at least 33% of land cover is covered with natural vegetation (to ensure the lake perennial)
    - Identify the natural areas in the catchment
    - Biodiversity inventory – capture entire food chain

- The jurisdictional agreements on the water usage and watershed protection need to be arrived at on a case to case basis involving all the stakeholders.
- Develop a comprehensive database (spatial with attribute information)
- Identify and demarcate the region around the lake where all activities are to be prohibited (Flood plain)
- The biodiversity of every water body should form part of the Biodiversity Registers (BR).
- The local Biodiversity Management Committees (BMC) should be given necessary financial support and scientific assistance in documentation of diversity.
- The presence of endemic, rare, endangered or threatened species and economically important ones should be highlighted.
- A locally implementable conservation plan has to be prepared for such species.

4. **Holistic and Integrated Approaches – Conservation and Management:** Integration of the activities with the common jurisdiction boundaries of Government para-statal Agencies for effective implementation of activities related to management, restoration, sustainable utilization and conservation. This necessitates:
   - Common Jurisdictional boundary for all para-statal agencies
   - To minimise the confusion of ownership – assign the ownership of all natural resources (lakes, forests, etc.) to a single agency – **Lake Protection and Management Authority** (or Karnataka Forest Department). This agency shall be responsible for protection, development and sustainable management of water bodies).
   - Custodian shall manage natural resources - let that agency have autonomous status with all regulatory powers to protect, develop and manage water bodies.
   - All wetlands to be considered as common property resources and hence custodians should carefully deal with these ensuring security.
   - Management and maintenance of lakes to be decentralised involving stakeholders, local bodies, institutions and community participation without any commercialization or commoditization of lakes.
   - Integrated aquatic ecosystem management needs to be implemented to ensure sustainability, which requires proper study, sound understanding and effective management of water systems and their internal relations.

- The aquatic systems should be managed as part of the broader environment and in relation to socio-economic demands and potentials, acknowledging the political and cultural context.
- Wetlands lying within the protected area of National Parks and Wildlife Sanctuaries shall be regulated under the Wildlife Protection Act, 1972. Wetlands lying within the notified forest areas shall be regulated by the Indian Forest Act, 1927 and the Forest Conservation Act, 1980; and the relevant provisions of the Environment (Protection) Act, 1986. The Wetlands outside protected or notified forest areas shall be regulated by the relevant provisions of the Environment (Protection) Act, 1986.
- Immediate implementation of the regulatory framework for conservation of wetlands by the Ministry of Environment and Forests, GOI.
- Formulation and implementation of the National wetlands policy both at state and at national levels.
- Socio-economic studies & land use planning in & around the lakes can help in providing ecological basis for improving the quality of lakes.
- Prohibit activities such as conversion of wetlands for non-wetland purposes, dumping of solid wastes, direct discharge of untreated sewage, hunting of wild fauna, reclamation of wetlands.
- Maintain Catchment Integrity to ensure lakes are perennial and maintain at least 33% land cover should be under natural Vegetation.
- Plant native species of vegetation in each lake catchment.
- Create new water bodies considering the topography of each locality.
- Establish laboratory facility to monitor physical, chemical and biological integrity of lakes.
- Maintain physical integrity - Free storm water drains of any encroachments. Establish interconnectivity among water bodies to minimise flooding in certain pockets . The process of urbanization and neglect caused disruption of linkages between water bodies such as ancient lake systems of many cities. Wherever such disruptions have taken place alternative arrangements should be provided to establish the lost linkages.
- Encroachment of lake beds by unauthorized /authorized agencies must be immediately stopped. Evict all unauthorized occupation in the lake beds as well as valley zones.
- Any clearances of riparian vegetation (along side lakes) and buffer zone vegetation (around lakes) have to be prohibited
- Penalise polluters dumping solid waste in the lake bed.

- Implement polluter pays principle for polluters letting liquid waste in to the lake either directly or through storm water drains.
- Lake privatised recently to be taken over and handed over to locals immediately thus restoring the traditional access to these lakes by the stakeholders.
- Restore surviving lakes in urban areas strengthening their catchment area and allowing sloping shorelines for fulfilling their ecological function.
- Alteration of topography in lake / river catchments should be banned.
- Appropriate cropping pattern, water harvesting, urban development, water usage, and waste generation data shall be utilized and projected for design period for arriving at preventive, curative and maintenance of aquatic ecosystem restoration action plan (AERAP).
- Desilting of lakes for removal of toxic sediment, to control nuisance macrophytes; further silting in the catchment be checked by suitable afforestation of catchment areas and the provision of silt traps in the storm water drains.
- Maintaining the sediment regime under which the aquatic ecosystems evolve including maintenance, conservation of spatial and temporal connectivity within and between watersheds.
- Conversion of land around the lakes particularly in the valley zones and storm water drains for any kind of development must be totally banned.
- Flora in the catchment area should be preserved & additional afforestation programmes undertaken.
- Check the overgrowth of aquatic weeds like *Eichhornia, Azolla, Alternanthera* etc. through manual operations.
- Aquatic plants greatly aid in retarding the eutrophication of aquatic bodies; they are the sinks for nutrients & thereby play a significant role in absorption & release of heavy metals. They also serve as food and nesting material for many wetland birds. Therefore, knowledge of the ecological role of aquatic species is necessary for lake preservation.
- Adopt biomanipulation (Silver carp and Catla– surface phytoplankton feeders, Rohu – Column zooplankton feeder Gambusia and Guppies – larvivorous fishes for mosquito control),aeration, shoreline restoration (with the native vegetation) in the management of lakes.
- Environmental awareness programmes can greatly help in the protection of the water bodies.

- Government Agencies, Academies, Institutions and NGO's must co-ordinate grass-root level implementation of policies and activities related to conservation of lakes and wetlands (both Inland and Coastal), their sustainable utilization, restoration and

development including human health. There is also a need for management and conservation of aquatic biota including their health aspects. Traditional knowledge and practices have to be explored as remedial measures. Cost-intensive restoration measures should be the last resort after evaluating all the cost-effective measures of conservation and management of the wetlands.

- A National Committee be constituted consisting of Experts, Representatives of Stakeholders (researchers, industrialists, agriculturists, fishermen, etc.) and Line Agencies, in addition to the existing Committee(s), if any, in order to evolve policies and strategies for reclamation, development, sustainable utilization and restoration of the wetlands and socio-economic development of the local people.
- At regional level, **Lake Protection and Management Authority (LPMA)** with autonomy, corpus funds from plan allocations of state and center and responsibility and accountability for avoiding excessive cost and time over runs. LPMA shall have stakeholders-representatives from central and state and local body authorities, NGO's and eminent people and experts shall be constituted
- Generous funds shall be made available for such developmental works through the National Committee, as mentioned above. Local stakeholders be suggested to generate modest funds for immediate developmental needs in the aquatic systems in their localities.
- Provisions be made for adoption of lakes and wetlands by the NGO's and Self-help groups for their conservation, management, sustainable utilization and restoration.
- Aquatic ecosystem restoration works taken up by any agency, Govt. or NGO's should have 10% of restoration costs (per annum) spent or set off for creating awareness , research and monitoring compulsorily in future.
- Public education and outreach should be components of aquatic ecosystem restoration. Lake associations and citizen monitoring groups have proved helpful in educating the general public. Effort should be made to ensure that such groups have accurate information about the causes of lake degradation and various restoration methods.

5. **Documentation of biodiversity:** The biodiversity of every water body should form part of the School, College, People's Biodiversity Registers (SBR, CBR, PBR). The local Biodiversity Management Committees (BMC) should be given necessary financial support and scientific assistance in documentation of diversity. The presence of endemic, rare, endangered or threatened species and economically important ones should be highlighted. A locally implementable conservation plan has to be prepared for such species.

- All kinds of introduction of Exotic species and Quarantine measures be done in consultation with the concerned Authorities and the data bank
- There is an urgent need for creating a `Data Bank' through inventorisation and mapping of the aquatic biota.
- Identify water bodies of biodiversity importance and declare them as wetland conservation reserves (WCR)

6. **Preparation of management plans for individual water bodies:** Most large water bodies have unique individual characteristics. Therefore it is necessary to prepare separate management plans for individual water bodies.
   - Greater role and participation of women in management and sustainable utilisation of resources of aquatic ecosystems.
   - Impact of pesticide or fertilisers on wetlands in the catchment areas to be checked.
   - Regulate illegal sand and clay mining around the wetlands.

7. **Implementation of sanitation facilities:** It was noted with grave concern that the water bodies in most of India are badly polluted with sewage, coliform bacteria and various other pathogens. This involves:
   - Preserving the purity of waters and safeguarding the biodiversity and productivity, dumping of waste has to be prohibited;
   - In addition to this, all the settlements alongside the water body should be provided with sanitation facilities so as not to impinge in anyway the pristine quality of water.

8. **Management of polluted lakes:** This programme needs priority attention. This involves:
   - Implementation of bioremediation method for detoxification of polluted water bodies.
   - The highly and irremediably polluted water bodies may be fenced off to prevent fishing, cattle grazing and washing, bathing and collection of edible or medicinal plants to prevent health hazards.
   - Warning boards should be displayed around such water bodies.
   - Collection of any biomaterials from such water bodies should be prohibited.
   - Based on the concept of **polluter pays,** a mechanism be evolved to set up efficient effluent treatment plants [ETP], individual or collective, to reduce the pollution load. Polluting industries be levied **Environmental Cess,** which can be

utilised for conservation measures by the competent authorities. A `waste audit' must be made compulsory for all the industries and other agencies.

9. **Restoration of lakes:** The goals for restoration of aquatic ecosystems need to be realistic and should be based on the concept of expected conditions for individual eco-regions. Further development of project selection and evaluation technology based on eco-region definitions and description should be encouraged and supported by the national and state government agencies.
    - Ecosystem approach in aquatic ecosystem restoration endeavour considering catchment land use plan as of pre-project status and optimal land use plan shall first be prepared for short term (10 years and 30 years) and long term periods keeping in view developmental pressure over time span.
    - Research and development is needed in several areas of applied limnology, and this programme should take an experimental approach which emphasizes manipulation of whole ecosystems.
    - Appropriate technologies for point and non-point sources of pollution and *in situ* measures for lake restoration shall be compatible to local ethos and site condition as well as objectives of Aquatic Ecosystem Restoration Action Plan (AERAP).
    - Traditional knowledge and practices have to be explored as remedial measures. Cost-intensive restoration measures should be the last resort after evaluating all the cost-effective measures of conservation and management of ecosystems.
    - Public needs to be better informed about the rational, goal and methods of ecosystem conservation and restoration. In addition, the need was realized for scientist and researchers with the broad training needed for aquatic ecosystem restoration, management and conservation.
    - Improved techniques for littoral zone and aquatic microphytes management need to be developed. Research should go beyond the removal of nuisance microphytes to address the restoration of native species that are essential for waterfowl and fish habitat. Basic research is necessary to improve the understanding of fundamental limnological processes in littoral zones and the interactions between littoral and pelagic zones of lakes.
    - Biomanipulation (foodweb management) has great potential for low-cost and long-term management of lakes, and research in this emerging field must be stimulated.
    - Innovative and low-cost approaches to contaminant clean up in lakes need to be developed.

- The relations between loadings of stress-causing substances and responses of lakes need to be understood more precisely. Research should be undertaken to improve predictions of trophic state and nutrient loading relationships.
- Improved assessment programmes are needed to determine the severity and extent of damage in lakes and wetlands and a change in status over time. Innovative basic research is required to improve the science of assessment and monitoring. There is a great need for cost effective, reliable indicators of ecosystems function, including those that would reflect long-term change and response to stress. Research on indicators should include traditional community and ecosystem measurements, paleoecological trend assessments and remote sensing. Effective assessment and monitoring programme would involve network of local schools, colleges and universities.
- Procedures such as food web manipulation, introduction of phytophagous, insects and fish lining, and reintroduction of native species show promise for effective and long-lasting results when used alone or in combination with other restoration measures. Further research and development needs to be undertaken on these aspects.
- Paleolimnological approaches should be used to infer the past trophic history of lakes and wetlands and to decide whether these systems should be restored. Paleolimnological approaches could also be used to infer whether a lake has been restored to its predisturbance condition.

10. **Valuation of goods and services:** Goods and services provided by the individual water bodies and the respective species to be documented, evaluated through participatory approach and be made part of the Biodiversity Registers (PBR: People's Biodiversity Registers, SBR: School Biodiversity Registers). If in any case the traditional fishing rights of the local fishermen are adversely affected by lake conservation or by declaring it as a bird sanctuary, etc they should be adequately compensated.

    - Ecological values of lands and water within the catchment / watershed shall be internalised into economic analysis and not taken for granted. Pressure groups shall play as watchdogs in preventing industrial and toxic and persistent pollutants by agencies and polluters.

11. **Regulation of boating:** Operation of motorized boats should not be permitted within lakes of less than 50 ha. In larger lakes the number of such boats should be

limited to restricted area and carrying capacity of the water body. In any case boating during the periods of breeding and congregations of birds should be banned. .

12. **Protection of riparian and buffer zone vegetation:** Any clearances of riparian vegetation (along side rivers) and buffer zone vegetation (around lakes) have to be prohibited.

13. **Restoration of linkages between water bodies:** The process of urbanization and neglect caused disruption of linkages between water bodies such as ancient lake systems of many cities. Wherever such disruptions have taken place alternative arrangements should be provided to establish the lost linkages.

14. **Rainwater harvesting:** Intensive and comprehensive implementation of rain water harvesting techniques can reduce taxation of water bodies and also minimize electricity requirements. The country needs in principle a holistic rainwater harvesting policy aimed at directing water literally from "roof-tops to lakes" after catering to the domestic needs.

15. **Protection of sacred grove-water body system:** National water policy shall recognize the ecological, environmental, economic and socio-cultural values of the aquatic systems. Sacred groves have been integral part of traditional watershed protection systems. Ponds, lakes, springs, streams and rivers associated with the sacred groves were integral to the landscape management systems of traditional societies of especially Indian highlands. Most of these groves lost their significance due to merger of them with the state reserved forests or due to cultural changes. There still exist thousands of sacred groves along the Indian countryside. If these groves are recognized, ecologically restored and brought under appropriate management mechanisms in collaboration with local communities, a fresh revival can happen of the water bodies associated with them.

16. **Environment Education**: It was felt among the participants that public needs to be better informed about the rational, goal and methods of ecosystem conservation and restoration. In addition, the need was realized for scientist and researchers with the broad training needed for aquatic ecosystem restoration, management and conservation. Public education and outreach should include all components of ecosystem restoration. Lake associations and citizen monitoring groups have proved helpful in educating the general public. Effort should be made to ensure that such

groups have accurate information about the causes of lake degradation and various restoration methods. Funding is needed for both undergraduate and graduate programmes in ecosystem conservation and restorations. Training programmes should cross traditional disciplinary boundaries such as those between basic and applied ecology: water quality management and fisheries or wildlife management: among lakes, streams, rivers, coastal and wetland ecology. In this regard the brainstorming session proposes:

- Environmental education program should be more proactive, field oriented and experiential (with real time examples) for effective learning.
- Environmental education should be made mandatory at all levels – schools, colleges, universities, professional courses, teachers and teacher educators at the teachers' training institutes (Tch, B Ed, D Ed)

17. **Adopt Inter-disciplinary Approach**: Aquatic ecosystem conservation and management requires collaborated research involving natural, social, and inter-disciplinary study aimed at understanding various components, such as monitoring of water quality, socio-economic dependency, biodiversity and other activities, as an indispensable tool for formulating long term conservation strategies. This requires multidisciplinary-trained professionals who can spread the understanding of ecosystem's importance at local schools, colleges, and research institutions by initiating educational programmes aimed at rising the levels of public awareness of aquatic ecosystems' restoration, goals and methods. Actively participating schools and colleges in the vicinity of the water bodies may value the opportunity to provide hands-on environmental education, which could entail setting up of laboratory facilities at the site. Regular monitoring of water bodies (with permanent laboratory facilities) would provide vital inputs for conservation and management.
    - Funding is needed for both undergraduate and graduate programmes in aquatic ecosystem conservation and restorations. Training programmes should cross traditional disciplinary boundaries such as those between basic and applied ecology: water quality management and fisheries or wildlife management: among lakes, streams, rivers, coastal and wetland ecology.
    - Aquatic sanctuaries be created and tanks of religious places be declared as heritage centers for *in situ* conservation.

WETLAND PROTECTION LAWS AND GOVERNMENT INITIATIVES

The primary responsibility for the management of these ecosystems is in the hands of the Ministry of Environment and Forests. Although some wetlands are protected after the formulation of the Wildlife Protection Act, the others are in grave danger of extinction. Effective coordination between the different ministries, energy, industry, fisheries revenue, agriculture, transport and water resources, is essential for the protection of these ecosystems. Thus, wetlands were not delineated under any specific administrative jurisdiction. Recently the Ministry of Environment and Forests of the Government of India issued draft Notification 2008 Regulatory Framework for Wetlands Conservation (Wetland Conservation Rules). Wetlands in India are indirectly protected by an array of laws given below:

- The Indian Fisheries Act - 1857
- The Indian Forest Act - 1927
- Wildlife (Protection) Act - 1972
- Water (Prevention and Control of Pollution) Act - 1974
- Territorial Water, Continental Shelf, Exclusive Economic Zone and other Marine Zones Act - 1976
- Water (Prevention and Control of Pollution) Act - 1977
- Maritime Zone of India (Regulation and fishing by foreign vessels) Act - 1980
- Forest (Conservation act) - 1980
- Environmental (Protection) Act - 1986
- Coastal Zone Regulation Notification - 1991
- Wildlife (Protection) Amendment Act - 1991
- National Conservation Strategy and Policy Statement on Environment and Development – 1992.
- Draft Notification 2008 Regulatory Framework for Wetlands Conservation (Wetland Conservation Rules)

In addition to the above laws, India is a signatory to the Ramsar Convention on Wetlands and the Convention of Biological Diversity. According to these formulations India is expected to conserve the ecological character of these ecosystems along with the biodiversity of the flora and fauna associated with these ecosystems. Despite these, there is no significant development towards sustaining these ecosystems due to the lack of awareness of the values of these ecosystems among the policymakers and implementation agencies. The effective management of these wetlands requires a thorough appraisal of the existing laws, institutions and practices. The involvement of various people from different sectors is essential in the sustainable management of these wetlands.

Apart from government regulation, development of better monitoring methods is needed to increase the knowledge of the physical and biological characteristics of each wetland resources, and to gain, from this knowledge, a better understanding of wetland dynamics and their controlling processes. Discussions based on accurate knowledge and increased awareness of wetland issues can then begin to develop management strategies (to protect, restore and/or mitigate) that account for the function and value of all wetland resources in the face of natural and socioeconomic factors, while continuing to satisfy critical resource needs of the human population.

The Legal framework for the conservation and management of Wetland Ecosystems is provided by the following National and International Legal instruments:

The Wildlife Protection Act, 1972: This act provides for the protection of wild animals, birds and plants. For the purpose of this act, the state government constitutes the **Wildlife Advisory board**, which performs the following functions: It advices the state government:

- In the selection of areas to be declared as Sanctuaries, National Parks and Closed Areas.
- In the formulation of policy of protection and conservation of wildlife and specified plants.
- In relation to the measures to be taken for harmonizing the needs of the tribals and forest dwellers with the protection and conservation of wildlife.

This Act imposes prohibition on hunting of wild animals, their young ones as well as their eggs except with prior permission of the Chief Wildlife Warden. This acts prohibits the picking, uprooting, destroying, damaging, possessing of any plant in a protected area, except with prior permission of the Chief Wildlife Warden. The State government may declare any area; which it considers to have adequate ecological, faunal, geomorphological, natural or zoological significance for the purpose of protecting, propagating or developing wildlife or its environment; to be included in a sanctuary or a National Park. No person shall, destroy, exploit or remove any wildlife from a National Park and Sanctuary or destroy or damage the habitat or deprive any wild animal or plant its habitat within such National Park and Sanctuary. The State government may also declare any area closed to hunting for a designated period of time if it feels the ecosystem of that area is disturbed by hunting.

Water (Prevention and Control of Pollution) Act, 1974: It is an Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water. To carry out the purposes of this act, the Central and the State government constitutes the Central Pollution Control Board (CPCB) and State Pollution

Control Board (SPCB) respectively. The main functions of the pollution control boards include:

- Advice the government on any matter concerning the prevention and control of water pollution.
- Encourage, conduct and participate in investigations and research relating to problems of water pollution and prevention, control or abatement of water pollution.
- Lay down or modify standards on various parameters for the release of effluents into streams.
- Collect and examine effluent samples as well as examine the various treatment procedures undertaken by the industries releasing the effluent.
- Examine the quality of streams.
- Notify certain industries to either stop, restrict or modify their procedures if it feels that the present procedure is deteriorating the water quality of streams.
- Establish or recognize laboratories to perform its functions including the analysis of stream water quality and trade effluents.

Forest (Conservation) Act, 1980: Without the permission of the Central government, no State government or any other authority can :

- Declare that any reserved forest shall cease to be reserved.
- Issue permit for use of forest land for non-forest purpose.
- Assign any forest land or portion thereof by way of lease or otherwise to any private person, authority, corporation, agency or any other organization, not owned, managed or controlled by government.
- Clear off natural trees from a forest land for the purpose of reafforestation.

The Biological Diversity Act, 2002: India is a signatory to the United Nations Convention on Biological Resources, 1992 and in accordance with that convention, brought into force The Biological Diversity Act, 2002. This act prohibits biodiversity related activities as well as transfer of the results of research pertaining to biodiversity to certain persons. It also necessitates the approval of National Biodiversity Authority before applying for Intellectual Property Rights on products pertaining to biological diversity. This act emphasizes the establishment of National Biodiversity Authority to carry out various functions pertaining to the Act, viz guidelines for approving collection, research and patents pertaining to biological diversity. It also notifies the central government on threatened species. The central government to develop plans, programmes and strategies for the conservation, management and sustainable use of the biodiversity. Where the Central Government has reason to believe that any area rich in biological diversity, biological resources and their habitats is being threatened by overuse, abuse or

neglect, it shall issue directives to the concerned State Government to take immediate ameliorative measures.

Convention on Wetlands of International Importance, especially as Waterfowl habitats, (Ramsar) 1971: To stem the progressive destruction of the wetlands, Ramsar convention was signed. Waterfowls are birds ecologically dependent on the wetlands. The various points agreed under Ramsar convention includes:

- Each contracting party should nominate at least one wetland having significant value in terms of ecology, botany, zoology, limnology or hydrology to be included in the List of Wetlands of International Importance (Ramsar sites) and precisely describe its boundaries.
- The contracting parties will have right to add further wetland sites to the list, expand the boundaries of the existing sites and also to delete or minimize the boundaries of the existing sites.
- Each contracting party shall strive for the conservation, management and restoration of the wetlands in the list.
- Establishment of nature reserves in the area of wetlands thereby protecting it as well as the biological diversity it supports.
- Restriction of boundaries or deletion of a wetland listed as Ramsar sites, should be immediately compensated by the creation of additional nature reserves for the protection of waterfowls and other species habiting that wetland.

International convention for the protection of Birds, 1950: To abate the ever dwindling number of certain bird species (particularly the migratory ones) as well as the other birds, this convention was made. This is an amendment to the "International Convention for the Protection of Birds useful to Agriculture, 1902". The objectives of this convention include:

- Protection to all birds, their young ones and their eggs especially in their breeding season.
- Prohibit hunting, killing, mass capture or captivating birds, except those causing intense damage to crops or other components of the ecosystem, such so that the above said components is in the danger of extinction.
- Adopt measures to prohibit industries and other processes causing contamination of air and water that has adverse effects on the survival of birds.
- Adopt measures to prohibit the destruction of suitable breeding grounds and the bird habitat and also encourage the creation of suitable land and water habitat for the birds.

Bonn Convention on Conservation of Migratory Species, 1979: According to the Bonn Convention on Conservation of Migratory Species, the participating parties :

- Should promote, co-operate in and support research relating to migratory species.
- Shall endeavour to provide immediate protection for migratory species which are endangered.
- Shall strive to conserve and restore those habitats of the endangered species in an effort to eliminate the chances of extinction of that species.
- Shall prohibit or minimize those activities or obstacles that seriously impede or prevent the migration of the species.

Convention on Biological Diversity, 1992: The main objectives of this convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. In accordance with this convention, each contracting party shall –

- Identify places supporting immense biological diversity.
- Monitor through sampling or other means the components of biological diversity identified and strive for the conservation of those components requiring urgent attention.
- Develop new or adapt existing strategies, plans and programmes for the conservation and sustainable use of biological diversity.
- Identify activities which have or may have significant adverse impact on the sustainability of the biodiversity in an area.
- It prescribes conservation of biological diversity by either *In situ* conservation mechanisms or *Ex situ* conservation mechanisms or both.

***In situ* conservation :** Each contracting parties shall declare a region harbouring immense biological diversity as a protected area and develop various plans and strategies for the establishment, conservation and management of these protected areas and also strive to conserve biodiversity beyond these protected areas.

- Promote environmentally sound and sustainable development in the areas adjacent to the protected areas so as to further enhance the development and protection of these protected areas.
- Promote the protection of ecosystems, prevent the introduction of alien species likely to have an adverse effect on the existing ecosystem and also rehabilitate & restore degraded ecosystems.
- Enforce legislative measures for the protection of threatened species and population.

Ex situ conservation : Each contracting party shall establish facilities for ex situ conservation and for research on plants, animals and micro-organisms, especially the threatened species, augment their number and take steps for their reintroduction in their own natural habitat.

Relative merits and scope of the respective Indian laws with respect to the wetlands protection and conservation is given in Table 1.

Table 1: Sections applicable to Wetlands in the various environmental laws

No.	Act	Relevant Sections
1	The Wildlife (Conservation) Act, 1972	Prohibits hunting of wild animals, their young ones as well as their eggs Prohibits the picking, uprooting, destroying, damaging, possessing of any plant in a protected area Can declare any area with high ecological significance as a national park, sanctuary or a closed area.
2	The Biological Diversity Act, 2002	Prior approval needed from National Biodiversity Authority for collection of biological materials occurring in India as well as for its commercial utilization. Prior approval from NBA needed before applying for intellectual property rights on products pertaining to Biological diversity. The NBA advices the concerned state government in selection of areas with immense biological diversity as National Heritage Site.
3	Forest (Conservation) Act, 1980	Without the permission of the Central government, no State government or any other authority can : ▪ Declare that any reserved forest shall cease to be reserved. ▪ Issue permit for use of forest land for non-forest purpose. ▪ Assign any forest land by way of lease or otherwise to any private person, authority, corporation, agency or any other organization, not owned, managed or controlled by government. ▪ Clear off natural trees from a forest land for the purpose of reafforestation.
4	Water (Control and Prevention of Pollution) Act, 1974	It is based on the **"**Polluter pays**"** principle. The Pollution Control Boards performs the following functions : ▪ Inspects sewage and effluents as well as the efficiency of the sewage treatment plants. ▪ Lay down or modifies existing effluent standards for the sewage. ▪ Lay down standards of treatment of effluent and sewage to be discharged into any particular stream. ▪ Notify certain industries to either stop, restrict or modify their procedures if the present procedure is deteriorating the water quality of streams.

5	Wetlands (Conservation and Management) Rules, 2008	**Prohibited Activities** ▪ Conversion of wetland to non-wetland use ▪ Reclamation of wetlands ▪ Solid waste dumping and discharge of untreated effluents. **Regulated activities** ▪ Withdrawal of water, diversion or interruption of sources ▪ Treated effluent discharges – industrial/domestic/agro-chemical. ▪ Plying of motorized boats ▪ Dredging ▪ Constructions of permanent nature within 50 m ▪ Activity which interferes with the normal run-off and related ecological processes – up to 200 m
6	Declaration of Coastal stretches as "CRZ", 1991	**Prohibited activities :** ▪ Setting up of new industries and expansion of existing industries in the CRZ. ▪ Discharge of untreated wastes and effluents from industries, cities or towns and other human settlements. ▪ Dumping of city or town waste for the purposes of landfilling. ▪ Land reclamation and disturbing the natural course of sea water. ▪ Mining of sands, rocks and other substrata materials, except those rare minerals not available outside the CRZ areas and exploration and extraction of Oil and Natural Gas. ▪ Harvesting or drawal of ground water and construction of mechanisms thereof within 200 m of HTL; in the 200m to 500m zone it shall be permitted only when done manually through ordinary wells. ▪ Any construction activity between the Low Tide Line and High Tide Line.
7	National Environment Policy, 2006	The principal objectives of NEP includes : ▪ Protection and conservation of critical ecological systems and resources, and invaluable natural and man made heritage. ▪ Ensuring judicious use of environmental resources to meet the needs and aspirations of the present and future generations. ▪ It emphasizes the "Polluter Pays" principle, which states the polluter should, in principle, bear the cost of pollution, with due regard to the public interest.

8	Eco – sensitive zones	Industries shall be located only within the Industrial estates and strictly as per the guidelines issued by the concerned state government. As far as possible, no fresh mining lease shall be granted in the eco sensitive zone. However, quarrying and mining are totally banned in the core area of the eco sensitive zone. Tourism activities shall be as per a tourism development plan prepared by the Department of Tourism. The sites of natural heritage in the zone would be identified and plans for conserving in the natural setting would be made. All the gene pools in the zone would be preserved.
9	The Environment (Protection) Act, 1986	Lays down standards for the quality of environment in its various aspects. Laying down standards for discharge of environmental pollutants from various sources and no persons shall discharge any pollutant in excess of such standards. Restrictions of areas in which industries, operations or processes shall not be carried out or carried out subject to certain safeguards.
10	National Water Policy, 2002	Water is a scarce and precious national resource and requires to be conserved and management. Watershed management through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams should be promoted. The water resources should be conserved by retention practices such as rain water harvesting and prevention of pollution.

Table 2 lists Indian Laws applicable to Conservation of Wetlands (with web link to the source documents). All these web sites were accessed on 4th Oct 2009. Annexure II lists all documents listed in table 2.

Table 2: Indian laws applicable to the conservation of Wetlands with web URL's

Sl. No.	Indian Laws	Source (Web URL)
1	The Indian Wildlife (Protection) Act, 1972	http://wbbb.gov.in/.../The%20**Wildlife**%20(**Protection**)%20**Act**, %20**1972**.**pdf**
2	The Indian Fisheries Act, 1897	http://faolex.fao.org/docs/pdf/ind42223.pdf
3	The Indian Forest Act, 1927	http://www.envfor.nic.in/legis/forest/forest4.pdf
4	The Territorial Waters,	http://www.icsf.net/.../pdf/.../1112177359709***Territorial_Wat

	Continental Shelf, Exclusive Economic Zone	ers_Continental_Shelf_Act,_1976.PDF
5	The Water (Prevention And Control Of Pollution) Act, 1977	http://envis.mse.ac.in/lawspdf/WATER%20PREVENTION%201 9771.pdf
6	Water (Prevention And Control Of Pollution) Act, 1974	http://www.kerenvis.nic.in/.../Water%20_Prevention%20and%20 Control%20of%20Pollution_%20Act,%2019...
7	The Maritime Zones Of India (Regulation Of Fishing By Foreign Vessels)	http://www.icsf.net/.../legalIndia/pdf/.../1112181428778***Marit ime_Zones_of_India_Rules,_1982.PDF
8	Forest Conservation Act 1980	http://karnatakaforest.gov.in/English/Acts_Rules/acts/FC_Act_19 80.pdf
9	The Environment (Protection) Act, 1986	http://www.envfor.nic.in/legis/env/eprotect_act_1986.pdf
10	Coastal Zone Regulation (Crz) Notification	http://www.alakal.net/CRZNotification25.07.06.pdf
11	Wildlife (Protection) Amendment Act, 1999	http://www.envfor.nic.in/legis
12	National Conservation Strategies On Environment & Development	http://www.envfor.nic.in/divisions/csurv/csps.pdf
13	Draft Ministry Of Environment and Forets, GOI – Notification	http://www.kerenvis.nic.in/legislation/draft_on_regulatory_frame work.pdf
14	The Biological Diversity Act 2002	http://www.ces.iisc.ernet.in/biodiversity/.../pdfs/Biodiversity%20 Act%20and%20Ru les,%20basic%20note.pdf
15	Convention On Wetlands (Ramsar, Iran, 1971)	http://www.med-ina.org/article%2010.pdf
16	Convention On Biological Diversity, June 1992	http://www.fao.org/ag/AGP/AGPS/Pgrfa/pdf/cbde.pdf
17	Bonn Convention On The Conservation Of Migratory Species Of Wild Animals.	http://www.unep-aewa.org/meetings/en/mop/mop2.../pdf/.../georgia.pdf
18	International Convention For The Protection Of Birds	http://www.cbd.gov.tr/contracts/paris_convention.pdf
19	National water policy, 2002	http://wrmin.nic.in/writereaddata/linkimages/nwp200256175155 34.pdf
20	National Policy for Hydro Power Development	http://www.nhpcindia.com/writereaddata/English/PDF/hydro-policy.pdf