SOUTH ASIA NET WORK OF LAKES AND RESERVOIRS (SASNET- L & R)

M.S. Kodarkar
Convenor,
Thematic network on Lake Water Quality Management
Driver Agency : Indian Association of Aquatic Biologists (IAAB), Hyderabad, India.
Global Water Partnership (GWP) – South Asia; India Water Partnership (IWP), Gurgaon, Haryana.

Introduction

South Asia, home to over one fifth of the world's population is facing water crisis. This region is in the grip of flood and draught cycles and there is a need to have a long term strategy for management of its water resources. The water stress in this region can be attributed to extensive development of water intensive agriculture, large scale industrialization and urbanization that exerts unsustainable demand of fresh water. The cumulative effect of these factors leads to increased degradation of fresh water resources like rivers, lakes ground water and brackish water areas. The crisis appears to be further aggravated through institutional and legal fratne works tuned to sectoral and/or administrative and political needs, having little consideration to scientific management of water on a hydrologic basis.

Global initiatives in water resources including the global water vision has recognized that Integrated Water Resources Management (IWRM) is the key to tackling many issues relating to management of water. In the overall freshwater scenario lakes and reservoirs make up a significant component, the benefits from which can be optimized through IWRM in meeting the ever increasing demand for this natural resource. Thus Lake and Reservoir management (L & R) offers a development strategy that will include assessment of threat factors, aspects of quality and quantity, recycle and reuse and over all sustainability. It can guarantee an economically viable, environmentally sustainable and socially equitable basis of water resources management.

Modern concept of management networking of stake holders is given high priority as such a mechanism brightens the chances of success through effective implementation of Integrated Water Resources Management (IWRM). In SASNET-L & R context, 'Lakes and Reservoirs' are the terms that encompass a wide variety of natural and man-made freshwater surface resources like perennial ponds, tanks, natural lakes and small and medium man-made reservoirs with definite non-riverine catchments. In water cycle of any region these ecosystems are first to impound rain waters and are mainly responsible for charging ground water table in different agro-climatic regions. Dams and riverine impoundments which are covered under independent associate programmes like Dam and development and River Basin Organizations (RBO) with fairly well established management strategies will not be included in SASNET-L & R.

Further, on the basis of geography, the surface water resources will be divided into (a) **Urban** and (b) **Rural lakes & Reservoirs** as the issues of conservation and management options markedly differ with respect to these two environments. For example, pollution due to sewage and industrial effluents is typical urban phenomenon, while siltation[1] linked with deforestation in the catchment and accumulation of pesticides are crucial in the case of rural water bodies. A special stress on urban water bodies is essential as they are the subject to large scale degradation and many cases even destruction in the last 25 years. Today, it is generally agreed that, if protected, these ecosystems have significant capacity to augment freshwater availability to meet ever growing urban freshwater demand.

Management of water quality

A lake with proper management of its water quality has the capacity of bestow a number of ecological, economical and socio-cultural benefits on its immediate environment. These positive impacts can be summarized as follows:

1. Charging of groundwater table
2. Aquaculture: Culture of food fishes, prawns etc.
3. Flood regulation, moderation and control
4. Conditioning of the climate
5. Sustenance of colloidal water for vegetation
6. Sustenance of biodiversity
7. Recreational sites
8. Silt as a source of manure
9. Livelihood for lake dependent communities like washer men and small dairy farmers
10. Community asset with cultural and educational value.

A. Identification of problems :

I. Reclamation and loss of lake area : A mix of socio-economical and political issues are involved in morphometric degradation of water bodies. Population pressure and high land value make open spaces in urban environment vulnerable to encroachment and land grabbing and lakes are no exception to it. Lack of awareness and prevailing socio-political climate make the lakes vulnerable to destructive forces. Thus destruction of catchment and reclamation of lakes for urban settlements and other developmental activities is a common phenomenon.

II. Eutrophication : Degradation of water quality due to organic enrichment (Eutrophication) is mainly on account of domestic sewage that enters a water body through point and non-point sources. Lakes in industrial zones face added problem of pollution from toxic industrial solid and liquid waste (Effluents). Eutrophication of a water body leads to loss of biodiversity, poor water quality and pollution of ground water.

III. **Cultural siltation** : Thousands of tons of silt is added into lakes all over the country as result of idol immersion. The siltation reduces water holding capacity and expose the lake bed area for further reclamation and encroachment.

IV. **Loss to lake dependent communities:** Fishermen, washermen and small dairy farmers depend on lakes for their livelihood and pollution of lake invariably affect the livelihood of this vulnerable groups belonging to weaker sections of the society.

V. **Wild growth of aquatic weeds and breeding of vectors**: Sewage contaminated water produces large scale out break of water borne, dependent or carried infections and diseases and the cause of epidemics.

VI. **Impacts from recreational activities :** Around, in and on water recreational activities need proper management and often, if not, properly regulated create problems of large scale pollution.

B. **Effects on lakes :** Poor water quality due to pollution results into negative manifestations thereby reducing the potential of water body as a source of water, productivity of food organisms and recreational potential. The effects can be summarized as follows:

1. Reduction of morphometry and hydrography of a water body
2. Loss of biodiversity and aquacultural potential
3. Poor water quality, fowl smell and loss of recreational potential
4. Breeding of vectors and spread of water borne, carried and related diseases
5. Groundwater pollution

C. **Remedial measures :** As a holistic approach to lake management a number of remedial measures can be initiated for protection, rehabilitation and conservation of a lake.

1. **Protection of catchment :** A lake is reflection of its catchment and management of the latter can be a very effective measure for protection of a water body. The management action plan can include a) protection of natural in-lets while planning development, b) laying of proper sewer lines as a part of betterment while developing a catchment for settlement to prevent sewage pollution, c) proper storm water drains so that rain water will recharge a lake , d) development of greenery, rainwater harvesting for groundwater recharge.

2. **Lake morphometry :** a) Proper demarcation of lake boundaries at Full Tank Level (FTL) and development of a ring road to prevent encroachment and land grabbing; b) Greenery around the ring road and c) Lake Shore Line Protection Zone (LSLPZ) on the line of Coastal Regulatory Zone (CRZ) in the case of Coastal line.

3. **Maintenance of lake :** Budgetary provision should be made to maintain a water body by concerned regulatory authorities (Panchayat, Municipalities and Corporation). The maintenance includes prevention of solid waste dumping, de-wedding and desilting activities.

4. **Aquaculture :** Introduction of composite fish culture/ larvivorous fish species to control mosquitoes.

5. **Recreational activities :** Introduction of recreational activities like boating.

6. **Environmental Center** : Establishment of environmental awareness centers to maintain data and creating awareness about ecology and environment.

D. IWRM and management of lakes:

To translate International concerns in water sector into concrete action GWP was conceived as an International network built on the spirit of partnership involving all types of organized groups like developed and developing country Governmental Organizations (GO), Non-Governmental Organizations (NGO), agencies of UN, professional associations and private sector. It was created to foster IRWM which aims to ensure the coordinated development and management of water, land and related resources. The IWRM as a mechanism is expected to ensure maximum economic and social welfare on sustainable basis. Thus IWRM is a philosophy that will ensure availability, sustainability and equity for different sectors of water use.

E. Management of tools for translation of vision into action : Programme For Action (PFA) :

At the end of GWP sponsored 2 - Day workshop on 'Lake Management in India' held in Hyderabad following problematic areas were identified for remediation through IWRM approach. The degradation of lake water quality was mainly linked to :

a) Siltation due to natural and cultural and other anthropogenic factors

b) Organic enrichment (sewage and organic waste) and

c) Socio-economic factors leading to reclamation and encroachment.

A. Siltation :

1. Desilting of lakes in summer seasons to increase its water holding capacity. The silt often rich in organic matter can be used as manure for neighborhood gardening or in agriculture. Licenses can be issues for free lifting of silt.

2. To prevent cultural siltation on account of idol immersion resulting into dumping of tons of slow dissolving materials like plaster of Paris, the artisans can be tarined in use of natural clay for idol making. Use of natural biodegradable paints can be encouraged in place of synthetic paint which contain toxicants like heavy metals.

3. Awareness campaign highlighting negative effects of cultural siltation involving Municipalities, NGO, GOs and voluntary groups.

B. Organic enrichment (Eutrophication) :

1. Biomanipulation : Controlled growth of biomass and its harvesting to reduce nutrient load.

2. Composting of harvested biomass

3. Treatment of sewage by intercepting drains by establishing Sewage Treatment Plants (STP)
4. Restabilization of food chain/web by introducing fish species
5. Introducing herbivorous fish species to harvest plant biomass
6. Assistance to fishermen communities for introduction of composite fish culture.

C. Morphometry and Hydrography of lake :

1. Establishment of Lake Management Committees/ Lake Conservation committees to assist Integrated development of a water body.
2. Demarking lake boundaries and garland roads to prevent encroachment.
3. Aforestation of the catchment and development of greenery in the peripheral zones of a water body.
4. Socio-religious functions to create awareness about lakes. Annual lake fares by holding 'melas', competitions, rallies etc.
5. Publication of awareness material.
6. Lake protection cell at Central and state levels to co-ordinate inter-departmental activities and to enlist support of lake dependent stake holders and general public.
7. Enactment of laws to prevent degradation of lake morphometry, ecology.

WATER SUPPLY OF THANE MUNICIPAL CORPORATION

K.D. Lala
Water Supply Department
Thane Municipal Corporation,Thane

Introduction

Thane City is situated in Thane District & it's a district hea quarter . It is divided by central railway in two halves. The Thane city is adjacent to the Municipal Limits of City of greater Mumbai (MCGM).The residential land within Municipal Corporation of Greater Mumbai is getting exhausted day & the prices of residential accomodation are continuously rising there & thus people are adopting cheaper accommodation in Thane area. Thane is connected Mumbai by local trains & Eastern Express Highway.

Prior to year 1982, Thane was 'A' Class Municipal Council having population of 4.72 lakhs. However, Since this municipal council having was adjacent to Municipal Corporation of greater Mumbai, the growth of population has been rapid & Thane Municipal Council limits were extended upto shil on East side & ghodbundar road on Northside. On 1st OCT. 1982 Thane Municipal Corporation was formed which includes Thane, Kalwa, Mumbra & surrounding 32 villages. Total area of corporation is 127.00sq.km.

Topography

The Topography of Thane Municipal Corporation is scenic. On one side it has the higher altitude like Yeor and the other sides coastal areas like Kalwa , Mumbra ,Diva etc. The climate is typically humid & the temperature is between 20°C to 30°C. The rains are restricted to four monsoon months of June To September. The tidal area is subjected to tidal water spread . Due to rapid urbanization underground water spread . Due to rapid urbanization underground water is not fit for drinking purpose.

Population Projection

The following table gives the trends of population increase Since 1981 and further

Population in Thousand

Year	Population Actual /projected	% increase in population
1981	472.40(A)	69.00%
1991	796.60(A)	59.00%
2001	1264.62(A)	59.00%
2011	2030.00(A)	61.00%
2021	2842.00(P)	40.00%
2031	3978.00(P)	40.00%

population projections are taken with MMRDA'S figures along with TMC's records.

Water Demand & Supply

Prior to formation of Municipal Council did not have independent water supply scheme of its own & it was purchasing water from Municipal Corporation of Greater Mumbai & Maharashtra Industrial development Corporation (MIDC). During the early eighties Maharashtra water supply & sewerage board (MWSSB) executed project called MWSSP-I covering 6 Municipal towns & 104 villages in Mumbai Metropolitan region.The project was designed for the year 1991. Total Municipal Corporation area including 32 villages were covered under the project . Total Water Supply from above project was 127.00 MLD. The scheme was commissioned in 1987. The Total Supply available to TMC was as under.

1. BMC → 30 MLD
2. MWSSP → 125 MLD
3. MIDC → 65 MLD

Till 1997 the above water supply was available. In 1998 30 **MLD** water from BMC was made available The following table shows the water requirement, the supply & shortfall of water to the TMC yearwise.

Year	Water Requirement	Supply Available	Shortfall of water	Remarks
1991	200.00	220	-	Surplus
1996	225.00	220	5.00	Shortfall
1997	240.00	250	10.00	Surplus
2001	280.00	350	-	partial commissioning of100MLD scheme
2011	366.00	350	16.00	Additional water requirement
2021	558.00	350	128.00	- ''-
2031	768.00	430	338.00	- ''-

TMC's Additional 100 MLD Water Supply Scheme

With the above table it can be said that upto 1997 water position in Thane Municipal limits is good. But with the increase in population & living standards of residents of city of Thane , there is definite need of additional water. Thane Municipal Corporation planned additional 100 MLD scheme with Basta source costing Rs. 121.42 crores funded under megacity scheme with MMRDA. The scheme commenced in Oct. 1998 & completed On May 2001. The scheme was executed jointly by TMC & MJP.

In the month of May 2001, the scheme was tested & commissioned with its full capacity of 100 MLD . The water was lifted through the scheme according to the requirements & now TMC is lifting full quantity of 100 MLD. The scope of 100MLD scheme was to bring the water to the door step of city limits i.e. upto Majiwade with this available water the water requirement of city upto 2011 will be fulfilled & upto 2011 than will not be any problem of water supply to the city. With this available water TMC's internal distribution system was not strong enough to distribute the available water. To have a equitable distribution of water TMC's internal distribution system needed strengthening.

Thane City Water Distribution system Phase I & II

For equitable distribution of water TMC's existing distribution system needs strengthening. Maharashtra Jeevan Pradikaran , a body of Govt. appointed M/s.Task consultant ,Pune to study the existing distribution system & to prepare the detailed estimates , design & drawing for the extensions & strengthening of existing distribution system. After detailed study , M/S. Task consultant submitted the detailed project report for the augmentation of existing distribution system costing Rs. 138.50Cr. .The augmentation project of distribution system is known by the name ' Thane city Water Distribution project'.

The project covers the following sub-works.

I. Strengthening of internal transmission system.

II. Consruction of sump & pump house.

III. Laying distribution system.

In the Thane City Water Distribution System Phase I & II project, Total 351 km of pipe line ranging from 100 to 800 mm dia are to be laid out of which 241.00 km. Length is already laid .Balance work of laying will be completed by Mar.2005. In this project total 37 no. of ESR's will be constructed to enhance the storage capacity from 34.00 ML to 110 ML, sump & pump house –5 no.s are also planned In this project . The total project will be completed by Dec. 2005.

Salient Features of the Project :

1. The City (Municipal limit area) is divided in 45 water districts.
2. One or two ESR will be feed water district.
3. Demand of water is calculated @135 lpcd as per requirements of CPHEEO at Consumer end after considering the losses & other use the per capita demand is worked @ 180 lpcd.
4. The residual head at consumer's end will be 17 m or more in each water district.
5. The use of D.I. pipe are used to achieve economy due to better hydraulic properties like 'c' value.
6. The source allocation is made according to the sources, no mixing of source water is allowed. Following arrangement is made.

    1. East zone (Kalwa, Mumbra) → MIDC Water .

2. Kopari → BMC water.
3. Thane City Central → Stem / 100MLD Zone,Northern zone Water .

Future Proposal

With the better infrastructural facilities provided by T.M.C . T.M.C's population is Growing at the rate of 6 to 7% per annum. To meet the additional demand of increasing Population Thane city needs additional sources of water Thane Municipal Corporation was moved forward in this direction & taken up the future water supply projects as follows :-

1. Shai Dam Project

TMC's follows up & Metaculous efforts at Govt. level successed to get the approval from Govt. for the Shai dam Project. It is a long term project of almost 10 years with a built in capacity of 550 MLD. This project will take care of the entire TMC's population upto 2041 Yr. The project will commence in Yr. 2015. As Mentioned earlier in this report the existing sources are sufficient upto 2011.For the period between 2001 & 2015 TMC has identified another source viz. the Bhatassa sources & additional 100 MLD Water is sanctioned from Govt.

2. Additional 100 MLD from Bhatsa

Govt. has accorded sanction to additional 100 MLD water to TMC as an interim measure From Bhatsa. This water will be lifted with few augumentation scheme of existing 100 MLD additional water 40 crores of funds will be required. As the distribution system is laid for the year 2001 & 2026Yrs., distribution system will take care for the population upto 2026. After 2026 some augmentation to the Distribution system will be made for the design period upto 2041 & water sources to TMC are quit enough to take care for the Yr. 2041. TMC had taken care on all fronts of sources & distribution of water. Thane Municipal Corporation has made the sincere & meticulous efforts to provide the Better infrastructural facilities for the people of thane & also to the future population as as well.

DETERIORATION OF THANE CREEK ECOSYSTEM

R. P. Athalye* and Goldin Quadros #
*Zoology Department, B. N. Bandodkar College of Science, Thane 400601,
WWF – India, MSO. National Insurance Building, 204 D. N. Road, Fort, Mumbai 400001.

ABSTRACT : Thane creek is one of the most important ecosystems around Mumbai and Thane. The mangroves surrounding the ecosystem form the vital green lung for the residents. It is also and important feeding and breeding ground for fishes. Locals have been living in harmony amidst this ecosystem for ages, but in the recent past man has misused this ecosystem by way of releasing sewage, dumping solid waste, etc. and has succeeded in choking the ecosystem.

Regular scientific studies or the ecosystem are important as they help in remedial measures and also help gauge the extent of pollution. Studies on Thane creek i.e. the physico-chemical parameters, mangroves, benthos, fish, heavy metals have been conducted by the authors since 1981. They throw light on the deteriorating condition of the ecosystem.

***Key words**: Thane creek, mangroves, deterioration, scientific studies.*

Thane creek (Lat. 19.00' to 19.15' N and Long. 72.55' to 73.00' E) is 26 km long (map 1). It is connected to the Mumbai harbour on its south and joins by minor connection with Ulhas river on its North near Thane city. The creek is fringed with mangroves along both the banks coupled with heavy industrialization and urbanization. On the east bank exist Asia's largest industrialized zone namely Thana – Belapur industrial area along with the Navi – Mumbai Urban area. While the west bank has the highly urbanized Mumbai and Thane regions along with good number of industries. Geologically, Mumbai – Thane region is a part of the Deccan trap that was formed by volcanic effusions at the end of the cretaceous period (Blasco, 1975). Primarily both the south and north connections of Thane creek isolate Mumbai island from the main land. The creek is narrow and shallow at the riverine end due to the presence of geomorphic head and broader and deeper towards the sea.

The creek is tidally influenced with the dominance of neretic waters and negligible fresh water flow except during the monsoon. The substratum of the creek in the midstream is made up of consolidated and unconsolidated boulders intermingled with lose rocks and rarely with sand and gravel. Extensive mudflats are formed along both the banks of the creek which are characterized by the growth of mangroves.

A total of 10 mangrove species are recorded along the creek namely *Avicenma marina, A. officinalis, ceriops tagal, Bruguiera cylindrical, B. gymnorhiza, Aegiceras corniculatum, Sonneratia apetala, S. caseolaris, Exceocaria agallocha, Rhizophora mucronata*. while the mangrove associate species included *Acanthus illicifolins, Aehiuropus lagopoides, Sesuvium portulacastrum, Salvadora persica, Derris trifoliate, Ipomea spp., Typha spp., Clerodendron therme*.

The presence of mangroves along both the banks has made Thane creek a highly productive ecosystem. Ecological studies are thought to be more important in understanding estuarine processes as they can indicate deterioration or improvement of the ecosystem. Thane creek is being regularly monitered by research institutions and agencies like BARC, NIO, CPHERI, CIFE, B. N. Bandodkar college of science (Goldin 2001). A review of some of the parameters regularly studied is summarized below.

The comparison of a recent study of parameters like salinity, DO, PO4-P, NO3-N, SiO3-Si, sediment texture, Organic Carbon, Phytoplankton and Zooplankton with the past available data indicates the following:

(1) Significant gradual lowering of salinity in the past 25 years. As a increase in reverine fresh water flow does not seem possible, the change can be attributed to the increases effluent load containing fresh water and reduced flow of tidal marine water due to hinderances created by human activities especially reclamation, construction of bridges, solid waste dumping, release of effiluents, etc.

(2) Urbanization and industrialization around the Thane creek has severely affected the water quality of the creek which is indicated from the comparison of DO. The gradual decline from once healthy to hypoxic conditions can be attributed to growing exploitation of the creek ecosystem and release of high sewage load.

(3) Comparison of nutrients (PO4-P, NO3-N, SiO3-Si) indicates that the phosphates in the creek have reduced but are still above the limits of unpolluted waters as suggested by Yentsch and Ryther (1957). While nitrates have remained almost constant whereas the silicates have increased tremendously which can be attributed to the increasing anthropogenic activities and volcanic origin of the area.

(4) The sediment texture indicates increasing siltation in the creek while the sediment Organic carbon % shows increase in the concentration indicating increased influence of sewage effluents leading to the deterioration.

(5) Plankton – the phytoplankton and zooplankton density and diversity showed decline indicating detrimental condition of the ecosystem, probably chemical pollution through industrial effluents, which however was not in the shape of our studies.

(6) Fishery – During the year 1991 – 93 around 22 species of fish were observed from the riverine end of the creek while during a recent study only 6 species were recorded. At the seaward end 67 species were recorded and which however do not enter the creek due to the pollution load. This has in fact affected the livelihood of the local fishing communities who have now diverted to aquaculture and have resorted to cutting the mangroves along the creek to develop aquaculture ponds.

This deteriorating condition of the creek can be attributed to heavy industrialization and urbanization that has taken place along both the banks of the creek. According to TMC – ES report (2000) there are about 2000 industries along the creek of which 51 are large, 250 medium and 1221 small industries. Moreover the human population has doubled in past 10 years adversely affecting the creek ecosystem.

Gajbhiye *et al*. (1981) reported Thane creek to receive 27 mld of industrial waste water and 0 mld of sewage water which increased to 180 mld and 350 mld respectively. (Annie Mathew 1989) While TMC – ES report (2000) quotes respectively 294 mld and 145 to 260 mld release in the creek within Thane city limits. Not only domestic and industrial effluents are released in the creek but since 1995 the creek is also being indiscriminately used as dumping ground for huge quantity of solid waste.

(7) Birds – Despite the anthropogenic activities and the pollution pressure the creek harbours a large variety of birds. Deshmukh (1990) listed 146 species of birds, Kulkarni (1999) reported 179 species from the middle to lower stretch of the creek. Nitsure and Pejaver (2002) recorder 69 species from the riverine stretch of the creek while Goldine (2001) observed 61 species in the intertidal region of the creek. This vast diversity of avifauna could be due to the fact that the birds only feed in the mangrove ecosystem and are not directly concerned with the water and sediment quality but the bargain could be accumulating the pollutants in their body which may prove detrimental in the long run.

(8) Metals – the studies have revealed that the metals like Zn, Cu, and Pd are significantly increasing in all the components of the food chain including fishes and prawns. They can adversely affect the human consumers.

The common man in Mumbai has now to some extend become aware of the importance and benefits of the mangrove wetlands. This has become possible due to the educational activities conducted by various institutions and NGO's like B. N. Bandodkar college of Science, Godrej, BNHS, HOPE, etc. Godrej and HOPE have to some extend even succeded in conversion and replantation of mangroves in Thane creek region although the creek has now reached a stage where it is almost dying.

MICROBIOLOGY OF POTABLE WATER

N.T. Joshi
Director, Padmaja Aerobiologicals Pvt. Ltd.

The drinking water of most communities & municipalities is obtained from surface sources - rivers, streams & lakes. Such natural water supplies, particularly lakes & rivers are likely to be polluted with domestic & industrial waters. Municipal water purification systems have been very effective in protecting the population against polluted water.

As a potential carrier of pathogenic microorganisms, water can endanger health & life. The pathogens most frequently transmitted through water are those, which cause infection of the intestinal tract, namely typhoid, & paratyphoid bacteria, dysentery (bacillary & amoebic) & cholera bacteria and enteric viruses (Jaundice, Polio etc). The causative organisms of these disease are present in the feces and urine of an infected person and when discharged may gain entrance into a body of water that ultimately serves as a source of drinking water.

It is therefore necessary to employ

1) Treatment facilities that purify Waste water prior to its disposal.

2) Water purification methods that provide safe drinking water.

Water that is free of disease- producing microorganism and chemical substances deleterious to health is called potable water; water contaminated with either domestic or industrial waste is called as non-potable or polluted water.

The objectives of primary concern in providing potable water are freedom from harmful microorganism and freedom from undesirable chemicals.

Let us study the situation in Thane Municipal Corporation limit for water quality.

As per environment status report published by Thane Municipal Corporation for the year 2003-2004 the corporation receives totally 350 MLD water from three major sources Shaheed Temaghar Water Authority MIDC & BMC: 98% of the population receives water from drinking water supply pipe line and 2% of the population drinks water from bore well and wells. Total population residing on the corporation growth is 12,61, 517 and 2% of which is 25,230.

This much population is dependent on Borewell or wells as the source of drinking water

The points is important as on the public health point of view.

Table I - Thane District Population Count

Decade	Population	% Growth
1951	91,054	
1961	136,591	33.30%
1971	261,615	47.80%
1981	474,170	44.80%
1991	795,833	40.40%
2001	1,261,517	36.90%
Average		40.60%

Table II - Thane District Male Female Count

	MALE	FEMALE	MALE: FEMALE RATIO
Total	674,660	586,857	869.8
Slum	231,266	186,010	817.3
Non Slum	443,394	397,847	897.3

Let us see the status of water quality of the city in general and microbiological status of water in particular.

Table III

Lake	**pH**	**C.O.D.**	**B.O.D.**	**NO_3**	**PO_4**	**Chl.a**	**DO_S**	**DO_b**
1.Khidkali Lake 2003	7.8	76	44.05	0.93	8.9	65.5	2	0.2
2002	7.5	68	26	0.85	7.98	47.1	3.5	0.6
2.Kausa Lake	7.6	183	56	0.35	2.04	210	2.8	0.5
2002	7.5	109	38	0.26	3.25	68.5	3.9	0.8
3.Kharegaon Lake	7.66	137	78	3.2	5.96	135	1.5	0.3
2002	7.5	111	61	2.86	5.96	39.21	2.1	0.4
4.Upvan Lake		92	56	0.93	3.8	4/8.00	2.5	0.3
2002	8	156	62	0.81	12.78	28.12	3.2	0.5
5.Jail Lake	7.9	129	56	0.9	4.89	263	2.6	0.4
2002	7.5	112	39	0.61	3.89	48.96	3.2	0.9
6.Makhmali Lake	7.6	184	66	0.04	1.33	134	2	0.4
2002	7.5	124	52	0.02	1.23	38.15	2.4	0.8
7.Kasarwadavali Lake	7.6	150	66	0.89	4.36	36	2.65	0.3
2002	7.5	112	49	0.64	3.89	29	4	0.4
8. Rewale Lake	7.2	260	66	3.78	5.4	118	2.8	0
2002	7.2	82	41	3.41	3.5	56	3	0
9.Narr Lake	7.1	136	57	0.87	11.36	68.8	2.6	0.2
2002	7	118	36	0.75	13.72	41.89	4.8	0.4

Units all units except pH and chlorophyll are in mg/L chlorophyll expressed as mg/m^3

Except in Upvan lake the values of COD & BOD indicate that the water quality is deteriorated in one year time drastically. Even the parameter like phosphate in some places shows an increasing tendency.

As per the environment status report –1999-2000

The ground water status in Thane Muncipal Corporation area is as under.

Table IV - ENVIRONMENTAL STATUS REPORT 1999-2000

Sr.No.	Parameter	Open well	Tube well	Limit class BISI 10500-1983	WHO
1	$_{P}$H	7.0-8.6	6.8-7.1	6.5-8.5	6.5-8.5
2	Turbidity	2.2-10.3	1.5-3.9	10	5
3	Chloride	59.0-134.0	44.0-78.0	250	---
4	Hardness	284.0-584.0	224.0-540.0	300	---
5	D.O.	4.2-6.7	1.9-5.9	5	---
6	B.O.D.	2.0-12.0	3	3	---
7	T.D.S.	466.0-722.0	---	---	1000
8	Alkalinity	300.0-450.0	---	---	---
9	Lead	---	0.1	0.1	0.01
10	Chromium	0.02-0.77	0.05	0.05	---
11	Cadmium	---	0.01	0.01	0.003
12	Zinc	Nil-0.44	5	5	3
13	Copper	---	0.05	0.05	1.2
14	M.P.N.	14-1600	500	500	---
15	F. Coli	6-350	---	---	0
16	E. Coli	0-20	---	---	0

All Results are in mg/L except pH turbidity and microbiological counts.

Interpretation: Comparing with WHO and ISI guideline for drinking water most of the tube well and open well water is contaminated with *E. Coli*. Only in case of tube well at Dhokali falls within the limit whereas water of all wells are found to be not fit for human consumption. This water can be used for domestic purpose other than human consumption. The regular monitoring of all open well and tube well is recommended.

The results indicate that the parameters like hardness, BOD, TDS, are above the permissible limits and we have seen that these value are increasing in the further years. The microbiological values like MPN, E- coli, are also above limits.

This is the water that is used for drinking by 2% of the population, which is subjected to the enteric disease.

The report published in the year 2002 indicates and states that the pollution in lakes Thane city is increasing and requires special attention

Table V - Lake survey

$_{P}$H	7.0-8.0	Limit 6.5-8.5
D.O.	Nil-8.0ppm	6.0 ppm
C.O.D.	14 ppm-408 ppm	-------
B.O.D.	9.0-155 ppm	2 ppm
Nitrate	Traces-4.1 mg/lit	20 ppm
Po4	0.02-11.8 ppm	-------
T.D.S.	700-1840 mg/lit	500 ppm
Zn.	0.01-0.048	15 ppm
Cu	0.007-0.039	1.5 ppm
Pb	0.01-0.03	0.1 ppm
Cr	0.02-0.05	0.05 ppm

From this examination it is observed that the Lake water Pollution is increased

The ground water report in 2002 is as under :

Table VII

Location	pH	MPN	Feecal Coliforms	E. Coli	DO	BOD	Total Hardness
1.Meena Kunh Well	7.38	8	0	0	4.8	7.3	286
2. Parmeshwar Niwas	7.44	1800	175	95	6.8	4.8	144
3. Dennis D'souza	7.12	1800	145	95	5.2	4.4	344
4. Shreeji Medical	6.91	8	0	0	5.8	1.5	338
5. Opp. Ambika Niwas	7.7	170	45	9	5.4	2.5	502
6. Near Sai Appt	8	350	110	40	4.4	1	362
7. Sunil Motors	7.23	1800	275	130	3.4	1	236
8. Hajuri Gaon	7.8	8	0	0	2.8	7.5	252
9. Mohanji Sundarji Rd	7.9	110	33	0	2.4	5	254
10.Jilani Wadi Road No.9	7.88	2	0	0	2.2	3	202
11.Siddarth Nagar	7.23	85	40	17	3	3	360
12.Kopari Colony BLD.22	7.7	80	33	9	4	2	346
13.Dhobi Ghat Bldg.12	7.6	26	0	0	3.4	0.5	57
14.B-Cabin Kalavati Bldg.	4.9	110	40	0	4	1	228
15.Near Laxmi Niwas	6.85	115	30	9	5.2	1.5	272
16.Kokani Kabarstan	6.9	350	40	20	14.3	5	240
17.Kopari Mun.School	7.51	250	80	45	0.4	9.5	396
18.Anad Nagar	7.33	150	65	40	3.2	2.5	296
19.Gaodevi Mandir	7.9	220	34	17	3.6	4	356
20.B Cabin. Datewadi	7.8	140	33	9	7.2	5	242
21.Navjivan Society	8.4	0	0	0	3.2	8.2	311
22.Haval Bhavan	7.8	425	40	20	2.4	5	476
23.Datta Mandir Chendani	7.81	120	40	20	1.4	0.5	336
24. Vaidya Vakhar	8	200	85	20	2.6	3	444
25. Vaidya SADAN	7.7	225	55	20	1.4	3	290
26. Lalbaug, Ghantali	7.9	280	110	17	5.4	3.6	260
27. Haridas Premji	6.83	1800	350	115	1.8	5.5	254
28. Kelkar Wada	6.86	1800	900	200	0.6	11	254

The water quality after treatment and at the source is analysed by TMC and the reports are encouraging.

Table VII - Quality of Drinking water for the Year 2003

Month	In Distribution System		At Point of Use	
	2002(%)	2003(%)	2002(%)	2003(%)
March	98	100	100	100
April	94.5	96.8	90.6	90.6
May	96	95	92.8	93.7
June	91.8	94.8	65	72
July	98.3	97.3	97.4	95.4
August	96.8	96.68	89.5	90
September	99	100	98	99
October	100	99	98	99
November	100	99	97.7	98
December	100	100	96.9	100
January	98.1	100	97.6	98
February	98.1	99.6	100	99
Average	97.7	98.16	93.62	94.5

Points to note :

1) 2% of the population drinks Borewell & well water.
2) The source of the ground water needs to be monitored, as there is risk of spreading enteric diseases if this water is polluted.
3) The lake water sample shows an increase in pollution parameter.
4) The microbial indicators of feacal contamination are showing values exceeding the limits.
5) The water needs purification before it is consumed.
6) The water at source shows increasing potability.
7) As the population is increasing the monitoring of ground water sample will play an important role in controlling the epidemics.

Inspection of a water producing system by a qualifier sanitary engineer is called a sanitary survey.

There may be changes in population types of industries, and

The quantity of sewage and the manner in which it is disposed: Data obtained from these surveys are of considerable value.

We know that chemical analysis indicates the chemical parameters of the water samples and also indicates the trend of pollution level. However, it is not sensitive or specific enough to detect minor degree of sewage contamination. Microbiological tests are extremely sensitive and specific in evidence of pollution.

We have analysed following water samples from following points for microbiological tests:

Table VIII

Sr no.	M.P.N.	Fecal coliform [E. coli.]
1	350	40
2	1800	175
3	425	110
4	350	65
5	1400	275
6	1800	350
7	1800	900
8	1800	145
9	1800	900
10	1800	425

The objective in such analysis would be to know the situation of microbial load at the specific time. We all know that

1) Pathogenic microorganisms are likely to gain entrance into water sporadically.

2) They do not survive for long period in water.

3) They could be missed in a sample.

It is known that the pathogens gain entrance into bodies of water via polluted waters (Sewage).

Escherichia coli and related organisms designated as coliforms, fecal streptococci (streptococcus fecalis) and clostridium perfringens are normal inhabitants of the large intestine of humans and other animals and are consequently present in feces.

Thus the presence of any of these bacteria in water is indication of pollution. If these organisms are present in water, the way is also open for intestinal pathogen to gain entrance.

The demand for larger quantities of potable water continuous to grow worldwide: It is at flash point at certain places: Accordingly there is more need for conservation together with more efficient waste water processes so that the water is available to all and at all times.

Simultaneously there is an increasing need to monitor the biological pollution of water as it is sporadic and can be missed in routine sampling & analysis. This is important tool & index of public health.

IMPACT OF ENVIRONMENTAL AWARENESS CAMPAIGN ON '*GANAPATI*' IDOL IMMERSION ACTIVITY IN MASUNDA LAKE, THANE CITY

V.A. Walavalkar* and Nagesh Tekale**
*Lecturer at VPM's Polytechnic
** Research Guide at B.N. Bandodkar College, Thane

ABSTRACT : Ganapati Festival is one of the prominent festivals celebrated by all communities irrespective of cast, creed and religion. Hence " Pollution due to Ganapati idol immersion in Masunda lake" has many social, religious, scientific & environmental dimensions. Hence this problem requires an input from many agencies to find the correct solution.

Local self-government, environmental laws, scientific investigations, determination of extent of pollution, finding alternatives to minimize the pollution and the main & important thing is to convince 'Ganesh Bhaktas' to understand this in right perspective. Hence the "Environmental Awareness Campaign" has a significant role in the process.

Local self-government, local & state newspapers, local schools, NCC, NSS, student volunteers were involved in this campaign. This campaign was launched by Non Government Organisations like Paryavaran Dakshata Manch (Enviro-Vigil), Haryali, HOPE and Jidnyasa. The result of this campaign was dramatic as there was a significant decrease in the number of Ganpati idols, immersed at Masunda lake from 1997-2003. This clearly indicates that the awareness campaign resulted in the change of mindset of the people in celebrating Ganesh festival, which in turn will save the water bodies in & around Thane.

'Thane' a city which was identified as a "City of Lakes" had more than 60 lakes in the 19th century. Thane is having a special surrounding of creek and national park, but its closeness to Mumbai resulted in over population of this city and making an environmental crisis.

Masunda is one of the prominent lakes present in the heart of the city; spread over 27 acres of land. The lake is surrounded by vehicles, roads, hawkers and even some hutments. All these factors contribute to the pollution of water. The chlorinated water from swimming tank, the washing of vegetables from nearby market & sometimes the outlet water from sewage treatment plant adds to this pollution. In 1993 when last disiltation of lake was done the depth of the lake reached to 18 feets.

Ganapati Festival: Ganapati festival is the joyously celebrated religious festival of Hindu community makes the city to participate celebrations, irrespective of cast creed and religion. Thousands of devotees gather on the lake every year to perform 'Visarjan' ceremony on 2nd 5th and 11th day of the festival. Traditionally Masunda has become a part of their religious faith.

Table 1 : Number of Ganapati's Immersed (Irrespective of its size)

Year	Days			
	1 1/2	5	11	Total
1997	2,217	3,052	10,320	15,589
2002	2,732	3,508	3,430	9,670
2003	2,587	3,144	3,208	8,839

Idol Immersion Practices :

Ganapati idol immersion in lake water creates many environmental problems. Ganpati idols traditionally made of 'shadu' (a specific type of soil) are becoming costlier & plaster of Paris (PoP) is fastly replacing 'shadu'. PoP purely is a chemical, which solidifies and hardens after forming a paste and also easy to mould therefore widely used for preparation of Ganapati idols.

100 Kg of Ganapati idol contains

69 Kg of PoP (Plaster of Paris)

10 Kg. Jute

10 Kg. Iron

6 Kg Colour (Paint)

5 Kg wood

_____

100 Kg

Environmental problems for water bodies :

Ganapati idols take 15 days to dissolve and disintegrate. The DO (dissolved oxygen) of water goes down & suspended solid increases. Water becomes turbid and fish mortality was observed.

Massive fish mortality was observed due to clogging by gypsum particles, lead level in water was also increased.

Sedimentation of gypsum in the water reduces the depth of the lake- also gypsum clogs the natural water springs of the water body.

The decrease in number of idols since 1997 in the Masunda lake is significant. This is the effect of remedial measures taken by local self-government regarding the saving of this lake by allowing a private party to take care of this lake environmentally. The environmental protection with contract for fishing, boating, etc.

The Campaign by NGO's :

Enviro-Vigil, Hope, Hariyali and Jidnyasa with the help of college and school students, TMC officials, Police, RTO and other agencies tried to save this water from ill-effects of immersion.

The focus of this awareness campaign was to develop an environmental perspective in the society about this festival. The process initiated by appealing the society regarding the size of the Ganesh Murti. The highlights of the campaign are as follows:

- It was appealed to the society that they should restrict the size of the Ganesh idol to one feet.
- Society was also requested to use Ganapati idol made up of 'shadu'- a soil and not of PoP.
- The colours used for painting should not contain any toxic material like heavy metals in it (expected to use biodegradable and non-toxic colours).
- The devotees could use wooden or metal Ganesh idol for festival and could retain it at home for next year.

The campaign was having a good success and large number of people have started using permanent idols or reduced the size of idol.

The appeal was made to the people to have immersion of Ganesh idol at their home in a container and giving that water to the plants; which is accepted and now it has actually translated in decrease in the number of idols immersed at Masunda lake.

The campaign was with the help of the students, who took this campaign to their homes and to the society. Hence the change in the mindset will starts from the new generation and it will surely show effects in the coming years.

POLLUTION OF WATER BODIES IN URBAN AREA

Manisha Pradhan
Sr. Chemist
Thane Municipal Corporation, Thane.

Lake &Water bodies are very important constituents of the urban environment and play important role for recreation as well as economic ways. Out of total 128 sq.km of Thane city area ,the minor water bodies i.e. lakes, tanks, nallahs occupy 1.9% & Thane and Ulhas creek which are the major surface water bodies occupy mainly 9% of total land of TMC.

The analysis of these water bodies indicate that the condition in the creek, river, lakes have deteriorated. The major cause of deterioration are release of sewage and industrial effluent from surrounding area, indiscriminate &illegal dumping of solid waste.

Lakes

Thane has approximately 34 lakes measuring some 6,70,000sq feet . Some of them like Masunda & Upvan have become major recreational areas.

Concerned over the deteriorating water quality in the lakes, the TMC had initiated a comprehensive “Lake beautification & Remediation programme “ in 1996 for 20 lakes.

The first lake to have undergone transformation was Kacharali lake. Encouraged by the success, remediation programme for more lakes have been undertaken and at present 10 major lakes in the city are being cleaned, with assistance from MOEF ,New Delhi.

This project being done departmentally, Advisory committee, consisting of expert from Kelkar Vaze College Mulund, Birla College ,Kalyan, has been contributed to advise the T.M.C.

The project has been conducted in scientific manner and consists of three major actions

1. Prevention of ingress in lake

All sewage and nallah lines have been diverted to stop the ingress of pollutants in the lake area.

2. Beautification of water bodies

Construction of parafit wall ,stone pitching etc has been carried out to improve the aesthetic appearance and also to prevent silting and encroachment of lake.

3. Bioremediation programme to improve the water quality

In order to maintain these lakes after their cleaning, TMC has given the lakes on a long

term lease of 25 years on BOT BASIS . This will make lake self sustaining and ensure their maintenance.

The progress of work is being continuously monitored by the Pollution Control Cell, which conducts regular sampling and analysis programme.

Ground Water

TMC has around 455 wells and 104 bore wells. Most of the citizens are dependent on the piped water supply but still the less developed area and slum area are dependent on the wells for their water requirement. Pollution Control Cell of Thane Municipal Corporation carrying out Ground water monitoring since its inception and it is observed that majority of the wells are bacteriological polluted and is not fit for drinking water. Central Pollution Control Board has awarded a work for project" Study on Assessment of Ground water Quality in Metropolitan City of Thane, NaviMumbai & Mumbai". Main aim of the study is to define remedial measure to conserve such valuable natural water source purposes.

The predominate reason for ground water pollutions are

- Bad/improper maintenance
- Discharge of wastewater and washing near the well leads to percolation & pollution of water table.

However in views of the increasing demand of water the TMC has been encouraging people to use the ground water for gardening, toilet, commercial construction & other purposes.

TMC has made separate budgetary provision for repair and maintenance of these wells and borewells. Health department also provides Chlorin solution to clean these wells.

Drinking water supply

TMC receives 350 MLD of water supply form MIDC, MMC, STEM and its own 100 MLD water supply scheme. Thane Municipal Corporation with its health department, water department and pollution control cell strives to maintain clean and adequate water supply to Thane city. Drinking water quality in terms of portability% with respect to Bacteriological quality in five years is as follows.

Summary of results

Year	2000	2001	2002	2003
At distribution system (water tank, direct line)	88%	91.25%	97.7%	98.16%
At point of use (Hotels, commercial Establishment)	73%	88.08%	93.62%	94.55%

It can be seen that, there is gradual increase in the water quality mainly due to continuous monitoring by the TMC.

At Point of use water samples are observed more polluted repeatedly due to unhygienic storage of drinking water in commercial establishment.

Proc. Pollution of Water Bodies in Urban Areas- August. 2004

BIOREMEDIATION OF THANE LAKES

G.T. Paratkar, B.B. Sharma, S.S. Barve, S.L. Dhuri, R. Tailor, G. Soman, R. Avin, R. Wagh
KET's V G Vaze College of Arts, Science & Commerce, Mithagar Rd, Mulund (E), Mumbai - 81

ABSTRACT : Thane is known as city of lakes since time immemorial. Lakes in the city add to aesthetic of any city. However the condition of lakes in Thane were deteriorating. The clean up of the lake has been taken up to save this precious natural resource from depleting. The present conventional clean up processes are not only expensive but also produce obnoxious waste by-products thereby imposing additional clean up or environmental cost.

Bioremediation is an emerging novel approach in rehabilitating areas fouled by pollutants or otherwise damage through ecosystem mismanagement. Bioremediation offers attractive and supplementary measures along with the conventional clean up technologies at a comparatively low cost and generally without benign environmental impact.

The present work on bioremediation of Thane lake includes preliminary data on physico-chemical conditions and biota of Thane lakes before and after bioremedial treatment.

Keywords : *bioremediation, thane lakes,*

Introduction

Water is very essential for the survival of life. Of the total water present on the planet, only 1% is fresh water which is available for various domestic purposes like drinking, cooking etc. However, the amount of total fresh water available is rapidly decreasing due to industrialization and other anthropogenic activities, all the water bodies including lakes are being polluted more than ever before. Disposal of sewage, garbage and hazardous industrial effluents directly into the water bodies, be it rivers, streams or lakes, has posed a serious threat to the aquatic life. Such activities are not only harmful for life but also destroy the aesthetics of the total environment. Therefore there is an urgent need to conserve this precious Natural Resource.

Thane is known as the City of Lakes, since time immemorial the lakes in the city add to the aesthetics of the city. However the present condition of lakes in Thane is fast deteriorating. It is high time now that we have to seriously look into the problem with novel remedial measures. The cleaning up of the lakes has to be taken up to save this precious natural resource from depleting. The Present day conventional clean up processes are not only expensive but also produce obnoxious waste by-products thereby imposing additional clean up or environmental costs.

To implement the Bioremediction Techniques, it is necessary to collect a exhaustive preliminary data for the successful application of Bioremediation technology for the clean up of the lakes.

Material and Methods

The apt technology may vary according to the basic preliminary data for the revival of the ecosystem of the lakes without disturbing the natural conditions. The following parameters can be considered to assess the water quality before and after implementing the Bioremediation measures.

1) Survey of lakes, topography : it is necessary to know the geographical location, age, depth and area of lake.
2) Physico-chemical features like colour, temperature and turbidity of water should be determined.
3) Chemical parameters like ph, electrical conductivity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total solids, chlorides, nitrates, phosphates etc should be determined.
4) Biological factors like flora and fauna, primary productivity should be determined.
5) Different pollutants like organic pollutants, diseases causing agents, plant nutrients, etc. should be determined.
6) Inorganic pollutants like mineral acids, inorganic salts, metal finely divided metal complexes, trace elements, etc. should be determined.

Results and Discussion

The various parameters of the three lakes were studied for a period of six months during which the microorganisms were added at regular intervals. The analysis of the samples was carried out at the laboratory of TMC at Kopri Colony Thane. The data obtained has been compiled in the table (Table no. 1, 2, & 3.).

The analysis of the three lakes show the following results :

Jail Lake

The pH level of the water of Jail Lake inititally was 7.26 in the month of Sep-Oct. 2003. The pH increased during the month of March and June and there was a slight reduction in the month of July

The Dissolved Oxygen levels of the surface and bottom waters increased as compared to the initial values (Table No.1).

The BOD and COD values show a considerable reduction. TDS showed abrupt changes, it showed decreased levels in March, April and June but show decreased values in the monts of May and July.

Phosphates show increase in the value, whereas the values of nitrate contents initially showed increase in the level and then a steep decline.

There is a slight decrease in the chlorophyll content.

Makhmali Lake

The pH values increased considerably from 7.3 to 9. The Dissolved Oxygen level show a steep increase, whereas the BOD and COD values in the different segments of the lake shows a decrease.

TDS also shows a marked reduction. Phosphates showed a slight reduction but the nitrate level increased. The chlorophyll content showed an increased level as compared to the initial level.

Rewale Lake

The waters of Rewale lake showed an increase in pH level and Dissolved Oxygen level. The BOD and COD values showed a reduction.

TDS also decreased whereas phosphates, nitrates and chlorophyll levels increased.

Monitoring and control measures

The natural water resources are degrading very fast and disappearing due to excessive exploitation, increased anthropogenic activities causing siltation and nutrient enrichment by direct pollution from domestic and industrial wastes. All lakes in the city are facing this problem due the altered management practices. A proper management plan should be framed to combat the different environmental problems.

Table 1 - JAIL LAKE INITIAL SAMPLE

No. of samples	pH	DO	BOD	COD	TDS	Phosphate	Nitrate	Chlorophyll	Ammonical	Nitrogen	TKN
1	7.26	5.8	40	280	0.0423	0.869	150	232	261	0.37	0.94

MARCH

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
Top-1	8.3	7.4	8	29	160	0.894	1.573	174	221	287	0.128	1.639
Top-2	8.44	8	6	24	120	0.755	1.688	168	240	274	0.15	1.584
Top-3	8.34	9.8	8	29	170	0.824	1.721	182	234	280	0.134	1.614
Bottom-1	8.34	11.6	8	33	110	0.296	1.77	166	209	325	0.672	1.522
Bottom-2	8.41	7.4	10	36	140	0.313	1.704	154	190	310	0.544	1.481
Bottom-3	8.44	9.6	10	36	130	0.41	1.688	177	210	290	0.578	1.523

MAY

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
Top-1	7.97	6	144	125	0.059	1.7	132	156	192	0.461	1.501	
Top-2	7.79	5	8	52	450	0.297	0.21	132	165	211		
Top-3	7.89	5.4		52	150	0.212	1.72	141	165	195		
Bottom-1	7.62	4.6	12	76	300	0.44	0.87	130	116	158	0.983	1.842
Bottom-2	7.88	5.2		68	150	0.115	1.75	126	137	163		
Bottom-3	7.94	4.8		64	300	0.127	0.93	154	148	183		

JUNE

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
Top-1	8.15	6.8	2	35	150	0.119	0.786	133	154	190	0.483	1.317
Top-2	8.2	7.2	4	48	140	0.237	0.77	138	159	205		
Top-3	8.21	8.2	-	8	90	0.025	0.754	139	170	177		
Bottom-1	8.31	8.6	3	12	16	0.144	0.443	127	117	154	0.189	0.367
Bottom-2	8.19	9.2	2	12	14	-	0.246	126	119	161		
Bottom-3	8.28	7.2	1	-	10	0.483	0.852	137	150	192		

JULY

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
Top-1	7.45	2.8	-	32	220	0.364	0.475	127	150	184	0.453	1.414
Top-2	7.43	1.2	4	28	140	0.678	0.148	132	151	201		
Top-3	7.48	5.2	2	36	200	0.534	0.525	137	160	178		
Bottom-1	7.47	4.4	3	24	240	0.314	0.279	121	111	151	0.171	0.325
Bottom-2	7.41	7.2		36	300	0.585	0.18	125	115	159		
Bottom-3	7.44	4.8	1	52	240	0.407	0.098	136	150	187		

Table 2 - MAKHAMALI LAKE INITIAL SAMPLE

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
1	7.31	2.4	20	220	700	0.0254	1.739	329	219	271	0.18	0.131

MARCH

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
Top-1	7.71	3	30	68	240	0.517	0.67	106	116	152	1.18	2.08
Top-2	7.79	2.8	23	48	210	0.51	0.642	100	116	142	1.212	2.13
Top-3	8.04	2.6	60	128	150	0.432	0.65	89	125	158	1.308	2.04
Bottom-1	7.8	1.4	48	100	160	0.307	0.44	123	147	186	0.896	2.027
Bottom-2	7.81	2.6	63	136	160	0.355	0.42	148	150	212	1.258	2.17
Bottom-3	7.96	1.8	50	104	110	0.334	0.41	105	126	150	1.413	2.1

MAY

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	a	Chlorophyll b	c	Ammonical	Nitrogen	TKN
Top-1	9.41	12	22	48	440	0.39	197	149	183	1.268	1.121	
Top-2	9.51	15.8	80	1.43	0.34	269	194	260				
Top-3	9.48	16	108	120	0.26	0.39	200	197	234			
Bottom-1	9.51	14.8	28	120	0.059	2.16	189	146	180	0.161	0.228	
Bottom-2	9.53	12.2	18	36	280	0.52	1.96	180	151	204		
Bottom-3	9.55	14.2	60	420	0.25	0.57	197	163	215			

JUNE

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
Top-1	8.78	11	9	76	120	0.458	1.59	60	150	345	0.323	1.817
Top-2	9.02	12	9	48	40	1.364	1.508	110	740	245		
Top-3	8.94	10	8	56	300	0.593	1.311	165	###	555		
Bottom-1	8.17	7	7	104	160	0.542	1.426	195	245	29	0.511	2.875
Bottom-2	8.24	8	8	80	90	0.754	1.23	90	540	90		
Bottom-3	8.57	7	7	72	90	0.449	1.081	175	435	800		

JULY

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
Top-1	7.81	12.6	16	96	170	0.254	0.163	110	575		0.6	1.766
Top-2	9.55	18.2	16	84	150	0.05	1.967	165	950			
Top-3	9.68	14.6	22	110	190			110	655			
Bottom-1	9.22	16	18	124	140			485	520		0.239	1.799
Bottom-2	9.33	12.5	19	76	160	0.042		405	530	5		
Bottom-3	10.4	12.2	24	132	180		1.869	145	580			

Table 3 - REWALE LAKE INITIAL SAMPLE

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
1	7.23	nil	166	372	640	0.0338	0.174	204	232	226		

MARCH

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
Top-1	8.1	nil	40	112	610	0.653	0.57	142	218	202	0.199	2.375
Top-2	7.96	nil	34	84	630	0.582	0.54	148	232	197	0.218	2.218
Top-3	8.12	0.1	34	76	610	0.648	0.5	151	237	210	0.184	2.316
Bottom-1	7.4	nil	28	80	540	0.225	0.47	138	177	294	0.844	2.834
Bottom-2	7.35	nil	34	124	510	0.21	0.41	132	195	228	0.937	3.114
Bottom-3	7.44	nil	30	116	510	0.238	0.44	138	220	277	0.814	2841

MAY

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
Top-1	8.72	0.8	20	28	368	0.042	0.573	279	119	497	0.668	0.875
Top-2	8.52	1	-	22	208	-	0.118	225	218	287		
Top-3	8.78	1	-	36	262	-	0.049	196	219	314		
Bottom-1	8.61	-	27	32	350	1.23	0.098	218	181	225	0.641	0.657
Bottom-2	8.54	0.6		25	250	1.25	0.36	174	167	247		
Bottom-3	8.4	0.6		24	350	0.61	0.131	203	129	290		

JUNE

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
Top-1	9.98	18.4	16	16	247	-	0.852	210	689	348	1.908	3.631
Top-2	9.99	28.2	15	-	180	0.297	0.36	117	625	-130		
Top-3	10.03	29.6	18	-	290	-	0.525	244	760	440		
Bottom-1	9.65	19.2	18	-	100	0.466	0.656	387	723	160	0.68	1.779
Bottom-2	9.66	20.2	17	80	110	0.525	0.721	244	539	-120		
Bottom-3	9.68	22.6	17	-	130	0.245	0.787	342	505	35		

JULY

No. of samples	pH	DO	BOD	COD	TDS	Phosphate Nitrate	Chlorophyll a	Chlorophyll b	Chlorophyll c	Ammonical	Nitrogen	TKN
Top-1	7.35	9.6	24	68	220	1.017	0.245	190	490		1.18	2.488
Top-2	7.06	2.8	54	164	260		0.393	480	1020			
Top-3	7.49	3.6	38	116	330	0.72	0.213	240	605	20		
Bottom-1	7.71	4	24	68	370		0.396	155	545		2.042	4.121
Bottom-2	8.31	8.4	30	100	240	1.636	0.164	105	195	5		
Bottom-3	6.81	0.8	32	108	260		0.525	225	370			

Following control measures must be taken into consideration:

1) Suitable Bioremediation techniques or combination of different techniques suitable for a particular lake should be decided and verified.
2) Initial cleanup of the lakes like the removal of plastic bags, excessive weeds and other floatables etc., must be carried out before the Bioremediation Process is applied.
3) General awareness among the people residing nearby the lakes is important to check the further pollution of the lake.
4) Oxygenation and mixing of water columns is essential for BOD reduction and thereby to increase the DO level. This can be achieved by using mechanical aerators.
5) To remove the pollutants and excessive nutrients from the lake suitable micro organisms will be introduced for the dissolution of nutrients and organic matter by microbial action.
6) Some varieties of flora and fauna known for the removal of certain chemicals should be introduced.
7) Seasonal variations before and after the Bioremediation treatment of water must be monitored.
8) Different indices such as Biological diversity index, Nutrient pollution index, Organic pollution index, Industrial pollution index, Pesticide pollution index and pollution load index should be monitored continuously to check the success of the Bioremediation management plan.

9) To increase the biodiversity of the lakes it is important to control all the sources of pollution. After a proper scientific study different species of flora and fauna can be introduced.

Maintenance

Development of Lake Ecology is a complex time consuming process. The lake quality must be continuously monitored for a long period after the. Application of Bioremediation Techniques.

The lake surroundings should be maintained properly for the effective Bioremediation Process.. This can be achieved with the involvement of the local people.

A responsible person should be appointed to take care of the Water Bodies in all respects like the Maintenance of the aerators, efficiency, and also to prevent the people to dump garbage in the Lakes

The surroundings should be maintained neat and clean

Special 'Kumbh' for collecting the "Nirmalya" should be maintained.

Different awareness Programmes should be implemented to maintain the health of the lakes

The involvement of young generation should be incorporated to prevent the Pollution in the region

CASE STUDY & PUBLIC INTEREST LITIGATION IN PROTECTION OF URBAN WATER BODIES

Sadhana Mahashabde
Advocate on panel for MPCB

Pre British times, cities had an intricate system of harvesting rainwater. Numbers of tanks were built up for water collection. Overflow of upper region tank used to get collected into lower tanks. These tanks were protected and used by local inhabitants. Later, the system incorporated usage of pumps and pipelines from water bodies. The gradual dependence on pumped up river water lead to the neglect of traditional water system. This negligence led to the drying up and choking of streams of water bodies. Drying up of water bodies have thrown out of the gear the lives of fisher folk and washer folk dependent on them. Degradation of water bodies continued to hamper human environment and reached alarming situation around 1970s.

Statutory Provisions in Protection of Urban Water Bodies

Constitutional Provisions :

Constitution of India had initially no provisions for Environment Protection until with the inspiration from Stockholm Conference on Human Environment (1972). The Constitution was ammended in 1976. The article 48A was added as directive principle State policy and article 51A(g) was added as fundamental duties of every citizen to protect and improve natural environment. Article 21 states right to life (fundamental right). Right to drink water is stated as Right to Life in M.C. Mehta v/s Union of India AIR 1987 SC 965. Article 226 and article 32 of the Constitution says, 'where fundamental right is infringed, a party can approach either High court or Supreme Court respectively for relief through writs'.

The Water (Prevention and Control of Pollution) Act 1974.

The Act vests regulatory authority in Central Board and State Boards and empowers these boards to establish and enforce effluent standards for factories discharging pollutants into water bodies.

The Environment Protection Act 1986

The purpose of this Act is to implement the decisions of Stockholf Conference more effectively. This umbrella enactment renders more powers to the Central government. This Act has adopted a new stand to locus standii through which, any Indian citizen can complain (with 60 days prior notice) against environmental abuse. Provisions of this Act are applicable to government agencies, too.

Public Interst Litigation (PIL)

In last fifteen years, an outstanding development of great importance is seen in the

growth of PIL. Through PILs, an individual or a group can seek relief in the interest of the general public and not for the purposes of individual or group. PIL has enriched the law and modified the traditional doctrine of locus standii and lead to new remedies and procedures.

Ganga Pollution case is a good example of use of PIL

Normally, as per procedure, the petitioner would have to send notice to the polluters, individually and file replies through Court. But, in this PIL, the Supreme court allowed exceptions like issuing show cause public notice and replies to be sent to the Pollution control Board.

Ahmedabad Chandola Lake PIL

The Court, through an interim order directed the authorities to remove unauthorized constructions and not to permit any constructions within 500 meters of lake.

Hamid Khan v/s State of MP

PIL, alleging the State of M.P. for failure and neglect in providing safe drinking water to people of Mandla district. High Court directed the State to extend free medical treatment and compensation to the affected people.

TAPAS filed PIL for right to receive safe and adequate supply of drinking water. The High Court of Delhi issued orders to the Union ministry of Tourism and ASI to conserve the ponds.

The declarations of coastal stretches as Coastal Regulation Zone (CRZ) is protecting coastal lines by imposing restrictions on any interference in the CRZ area vide the CRZ notifications. Indian Council for Enviro-Legal Action v/s Union of India 1996 5SCC 281, and Bittu Sehgal case led to the amendment of CRZ notification.

Delay in Jurisdiction

In many PILs, despite the passage of several years, petitions have not been heard beyond preliminary arguments.

Overlapping of jurisdiction of land-owning agencies also raised serious problems in implementation process, a lot of precious time is being lost while the Central government authority and Municipal authority, and all these bodies deny responsibilities and try to push the blame on to each other.

PIL to protect urban water bodies of Delhi, filed by NGO TAPAS faced similar such problems.

NGOs working in Powai Vihar Lake area also faced similar problems.

Norms for Environmental Protection

Public Trust Doctrine

As per this doctrine, the state is the trustee of all natural resources which are by nature, meant for public use and enjoyment. Public at large, is the beneficiary of the sea

shores, running waters, air, forests, and ecologically fragile lands. These resources, cannot be converted into private ownership.

Based on this doctrine, the prayers of "Span Motel Case on banks of river Beas. (M.C Mehta V/s Kamal Nath 1997 SCC 388)" , were granted by the Court.

Under the Public Trust Doctrine, there are three types of restrictions on government, namely,

1. Natural resources should be used for public purpose only, and should be available for public.
2. These resources may not be sold even for a fair cash equivalent.
3. Property must be maintained for particular type of usage.

In MonoLake case, one of the important streams of the lake was diverted for water supply to Los Angeles. Based on this principle, the Court ordered against it, for protecting the Lake.

Polluter Pays Principle

Based on this principle, court can direct the polluter to pay damages, not only for restoration of ecological balance but also to pay damages to the victims.

The court ordered the respondents to do so, in Span Motel case.

In Calcutta Tanneries case (M.C Mehta v/s Union of India 1997 2SCC 411), the court ordered tanneries to pay since the tanneries were discharging untreated noxious and poisonous effluents into Ganga river.

Precautionary Principle

This is basically duty to foresee and assess the environmental risks and to warn the potential victims of such risks and to behave in ways that prevent or mitigate such risks. This principle is traced in protecting Hussain Sagar lake in Hyderabad (A. P. Pollution Control Board v/s Prof. M.V. Nayudu AIR 1999 SC 812)

Environmental Impact Assessment (EIA)

EIA is the study of direct and indirect impact of the project. The logic of such an assessment dictates that before a project is undertaken its economic benefits must substantially exceed its environmental costs.

Non Governmental Organisations (NGO)

NGO's active participation ensures that the people who are likely to be most directly affected by environmental hazard will have major role in monitoring and implementing pollution control policy and conservation policy.

Sustainable Development

Sustainable Development is defined as using living resources in a manner that does

not exceed their natural capacity for regeneration and using natural resources in proper manner.

Coca Cola case revealed that excess water was drawn beyond the underground water table capacity leading to fatal damage to the water bodies in the nearby vicinity.

Intergenerational Equity

This principle proponent that present generation has a moral obligation to manage the water bodies in a manner that will not jeopardize the aesthetic and economic welfare of the generations that follow.

Wholistic Approach

Though the court orders are issued to protect and preserve the environment, public participation, awareness of town planners are the key factors in actually achieving the goal of preservation and revival of water bodies.

In Chandola Lake Ahmedabad case, In spite of the High Court orders, the implementation was not done for want of support from the local public. The residents of Ahmedabad did not come forward to support the campaign to save the lakes; neither did any NGO take the initiative. The public openly expressed resentment against the order. This case exposes the lack of technical insight of town planners who laid out the expansion plans of the city with scant regards to the natural drainage patterns and topography of the area, thus effectively destroying the lakes.

Thoughtful approach should be taken in proper use of water bodies near parks and grounds for sprinkling water in grounds and watering parks/lawns. Wells near Shivaji parks are neglected and local political leaders sought Municipal water connections with great credibility and prodigality for sprinkling water in grounds.

Priority to water supply for urban areas

Water from nearby water bodies is diverted for want of water supply to urban areas.

Water from Surya and Vaitarna rivers is diverted for water supply of Mumbai and New Mumbai and relevant rural areas are deprived from their right of irrigation needs. Whereas this portable water is available at a meager cost of 3 rupees per thousand liters and this water is misused and wasted on large scale.

Suggestions and recommendations

1. Formation of Lake Management Authority to protect, preserve and revive the water bodies.
2. BMC regulations have been issued to provide for rain water harvesting system. BMC should lay down detailed specifications for rain water harvesting system.
3. There should be specific regulations for drawing water from water bodies. Drawing water beyond under ground water table capacity should be restricted.
4. Government agencies, organisations, citizens, groups and NGO should collectively work to achieve common goal of protecting, preserving and reviving water bodies.

NGO'S AND ENVIRONMENTAL ISSUES IN RELATION TO PROTECTION AND CONSERVATION

Sanjay Joshi
Dept. of Biology,
B. N. Bandodkar College of Science, Thane.

Secretary, Enviro-vigil
(Paryavaran Dakshata Manch) Thane.

Introduction

Since the time immemorial, the human beings are highly dependent upon the nature for it's various resources. In fact, the very survival of the human species is wholly dependent upon these natural resources. The ancient civilizations bore obligations and gave utmost respect to Mother Nature.

Thus there was a perfect coordination between human activities and various natural phenomena. Both were living happily. As human civilization started becoming more industrially oriented, the things began to change. The industries were developed to provide better living conditions to mankind. However, during this development, natural phenomena were overlooked and were not given any significance. This human attitude started working like a slow poison. Mother Nature could not bear such inhumane assault on herself and started to give bad fruits to the wrong deeds of man. Such abuse of the natural resources has resulted in the major environmental issues that are posing direct threat to the survival of man and other natural elements within the biosphere. However, certain people were unable to tolerate such an attack on Mother Nature and began to think more logically and objectively to provide concrete solutions to various environmental issues. Development for the betterment of mankind was and is essential but not at the cost of the nature. Thus groups of the 'friends of environment' started emerging gradually as the people committed for betterment of environment started to come together for this special cause to save the environment from being abused by their own species. These individuals soon realized that to prevent abuse of the environment, a concerted effort is essential; it is not a task of a single person. This then resulted in the formation of the NGOs or Non-Governmental Organizations all around the world gradually.

Working in harmony : NGOs in Thane city

Thane city has been bestowed with the beauty of Mother Nature. Surrounded by enchanting scenic hills of Yeoor forest along the western region, beautiful Parsik hills on the eastern region and a vast expanse of the famous Thane Creek that joins the Arabian Sea. Apart from these, Thane city had several beautiful fresh water lakes. Unfortunately, many of these have literally vanished or are on the verge of being vanished. Thanks to the

human species again. However, NGOs working for the environmental cause in Thane took up this challenge of protecting the lakes and other deteriorating environmental elements. These NGOs are really doing a wonderful job within their own limits and capacity to save nature and environment from being abused. These NGOs are involved in creating awareness among the masses regarding different environmental issues. Following is a brief account of the work of NGOs working in the field of environment in Thane city.

Afforestation:

Trees are an important component of ecosystems. The lush green forests are said to be the 'lungs' of human population, especially in the urban areas. One of the inhumane assault on nature by man is cutting down the trees and the forests all over the world. This has resulted in a severe environmental crisis. NGOs like Hariyali, HOPE (Hear On Project Environment), *'Vrikshavalli'* etc. are doing a very good job in massive tree plantation. This is being done with public participation at select areas, which have been barren for past several years. Hariyali has planted several thousand trees in different places. *Vrikshavalli* has implemented a novel idea of 'Seed First' through their *'Aadhi Beej Ekle'* campaign. Jidnyasa trust is also doing lot of plantation with the help of their strong force of volunteers from various schools. These NGOs are planning to bring the lost greenery back to the city. Enviro-Vigil has started managing vast expanse of *Gavalidev* Forest located behind NOCIL along Thane- Belapur Road.

Water Conservation

Water is the most important and precious natural resource. Its proper management and conservation have become the most important activities on the agenda of the NGOs. The rain water harvesting programme has been successfully implemented by Enviro-Vigil (Paryavaran Dakshata Manch) in Vasant Vihar and Lokpuram residential complexes prior to the last year's (i.e. 2003) monsoon. This year, Thane Municipal Corporation has given a major contract to Enviro-Vigil for rain water harvesting in Thane city. Hariyali has successfully implemented the construction of bunds in the Yevoor Hills to store rain water. Jidnyasa is actively involved in creating public awareness regarding the hazardous effects of *Ganesh* idol immersion on the flora and fauna of lake waters in the city. Enviro-Vigil has conducted a research project on this aspect. Enviro-Vigil is also in the process of adopting technology for waste water recycling.

Solid waste Management:

As of today, Enviro-Vigil is pioneer in the field of solid waste management. Municipal solid waste is hazardous to the health and hygiene of the people at large. Its unscientific and careless handling has resulted in severe environmental pollution. Enviro-Vigil undertook the challenge of managing the city's solid waste in the year 1998. So far, the response form the people in general has been fair. But the idea of managing the solid waste is slowly spreading through the society due to massive public awareness campaigns being launched by Enviro-Vigil. Enviro-Vigil has also set up a '**Common Bio-Medical Waste Treatment Facility'** for Thane Municipal Corporation. This facility is located in the premises of Chhatrapati Shivaji Maharaj Hospital, Thane-Belapur Road, Kalwa, Thane. This facility takes care of hospital waste from all types of city hospitals, clinics and also of the hospitals

form Mira-Bhayander, Vasai, Virar, Nala Sopara etc. This has become the most ideal system and a 'role model' as it is the first of its kind run by NGO, not only in Maharashtra, but also in India. Hariyali, and other NGOs like *Vrikshavalli* are also providing their input in solid waste management.

Nature Literacy and Awareness Programmes

Schools, colleges and such educational institutions contribute little to the environment literacy. They have their own limitations as imposed by curricula. NGOs can do a wonderful job in this regard. Enviro-vigil has started a school entitled 'Paryavaran Shala' (School of Environment) in Thane city since last year. This school is open to the students from 7th, 8th and 9th classes. In this school, informal education about nature and its various elements is given. Experts in various fields of nature and environment are the resource persons. Hariyali and Jidnyasa are also involved in nature literacy programmes. Jidnyasa is providing Para Military training to the students from 6th to 10th classes. Through this programme, students are introduced to various nature adventures. Enviro-Vigil organizes a *'Nisarga Mela'* on the 2nd October every year as a part of World Wildlife Week Celebration. Hundreds of students from various schools participate in daylong activities. HOPE arranges nature and wildlife film and slide shows on a regular basis by inviting eminent naturalists and environmentalists. HOPE and Hariyali have jointly set up a 'Nature Park called *'Ritu-Chakra'* (Cycle of the Seasons) near Kalwa bridge along the bank of Thane creek. This was once a dumping ground for dumping of the city waste. It also has a nature education center.

Organizing Seminars, Workshops, etc

Open discussions and interactions with the counterparts form around the nation is an essential part of the environmental NGOs. Jidnyasa and Hariyali organize seminars on various environmental issues form time to time. Enviro-Vigil had organized seminars on "Green Careers" to provide information and resources regarding the career opportunities available in the field of nature and environment. This concept is receiving a wide recognition and Enviro-Vigil is planning to start a series of seminars based on this theme throughout the state of Maharashtra.

From this account, the state of the environmental activities conducted by NGOs in Thane city becomes clear. The NGOs certainly act as connecting link between the Civic administration, the Local Self Government and the general public. NGOs thrive on a solid, strong support provided by their strong force of workers. These are the people who are oblivious to a certain position in the organization, who are working with a strong dedication, motivation and commitment for the environmental cause. Knowing that this is a 'thankless job', these people devote their time and most of the time, money also in working for preservation of nature.

Please Note: This is not a scientific paper. The information given is based upon actual work experience of the authors. Hence no references are cited.

Proc. Pollution of Water Bodies in Urban Areas- August. 2004

AN ACTION PROGRAMME FOR MITIGATING ENVIRONMENTAL IMPACT OF URBANISATION (SUCH AS POLLUTION) ON WATERBODIES OF THANE

Sanjay V. Deshmukh
Ecologist
B-50, Shrirang Society, Thane 400601.
Tel. & Fax: 022 25331045; E-mail: docsvd@yahoo.com

***Keywords**: mitigating urbanisation, urban pollution*

Introduction

By maintaining health and enhancing the quality of life by the availability of ample supplies of safe drinking water and by the provision of sufficient water to satisfy the legitimate requirements of agriculture and industry, water has an essential role to play in all cultures. Unfortunately, use of water for domestic purposes, by agriculture and in industry can have major impacts on the water environment, which can result in serious problems at regional, national or international levels. These problems, though relate to pollution primarily, are also derived from (a) the consequences of urban drainage and flood alleviation activities and (b) the depletion of water resources outside the urban areas.

Water Security in 21st Century

The issues of water are becoming increasingly important to the environment, particularly human health, and food security. Since, water is becoming more scarce, and more difficult to access, less water is available for maintaining ecosystems. Moreover, there is an urgent need to ensure that potential crisis is confronted on all fronts - from research to policy to action, because the conflict over shared water resources is growing.

For this reason, the World Water Council convened in late 90's, a World Commission on Water for the 21st century. The Commission is co-sponsored by FAO, UNDP, UNEP, UNESCO, UNICEF, WHO, WMO, and the World Bank. Assisted by its Secretariat in Paris, the Commission has developing a long-term vision on Water, Life and the Environment in the 21st century. Its objectives are to develop knowledge on what is happening in the water sector regionally and globally, produce a consensus on a World Water Vision for the year 2025, raise awareness of water issues among policy makers and general population, and utilise the knowledge and support generated to contribute to a framework for action.

Impact of Urbanisation

The continuing shift in population from rural to urban areas coupled with the overall growth in the populations of Indian cities is placing enormous pressures on the water environment of many cities. Serious shortages of water are made worse by the degradation of environmental quality resulting from urban development. Many areas in cities lack sewerage and sanitation systems entirely. Whereas, some of the cities consistently have

problems with repair and maintenance of sewerage systems. Peoples' health suffers and women as household managers and water managers in particular, are badly affected. Where sanitation does exist, disposal of seepage and latrine contents is frequently unsatisfactory.

Thane has emerged as one of the most thickly populated cities in the Country, thanks to its proximity to the Island City of Mumbai, which, with its population density of over 30,000 persons per sq. km, is on the verge of population explosion. Once considered as one of the biggest industrial estates of Asia, Thane has been subjected to all that which comes with it. Yes, the pollution of water, air and soil has become a major problem of the City of Thane, which is contributing to irreversible damage to its environment.

Mitigating Urbanisation: An Integrated Approach

The problem of Thane is thus that of other cities facing increasing difficulties in meeting overall development goals, which are to ensure that people live healthy and productive lives and that the natural environment is protected and enhanced where feasible. To overcome the problems of Thane, one needs to understand linkages between water, urban development and the environment of Thane, and develop a Consortium of Academic as also Scientific Institutions (both – government and non-government), Experts drawn from various disciplines who would work for mitigating the environmental impact of urbanisation on waterbodies of Thane.

Objectives of the Consortium

The general objectives of the integrated coordinated effort for mitigating/ preventing stresses (of pollution) on the waterbodies of cities such as Thane are:

- to develop a sustainable framework to address the growing water crisis and
- to protect the continent's water resources and aquatic environment from the increasing volume of pollution from cities.

If one looks at the linkages between freshwater systems and estuarial and coastal waters of Thane, the above effort may need attention in specific circumstances. Hence the specific objectives of the effort could be to: *mitigate the environmental impact of urbanization (such as pollution) on waterbodies (freshwater and coastal and inland aquatic systems), through an integrated approach to managing urban water resources, taking cognizance of the links between water, urban development and the environment.*

Principles Underlying the Strategy

The fundamental principles, which are envisaged in the proposed strategy (these are subject to change) include:

- Holistic and integrated approach
- Realistic and attainable objectives in both short and long-term time scales
- Participatory approach to decision making and implementation
- Social and gender equity

- The polluter pays principle
- Sequential development and
- Sustainability of the effort.

Strategy Development Considerations : Problem Identification

It is believed that "To be effective, a mitigation strategy must be based on a sound understanding of the problem". This requires data collection based on precision sampling and analysis to enable :

- Identification of current and future uses of water sources and their related quality objectives
- Identification of the causes and consequences of pollution of waterbodies, as also water depletion
- Identification of the critical pollutants – physical, chemical and/or biological; conservative and/or non-conservative; point sources and/or non-point sources
- Identification of problems associated with inadequate urban drainage and
- Identification of water sources at risk: surface or ground, within the urban area or outside

Factors Influencing Mitigation Strategy

In the context of city such as Thane, there are some special circumstances, which may influence the formulation and implementation of a mitigation strategy. They are provided below:

- Due to land contamination in high-density housing areas without effective drainage, sanitation and urban agricultural activities, considerable amounts of pollution enter the aquatic environment from non-point sources.
- Domestic animals contribute significant faecal pollution in high-density residential areas.
- Soil erosion from open lands, barren hills, footpaths and roadways contribute large volumes of inert suspended solids.
- The increasing number as also generally poor state of maintenance of motor vehicles contributes to oil leakage and heavy exhaust emissions, which cause both, contamination of waterbodies, and that of ground water sources.
- Surface water sewers though provided, are often of insufficient capacity to meet current demands. Moreover, open manholes and damaged gully covers in some areas permit the entry of solids from roads and paths together with rubble dumped by the public. This lack of capacity and maintenance results in frequent blockages, which cause flooding of property, public areas and rivers with sewage.
- Due to ever-increasing population, the solid waste collection services are inadequate, which can frequently lead to the deposition of household and industrial refuse in drainage channels and open sewers with consequent blockage problems and release of pollutants into the water cycle. Also, high ambient temperatures amplify pollution effects.

I believe that some of the above-mentioned problems are due to a lack of public concern and/or awareness. Solutions to such problem often depend upon stakeholder participation in any remedial work. Lack of financial and human resources often constrain remedial work, the need for which is well recognised by the concerned authorities.

Mitigating Actions

There are no universal solutions to the problems of pollution of urban waterbodies. However, mitigation and decisions need to be arrived at after careful consideration of the characteristics of a specific location. In such cases, a number of generic actions, which may be appropriate on their own or in combination with others, can be derived at. Some of the technological actions are provided below:

- Take measures to minimise generation of waste and its discharge to (the) aquatic environment. This cold be achieved by reducing the consumptive use of water and goods.
- Reduce pollution effects by lowering water consumption. But this may have undesirable consequences of causing blockages in sewers or reduced flow in urban watercourses.
- Depending on local conditions as well as public needs, ensure effective on-site sanitation.
- Provide effective surface water drainage and flood alleviation systems
- Establish conventional wastewater treatment systems
- Ensure effective solid waste collection, and establish system for its recycling and disposal.
- Develop bioremedial (aquaculture and/or nutrient removal) technology using plants through establishment of ponds. This would prove to be a potential source for beneficial use and income generation.
- Provide as far as possible localised solutions to the problems.

In all of the above options it is important to utilise the concept of sequential improvement so that the end-users, particularly the urban poor, perceive a genuine benefit. Local stakeholders, including women should play an active role in the selection of mitigation options and the establishment of the institutional framework.

Monitoring and Evaluation

The various activities, which are to provide the demonstration aspects of the actual work to be carried out by the Consortium, will have a short-term role and will also serve as starting points for the wider implementation of the results of the effort. Project-specific indicators need to be based on their suitability for wider applicability across the region and should be used throughout the implementation. It is thus vital that progress in these initial demonstration activities is assessed against objectives and milestones agreed at their commencement.

Fundamental points for the development of a mitigation strategy would include :

- Define the problem - identification of point and non-point sources and their flows and compositions, determination of deficiencies in sewerage and drainage systems
- Identify the water resources (surfacewaters and groundwaters) at risk, with their current and potential uses
- Identify administrative, institutional, legislative and resource constraints, which need attention before the strategy can be operated.
- Identify Donor/s for supporting this activity. Also, determine the potential for collaboration between all interested organisations to aid implementation of the strategy
- Stage the implementation of the strategy within a realistic and attainable framework for both short-term and long-term impacts
- Consult with appropriate government authorities, on the establishment of organisations for the integrated management of waterbodies. This would ensure long-term success in the efforts of management of water resources of the City of Thane.

Urban areas are pollution prone and make considerable demands on the water environment of the region. But they also have responsibilities to protect the environment for the benefit of everyone. Any strategy for mitigating environmental impact on waterbodies of urban areas must take into consideration these wider environmental responsibilities.

Opportunities ahead

The Seminar on "Pollution of waterbodies in Cities" proposes to bring out clearly, various factors that contribute to polluting our lakes, sources of fresh water as well as estuaries. It is also learnt that various Government as well as Private agencies would present their work related to providing answers to the problems of pollution. Particularly use of technologies such as bioindication and bioremediation in minimising/ and preventing (wherever possible) pollution would be discussed at large.

The Seminar would supposedly be addressing three principal questions :

- What are the possibilities of developing early warning systems for identifying pollution of waterbodies?
- What is the potential of biotechnology in treatment of wastewater, specifically, in biodegrading or separating heavy metals and other toxins, and in purification? Whether any such technology is currently in practice?
- What are the possibilities for various organisations as well as individuals to changing the approach of policy makers and develop a political will to prevent pollution of waterbodies?

The panel discussions based on presentations would reflect the collective judgement of the participants that would set tone for recommendations of the Seminar on:

- The likely impact of pollution on waterbodies, particularly water demand and supply, and over what period of time

- The enabling policy framework (public/ private, incentives, IPR etc.) that could affect the development and/ or adoption of new technologies in mitigating the pollution impact
- The extent and kind of additional research that may be needed for pollution prevention and
- The desired combination of public and private sponsorship/ participants in such research.

I am sure the recommendations of the participants of this Seminar will be of utmost importance in developing a research agenda for addressing the issue of mitigating/ preventing pollution of waterbodies in Thane, thereby ensuring water security in the years to come.

Proc. Pollution of Water Bodies in Urban Areas- August. 2004

LAB-SCALE STUDIES ON BIOREMEDIATION OF WASTEWATER FROM CALICUT CORPORATION, KERALA

Shiny K.J.
Centre for Water Resources Development and Management, Kunnamamgalam, Calicut, Kerala
Present address: Lecturer in Zoology, R.J. College, Ghatkopar, Mumbai
e-mail: shinykj@rediffmail.com

ABSTRACT : In the absence of an integrated sewerage system, wastewater from Calicut Corporation is being indiscriminately discharged without any treatment into the Canoly canal, nearby wetlands and the Arabian Sea. Groundwater sources in and around Calicut city are being polluted due to this. Proposals for improving the wastewater disposal and treatment systems are under consideration by the Corporation.

In recent times, there has been considerable interest in using eco-friendly methods for wastewater treatment. In this context, lab-scale studies were conducted to evaluate the potential of some locally available macrophytes, which are considered as weeds to remediate urban wastewater. The results indicate that they could be used as a low-cost, sustainable and environmentally safe method for the treatment of wastewater. In addition to the nutrients, nitrate and phosphate, some species were found to be very efficient in the reduction of BOD, COD as well as removal of coliforms and total suspended solids.

***Key words** : Calicut Corporation, wastewater, macrophytes, bioremediation, water quality*

Introduction

As a clean environment is a pre-requisite to good health, proper collection, treatment and safe disposal of sewage warrant prime attention of administrators. Calicut Corporation with an area of about 84 sq.km and a population of nearly 4,20,600 is the second priority city after Trivandrum and Kochi for urban development in Kerala. The drains of the city receive domestic waste, hospital and hotel wastes as well as storm runoff. In the absence of an integrated sewerage system, wastewater from Calicut Corporation is discharged into the Canoly canal, wetlands and the Arabian Sea. The wetland ecosystem interlinked with the city is facing problems due to this. Groundwater sources in the area are also being contaminated both chemically and bacteriologically. Since eighty percent of the households in Kerala depend on open wells as their source of potable water, this poses a problem.

The Calicut Corporation is considering proposals for improving wastewater disposal and treatment systems. Integrated sewerage systems are being planned. Conventional wastewater treatment technologies make use of chemicals to improve the water quality. However these have several after effects. In civil engineering, algae and higher plants are considered as nuisance organisms to be eliminated physically and chemically from the treatment process. Many new developments have occurred due to revived interest in the eco-friendly methods for wastewater treatment. Bioremediation is an emerging technology in this area. The present day bioremediation technologies are based on the potentials of almost all types of life forms, *viz*., plants (phytoremediation), microorganisms (microbial

remediation) and animals (zooremediation).

Sheffield (1967) and Cornwell *et al* (1977) were the pioneers to demonstrate the nutrient removal potential of aquatic plants. In the early 1960s NASA began actively researching into phytoremediation for wastewater treatment. Floating higher aquatic plants are used in wastewater treatment (Reddy and Smith, 1987). The use of emergent marsh plants and engineered marsh-based systems for the treatment of wastewater has gained prominence over the last few decades (Reed *et al*., 1995).

Employing plant diversity requires less energy, aeration and chemical management than conventional methods. The extensive root network, or rhizosphere provides the structure and nutrient support for diverse microbial communities. As these technologies are quite safe on ecological and health aspects due to least application of chemical compounds, these are projected as the ecotechnologies for the present century.

In this perspective, lab scale studies were conducted to evaluate the potential of a few locally available macrophytes to remediate wastewater from Calicut Corporation. Most of these are considered as weeds and hamper the various uses of water resources in the locality.

Material and Methods

The aquatic flora selected as test species for experiments in this study include the two ferns *Azolla rubra* R.Br. and *Salvinia molesta* Mitchell, the three duckweeds - *Lemna perpusilla* Torrey, *Spirodela polyrrhiza* (L.) Schleid and *Wolffia globosa* (Roxb.) Hartog and Plas. as well as *Pistia stratiotes* L. The plants were collected from the local water bodies and acclimatized in laboratory conditions. They were identified as per Gupta (1979). Integrated wastewater samples from Calicut Corporation were collected and used for the study.

Aliquots of wastewater were in five different concentrations (50,100,150,200 and 250 ml wastewater/l) were used for the treatment studies.

Macrophytes Mm Macrophytes were introduced for a treatment period of seven days (in triplicate). Controls were maintained for each set without plants to determine whether the treatment effects due to presence of the plants were significant. The plants were blotted and weighed before introducing them into the experimental troughs with two litres of experimental wastewater. 5 gm/l of *Pistia* and *Salvinia* was taken while 2 gm/l of *Azolla, Lemna* and *Spirodela* (due to rapid doubling time) were used for the experiments.

Physicochemical and bacteriological parameters of experimental and control sets were analysed at pre and post experimental stages as per APHA.

The parameters analysed include pH, electrical conductivity, TSS, DO, BOD, COD, hardness, NO3-N, PO4-P, SO4, Ca, Mg, total coliforms, fecal coliforms and *E.coli*.

The data was analysed for all parameters for significance between dilutions, stages of experiments and presence or absence of test species using Analysis of Variance (SPSS software).

Results and Discussion

In this study the role of six aquatic plants in improving the quality of wastewater was evaluated under laboratory conditions. All the plants showed natural ability to uptake nutrients (NO3 and PO4), reduce BOD, COD, TSS and coliform count. Some plants showed excellent

performance with respect to selected parameters. Tables 1-6 show the results obtained using the macrophytes for wastewater treatment. Table 7 represents the values and figure 1 depicts the graphs for maximum percentage reductions for various water quality parameters.

Table 1 - Experimental Sets Treated with *Salvinia molesta* Mitchell

Parameters	50 ml Wastewater/l			100 ml Wastewater/l			150 ml Wastewater/l			200 ml Wastewater/l			250 ml Wastewater/l		
		After			After			After			After			After	
	Before	E	C	Before	E	C	Before	E	C	Before	E	C	Before	E	C
EC	126.3	105.4	126.1	163.2	142.3	160.8	235.6	217.2	236.1	309.1	295.3	308.4	359	345.4	360.3
TSS	30.3	29.17	29.7	45.6	35.7	42.3	57.4	41.79	56	76.45	46.79	75.4	98.3	56.52	97.1
DO	2.81	4	2.92	1.2	3.2	3.4	0	1.98	0.24	0	1.68	0.16	0	0.53	0.1
BOD	13.1	6.1	12.6	19.3	7.87	17.9	24.6	9.22	23.8	32.2	10.37	30.2	40.3	17.4	39.6
COD	33.5	29.45	31.8	55.14	45.38	52.6	79.35	62.84	75.8	100.6	75.95	98.3	118.5	87.22	115.7
NO_3-N	1.06	0.58	1.01	2.41	1.21	2.32	4.87	2.32	4.8	6.37	2.78	5.93	8.12	3.06	8
PO_4-P	0.8	0.51	0.65	2.2	1.91	2	4.8	2.53	4.47	5.9	2.81	4.9	7.2	3.64	6.9
T.C	15 x10^5	23x10^4	14x10^5	24 x10^5	57x10^4	23x10^5	64 x10^5	23x10^5	59x10^5	93 x10^5	36x10^5	91x10^5	19 x10^6	80x10^5	18x10^6
E.Coli	+ ve	-ve	+ ve	+ ve	-ve	+ ve	+ ve	-ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve

Table 2 - Experimental Sets Treated with Azolla rubra R. Br.

Parameters	50 ml Wastewater/l			100 ml Wastewater/l			150 ml Wastewater/l			200 ml Wastewater/l			250 ml Wastewater/l		
		After			After			After			After			After	
	Before	E	C	Before	E	C	Before	E	C	Before	E	C	Before	E	C
EC	126.3	104.4	126.1	163.2	144.2	160.8	235.6	219.5	236.1	309.1	300.5	308.4	359	347.1	360.3
TSS	30.3	23.6	29	45.6	34.11	42.3	57.4	40.29	56.2	76.45	51.68	75.3	98.3	62.62	97
DO	2.81	4.3	2.92	1.2	3.85	3.4	0	1.81	0.24	0	1.53	0.16	0	1.2	0.1
BOD	13.1	5.89	12	19.3	7.91	18	24.6	8.86	22.4	32.2	12.24	30.6	40.3	16.8	38.4
COD	33.5	32.54	30.2	55.14	52.16	52.6	79.35	73.32	74	100.6	92.35	96.4	118.5	106.9	115.4
NO_3-N	1.06	0.74	1	2.41	1.54	2.35	4.87	3.05	4.82	6.37	3.82	6	8.12	4.85	7.9
PO_4-P	0.8	0.58	0.73	2.2	2.11	2.13	4.8	2.95	4.6	5.9	3.46	5.78	7.2	3.72	6.8
SO_4	2	1.05	1.9	3.4	1.68	3.5	5.8	2.71	5.6	6.2	3.4	6.3	9.6	5.51	9.5
T.C	15 x10^5	77 x10^4	14 x10^5	24 x10^5	13 x10^5	23 x10^5	64 x10^5	39 x10^5	63 x10^5	93 x10^5	62 x10^5	91 x10^5	19 x10^6	13 x10^6	18 x10^6
E.Coli	+ ve	-ve	+ ve	+ ve	-ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve

Table 3 Experimental Sets Treated with *Pistia stratoites* L.

Parameters	50 ml Wastewater/l			100 ml Wastewater/l			150 ml Wastewater/l			200 ml Wastewater/l			250 ml Wastewater/l		
	Before	After			After			After		Before	After			After	
		E	C	Before	E	C	Before	E	C		E	C	Before	E	C
EC	126.3	106.81	126.1	163.2	145.7	163.6	235.6	214.8	236.1	309.1	292.4	308.4	359	340.4	360.3
TSS	30.3	21.36	29.7	45.6	24.9	44.6	57.4	29.21	56.9	76.45	32.41	75.91	98.3	33.04	97.81
DO	2.8	4.6	2.9	1.2	3.3	1.05	0	2	0	0	1.96	0.1	0	0.84	0.1
BOD	13.1	4.98	12.6	19.3	6.95	17.9	24.6	6.89	23.8	32.2	8.05	30.2	40.3	12.09	39.6
COD	33.5	23.85	30.2	55.14	37.66	53.4	79.35	50.31	74.6	100.6	6.16	95.3	118.5	68.73	114.8
NO_3-N	1.06	0.42	1	2.41	0.84	2.35	4.87	1.47	4.82	6.37	1.45	6	8.12	2.23	7.9
PO_4-P	0.8	0.48	0.72	2.2	1.26	2.1	4.8	2.48	3.92	5.9	2.63	4.8	7.2	3.48	6.8
SO4	2	0.95	1.9	3.4	1.21	3.5	5.8	2.19	5.6	6.2	2.8	6.3	9.6	5.51	9.5
T.C	15 x10^5	11 x10^3	14 x10^5	24 x10^5	7 x10^3	23 x10^5	64 x10^3	43 x10^5	59 x10^3	93 x10^5	75 x10^5	91 x10^4	19 x10^5	20 x10^5	18 x10^6
E.Coli	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve

Total Suspended Solids removal was greatest in *Pistia* (66.4%), followed by *Lemna* (62%), *Salvinia* (42.5 %), *Azolla* (36.3%), *Spirodela* (32.6%) and *Wolffia* (20.3%). BOD reductions were maximum in *Lemna* (82.6 %), followed by Pistia (75%), *Salvinia* (67.8%), *Azolla* (64%), *Spirodela* (46.1%) and *Wolffia* (10.2%). COD reductions by macrophytes was in the order of 46% in *Lemna*, 42% in *Pistia*, 26.4% in *Salvinia*, 10.6% in *Spirodela*, 9.8 % in *Azolla* and 5.2 % in *Wolffia*.

Table 4 - Experimental Sets Treated with *Lemna perpusilla* Torrey

Parameters	50 ml Wastewater/l			100 ml Wastewater/l			150 ml Wastewater/l			200 ml Wastewater/l			250 ml Wastewater/l		
	Before	After		Before	After		Before	After		Before	After		Before	After	
		E	C		E	C		E	C		E	C		E	C
EC	98.1	94.6	97.4	107.3	105.3	103.4	129.5	124.6	127.8	150.6	143.5	148.7	197.2	182.6	193.4
TSS	29.6	11.22	29.1	40.2	17.93	39.5	52.3	26	51.7	73.4	42.13	72.7	84.6	49.1	83.9
DO	3.6	5.2	3.73	2.4	4.3	2.52	1.12	2.8	1.25	0	1.6	0.2	0	1.2	0
BOD	10.3	4.5	9.68	16.4	5.28	15.8	21.9	5.98	21.3	31.6	6.51	31.01	42.3	7.36	41.6
COD	25.75	16.87	24.1	39.04	23.74	37.18	50.93	29.23	49.29	79	42.66	77.38	88.12	52.87	86.48
NO_3-N	0.96	0.33	0.81	1.32	0.41	1.17	2.74	0.71	2.57	3.92	0.81	3.78	4.56	0.85	4.41
PO_4-P	0.37	0.23	0.36	1.06	0.61	1.02	1.84	0.91	1.79	2.1	0.9	1.97	2.4	0.74	2.23
SO_4	0.8	0.42	0.79	2.52	1.05	2.5	4.8	1.79	4.76	5.9	2.58	5.83	7.2	3.58	7.08
T.C	20 $x10^5$	11$x10^4$	19$x10^5$	28 $x10^5$	42$x10^4$	26$x10^5$	39 $x10^5$	12$x10^5$	38$x10^5$	43 $x10^5$	16$x10^5$	41$x10^5$	64 $x10^5$	30$x10^5$	63$x10^5$
E.Coli	+ ve	-ve	+ ve	+ ve	- ve	+ ve	+ ve	- ve	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	+ ve

Table 5 - Experimental Sets Treated with *Spirodela polyrrhiza* (L.) Schleid

Parameters	50 ml Wastewater/l			100 ml Wastewater/l			150 ml Wastewater/l			200 ml Wastewater/l			250 ml Wastewater/l		
	Before		After	Before	After		Before	After		Before	After		Before	After	
		E	C		E	C		E	C		E	C		E	C
EC	98.1	95.2	97.4	107.3	104.6	103.4	129.5	128.4	127.8	150.6	143.2	148.7	197.2	187.6	193.4
TSS	29.6	23.56	29.1	40.2	29.55	39.5	52.3	37.55	51.7	73.4	51.1	72.7	84.6	57.02	83.9
DO	3.6	5.61	3.73	2.4	4.75	2.52	1.12	3	1.25	0	1.75	0.2	0	1.32	0.1
BOD	10.3	6.62	9.68	16.4	10.92	15.8	21.9	13.23	21.3	31.6	17.03	31.01	42.3	24.41	41.6
COD	25.75	20.29	24.1	39.04	29	37.38	50.93	41.61	49.29	79	63.83	77.38	88.12	69.97	86.48
NO_3-N	0.96	0.39	0.81	1.32	0.48	1.17	2.74	0.95	2.57	3.92	1.16	3.78	4.56	1.26	4.41
PO_4-P	0.37	0.23	0.36	1.06	0.6	1.02	1.84	0.95	1.79	2.1	1.04	1.97	2.4	0.79	2.23
SO_4	0.8	0.49	0.79	2.52	1.46	2.5	4.8	2.64	4.76	5.9	3.52	5.83	7.2	5.21	7.08
T.C	20 $x10^5$	24 $x10^4$	19 $x10^5$	28 $x10^5$	66 $x10^4$	26 $x10^5$	39 $x10^5$	11 $x10^5$	38 $x10^5$	43 $x10^5$	14 $x10^5$	41 $x10^5$	64 $x10^5$	29 $x10^5$	63 $x10^5$
E.Coli	+ ve	-ve	+ ve	+ ve	- ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve

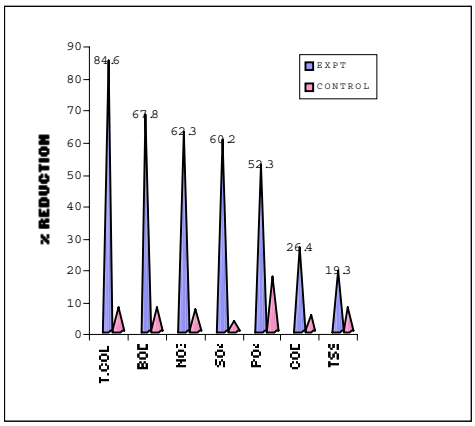
Table 6 - Experimental Sets Treated with *Wolffia globosa* (Roxb.) Hartog and Plas.

Parameters	50 ml Wastewater/l			100 ml Wastewater/l			150 ml Wastewater/l			200 ml Wastewater/l			250 ml Wastewater/l		
	Before	After		Before	After		Before	After		Before	After		Before	After	
		E	C		E	C		E	C		E	C		E	C
EC	98.1	95.3	97.4	107.3	102.8	103.4	129.5	125.4	127.8	150.6	142.2	148.7	197.2	188.8	193.4
TSS	29.6	27.5	29.1	40.2	34.9	39.5	52.3	43.1	51.7	73.4	59.16	72.7	84.6	67.43	83.9
DO	3.6	4.9	3.73	2.4	3.8	2.52	1.12	2.5	1.25	0	1.2	0.2	0	0.89	0.1
BOD	10.3	9.65	9.68	16.4	15.32	15.8	21.9	20.34	21.3	31.6	28.38	31.01	42.3	38.62	41.6
COD	25.75	22.45	24.1	39.04	35.06	37.38	50.93	50.839	49.29	79	75.37	77.38	88.12	83.54	86.48
NO_3-N	0.96	0.57	0.81	1.32	1.8	1.17	2.74	1.16	2.57	3.92	1.68	3.78	4.56	2.25	4.41
PO_4-P	0.37	0.3	0.36	1.06	0.85	1.02	1.84	1.39	1.79	2.1	1.51	1.97	2.4	1.77	2.23
SO_4	0.8	0.77	0.79	2.52	2.23	2.5	4.8	3.62	4.76	5.9	3.82	5.83	7.2	5.21	7.08
T.C	20 $x10^5$	11$x10^5$	19$x10^5$	28 $x10^5$	16$x10^5$	23$x10^5$	39 $x10^5$	23$x10^5$	38$x10^5$	43 $x10^5$	29$x10^5$	41$x10^5$	64 $x10^5$	48$x10^5$	63$x10^5$
E.Coli	+ ve	-ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve

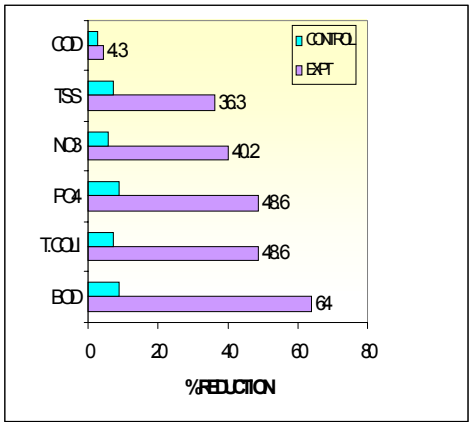
Table 7 - Maximum Percentage Reduction in Selected Water Quality Parameters on Treatment with Aquatic Macrophytes

PARAMETER	PISTIA		SALVINIA		LEMNA		SPIRODELA		WOLFFIA		AZOLLA	
	E	C	E	C	E	C	E	C	E	C	E	C
TSS	66.4	2.1	19.3	7.2	62.1	1.68	32.6	0.82	20.3	1.69	36.3	7.23
BOD	75	7.25	67.8	7.2	82.6	1.65	46.1	6.02	10.2	6.02	64	8.94
COD	42	3.12	26.4	5.I	46	2.05	25	6.41	12.8	9.8	4.3	2.8
NO_3-N	77.2	5.7	62.3	6.9	79.3	15.6	72.4	15.62	57.7	11.36	40.2	5.8
PO_4-P	55.4	18.64	52.3	16.9	69	7.08	67	7.08	26.09	7.08	48.6	8.75
T.C	99.7	7.81	84.6	7.8	93	7.14	88	7.14	45	7.14	48.6	7.14

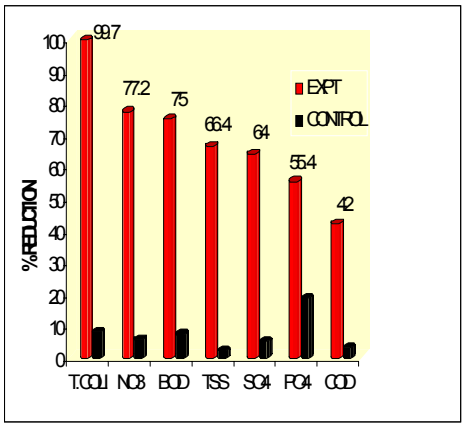
E-experiment, C-control, TSS-total suspended solids, BOD-biochemical oxygen demand, COD-chemical oxygen demand, T.C.–total coliforms



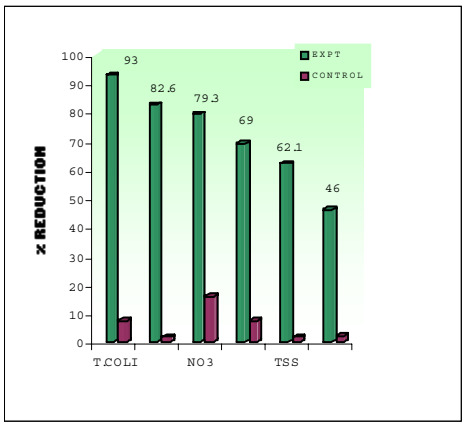
SALVINIA



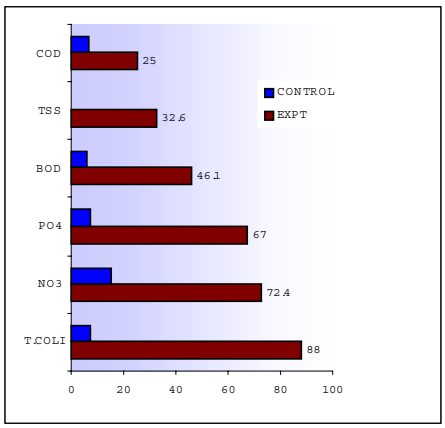
AZOLLA



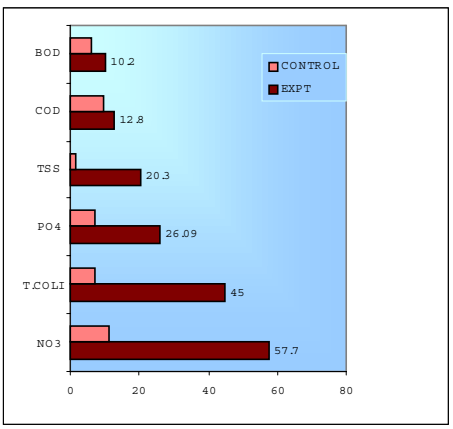
PISTIA



LEMNA



SPIRODELA



WOLFFIA

Fig. 1 : Graphs Showing the percentage reduction in important Water Quality Parameters

Nitrate removal was best in *Lemna* (81.3 percent) followed by *Pistia* (77.2%), *Spirodela* (72.4%), *Salvinia* (62.3%), *Wolffia* (57.7%) and *Azolla* (40.2%). Phosphate removal potential of experimented macrophytes are *Lemna* (69%), *Spirodela* (67%), *Pistia* (55.4%), *Salvinia* (52.9%), *Azolla* (48.6%) and *Wolffia* (28.03%). In earlier studies by Tripathy *et al.* (1991) using four macrophytes, nitrogen and phosphorous removal efficiency was in decreasing order-*Pistia*, *Lemna* and *Salvinia*. However in this study, *Lemna* was found to be more efficient. Removal of phosphate is limited to the plant need and usually does not exceed 50-70 percent of the phosphorous contained in the wastewater (Richardson and Daigger, 1984). The present study is in conformity with the above finding. Sulphate removal efficiencies of the macrophytes experimented are *Pistia* (64.3%), *Lemna* (62.7%), *Salvinia* (60.2%), *Azolla* (53.2 %), *Spirodela* (45%) and *Wolffia* (35.2 %).

Excellent coliform reduction was obtained in experiments with *Pistia* (99.7 5) and *Lemna* (93%). Percentage reductions for other plants are *Spirodela* (88%), *Salvinia* (84.6%), *Azolla* (48.6 %) and *Wolffia* (45.8 %).

Significant differences $p<0.01$ were obtained between pre/post experimental stages as well as presence/absence of macrophytes in statistical tests (ANOVA). 2-way interactions were also studied between dilution and stages of observation; dilution and presence/absence of plant; stages of observation and presence/absence of plant. Nearly all the parameters showed significant interactions ($p<0.05$).

The mechanisms for contaminant removal in these systems may be complex involving physiological characteristics of the plants, biological and physicochemical reactions in the aquatic environment. Physical processes include sedimentation aided by slowing down of water by plant parts. Roots and stem provide surface for bacterial growth. They act as media for filtration and adsorption of solids (TSS reduction) Transfer of oxygen occurs from leaves to root tips. Oxygen not consumed in root respiration can enter the water column and be used by aerobic bacteria for oxidation of organic matter (Reddy and De Busk, 1987).

Nitrogen removal is by plant uptake and subsequent harvest. Plants provide surface for attachment of nitrifying bacteria (Reed *et al.* 1988). Phosphorous removal is also by plant uptake and subsequent harvest as well as chemical adsorption and precipitation reactions. Calcium, magnesium and sulphate removal is by plant uptake. Physical processes such as sedimentation, adsorption and UV radiation remove bacteria and viruses. Chemical oxidation and exposure to biocides (Polprasert, 1996) also account for their removal. Biological methods are ingestion by ciliates, nematodes (Gersberg *et al.* 1987) and antimicrobial properties of certain aquatic plants.

Conclusion

Judicious selection of appropriate species is the key to successful bioremediation. The study reveals excellent potential of several locally available aquatic flora for ecologically sound wastewater treatment. The decreasing order of efficiency in improving the water quality was: *Pistia>Lemna>Spirodela>Salvinia>Azolla>Wolffia*. Evaluation of individual water quality parameters has been done and this may help in field applications.

Such aquatic systems are low cost and low energy alternatives to conventional treatment systems. These technologies are applicable in areas without land constraints and plenty of sunshine. The routine operation and maintenance of the system can be done locally and are such that they can be acquired with only minimum training. They can be sustainable options, especially if the gradient of location permits the delivery of wastewater as is the case of Calicut Corporation, which is at sea level.

The local government should recognize wastewater reuse through natural treatment systems as an option to conventional treatment plants in areas without land constraints. They may be used in conjunction with conventional treatment systems as a preliminary step towards advocating use of natural treatment systems for wastewater treatment. Appropriate treatment systems can be developed considering the area's climate, topography and socio-economic factors. Domestic and industrial wastewater must be separated and treated individually to make recovery and reuse more sustainable.

Acknowledgement

This work was supported by grants from Department of Science Technology and Environment, Government of Kerala. The author is indebted to Dr. Remani K.N., Head in charge, Environmental Studies Division, CWRDM for the encouragement and facilities provided.

References

APHA, 1995. **Standard Methods for Examination of Water and Wastewater**.

American Public Health Association, Washington D.C.19th Edition

Cornwell, D. A., Zollek, J., Partrinely, C. D., Furam, T. S. and Kim, J. I., 1977.

Nutrient removal by water hyacinth. *JWPCF,* 49: 57-65

Gupta, O. P., 1979. **Aquatic Weeds: Their Menance and Control**. Today and Tomorrow's Printers and Publishers, New Delhi, 272 pp

Gersberg, R. M., Lyon S. R., Brenner, R., and Elkins, B. V., 1987. Fate of viruses in artificial wetlands. *Appl. Env. Microbiol.,* **53**:731-736.

Polprasert, C., 1996. **Organic Waste Recycling**, 2nd edition, John Wiley and Sons, **Chichester, 412 pp**

Reddy, K.R. and W.H. Smith (Eds.), 1987. **Aquatic Plants for Water Treatment and Resource Recovery.** Magnolia, Orlando.

Reddy, K. R. and de Busk, T. A., 1987. S**tate-of-the-art utilisation of aquatic plants in water pollution control.** Water Sci. Tech. 19: 61-79

Reed, S. C., Middlebrooks, E. J., and Crites, R.W., 1988. **Natural Sytems for Waste Management and Treatment.** McGraw-Hill , New York, 305 pp

Richardson, D. L. and Daigger, G. T., 1984, **Aquaculture: The Hercules experience.** *J. Env. Engg., ASCE*, 110: 949-966

Sheffield, C. W., 1967. **Water hyacinth for nutrient removal.** *Hyacinth Cont. J.,* **6**: 27-30

Tripathi, B. D., Srivastava, J. and Misra, K., 1991. **Nitrogen and phosphorous removal capacity of four chosen aquatic macrophytes in tropical freshwater ponds.** *Env. Con.*, **18**: 143-147

लक्षावधी ग्राहकांनी गौरविलेली दर्जेदार पितांबरी उत्पादने

पितांबरी® ISO 9001 - 2000 ने प्रमाणित कंपनी

5592 2911 /2539 6848

Forthcoming Conferences

Human Health and Nutrition : A Biotech Approach

12th & 13th December 2004

Organised by

B.N. Bandodkar College of Science , Thane

Water Management (Inter Disciplinary)
Scenario 2025
Problems, Issues and Challenges

21st & 22nd January 2005

Organised by

K.G. Joshi College of Arts &
N.G. Bedekar College of Commerce, Thane

Catalysed & Supported by

OUR MOTO

Let us Conserve,
Preserve & Share
Our Nature

Upvan Lake, Thane

Students cleaning the Upvan Lake
under guidance of Jidnyasa

'Nirmalya-Kalash' Installed by
Jidnyasa at Upvan Lake, Thane

V.P.M.'s POLYTECHNIC
INFORMATION TECHNOLOGY CENTRE

"Jnanadweepa", College Campus, Chendani Bunder, Thane (w) 400 601.
Tel .: 2533 9866, 2544 2233 E-mail : vpm_polytechnic@rediffmail.com
E-mail : vpmpoly_it@vpmthane.com URL : www.vpmthane.com

Government Recognised One Year Post Graduate / Post Diploma Courses

Advanced Diploma in Computer Software System Analysis & Applications
Eligibility : Engineering Diploma / Any Graduate with min. 40% marks
Contents : Computer Organization & Networking, Software Engineering, RDBMS, Visual Basic, Web Design & Development, Project.
Morning Batch : 8 am - 11 am Evening Batch : 6pm - 9 pm

Batches Starting from July

Advanced Diploma in Industrial Safety
Eligibility : Engineering Diploma / Graduate in Physics/Chemistry with 2 yrs. experience
Contents : Safety, Health & Environment Management, Safety Engineering-I & II, Quality Control in Occupational Safety Health & Environment Legislation, Industrial Hyginic & Occupational Health, Safety in Construction Industry, Advance Safety Management & Engineering, Environmental Management, Applied Ergonomics, Project
Batch Timing : Monday to Saturday 5 pm - 9 pm, Sunday 9 am - 1 pm

Post Diploma Course in Computer Maintenance Engineering
Eligibility : Engineering Diploma
Contents : Computer Architecture & Peripheral Devices, Operating Systems, Networking Technologies, Advance Server Applications, EDP Management and Servicing Techniques

Maharashtra State Certificate Course in Information Technology
Duration : 3 Months Eligibility: S.S.C.
Contents : Computer Competency, Application Software, Browsers, Personal Information, Managers, Operating Systems and Utilities. The system Unit, Input and Output, Secondary Storage, Communations and Connectivity, The Internet and The Web, Multimedia, Web Authoring.

Batches After Every 3 Months from July & Onwards

Government Recognised Post SSC Information Technology Courses

Duration : 6 Months (July to Dec.) (Jan to June)

Certificate Course in Information Technology
Fundamentals of Computers, DOS, Windows, MS Office, Marathi Package, Internet, Lotus, Smart Suite)

- **Certificate Course in Web Page Design**
  Fundamentals of Computers, DOS, Windows, Internet, HTML, Front Page-2000, Dream Weaver 3.0, Flash 4.6

Certificate Course in Computer Programming
Eligibility H.S.C. / CCIT
Fundamentals of Computers, DOS, Windows, C Programming, Visual Basic

Batches : Morning, Afternoon & Evening

For Prospectus & Admission Contact Between 8am & 8pm. Tel. : 2533 98 66 / 2544 22 33