CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Freshwater is essential to human society and the natural environment. Humans use freshwater for household purposes, such as drinking and washing, and to generate economic goods and services (Ferng 2007).

The ongoing development pressure in south Chennai city especially, of the IT industry, housing sector and industrial development adds to the existing problems of urban and peri-urban natural resources management, especially the water bodies and their sustainability. Some of the recent studies dealing with different impacts/issues due to urbanization process on Lake systems are reviewed below. The recently emerging IWRM (Integrated Water Resources Management) concept demands consideration of multi-stakeholder involvement in demand management and strike a balance with natural environment.

The Global Water Partnership defines IWRM as “A process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (Rahaman and Varis 2005). The overall goal of IWRM is to strengthen water governance frameworks, and in so doing, improve the
development, management and use of water. Strong emphasis is also placed on public participation, especially from women and low-income groups.

### 2.2 SUSTAINABILITY OF WATER BODIES

Water, precious and non-renewable resource, is not only the most basic of needs but also is at the centre of sustainable development and poverty eradication. Water is closely linked to health, agriculture, energy, and biodiversity (Mwanza 2003) of any country. Quantity and quality of water are inextricably linked and there is a need for sustainable water development (SWD) in both developed and developing countries, which is “the development of water in a manner in which an adequate supply of good quality water is sustained and the watercourse ecosystem is maintained for the uses of future generations” (Pichyakorn 2002). It includes five specific elements:

- The right to use water
- The protection of water resources and prevention of water degradation
- The maintenance of water flow
- An ecosystem related approach
- Procedural elements to achieve sustainable development.

#### 2.2.1 Integrated Development

Integrated water resources management (IWRM) has emerged precisely in response to the observation that water resources infrastructure and management have traditionally been developed for each water related sector (such as irrigation, urban water supply, industry) independently, with no or little coordination between sectors. It refers to the need to consider water in a
more holistic way, by taking into account all aspects of water resources
development, management and use, and the effects of these on each other,
with a view to maximizing and reconciling the economic, social and
environmental benefits of water use (CAP-NET 2005).

The right to use water involves comprehensive continuing review,
strategic counseling, crisis management, creative dispute resolution, and
enhanced relations with stakeholder and community groups. Protection of
water resources and prevention of water degradation includes addressing non
point sources of pollution on a national, regional and local basis; land use
controls; integration of water and land management; and regulation of inter
basin transfers. Maintenance of water flow involves in-stream flows and
environmental flows and may require appropriate controls. An ecosystem-
related approach should not be limited only to watercourse mainstream or
tributaries, but it should also incorporate terrestrial and marine environments
interacting with it; promote health of the entire ecosystem; and utilize
watershed management authorities.

The Bogota river at Colombia (Castaneda 1989), affected with high
degree of pollution, growing volumes of uncontrolled rubbish in the city,
unchecked mining of quarries within and around urban premier resulted in
gradual extinction of native flora and fauna, drying up of swamps and
increased ground water pollution. A similar study was conducted in Taiwan
about competing fresh water demand for economic activity and for
ecosystems (Ferng 2007). In these circumstances, conflicts between sectors
in water uses, the issue of governance and environmental polices takes prime
stage. For example, Montero et al (2006) studied on collaborative governance
for sustainable water resources management in Mexico on the Ayuquila river
basin. The river basin had complex environmental problems, arising from
land use change, forest fires, soil erosion, water pollution, groundwater
depletion and insufficient use of water for urban water supply and irrigation. In order to understand the multi functionality of nature and to improve the environmental problems, the local municipality responded directly by a collaborative action team with a plan on focus of integrated water resources management.

To move toward SWD, freshwater needs to be managed in a holistic manner, or in other words, with an ecosystem approach. Once a good scientific understanding of the nature, quantity and quality of available water resources has been gained, then proper planning for future water uses is possible. Reliable scientific data and interdisciplinary approach must be the basis for political decisions in water policy. Developing and enacting regionally appropriate regulations and water use policies are important aspects of the SWD approach (McCaffey and Weber 2005).

### 2.2.2 Social Development Impacts

Lakes, wetlands and reservoirs (Fresh water systems) are special ecosystems with important environmental functions that cannot be replaced by other ecosystems. They provide habitat for important species of wildlife, remove suspended particles and pollutants from flowing water, and protect fragile coastlines from erosion and storms (Mitsch and Gosselink 2000; Costanza 1997). One of the principles of sustainable ecosystem management is the recognition that humans are a part of ecosystems (Christensen et al 1996; Grumbine 1994; Harwell et al 1996; IEMTF 1995). Human society has the potential to control the ecological quality of the natural system and to manage those ecosystems at specified levels of sustainability (FDEP 1996; Harwell 1997).

The health of an ecosystem depends upon the maintenance of various ecological service levels such as, supply of potable water, soil fertility,
clean air, biodiversity, energy transfers and nutrient cycling (Cairns and Pratt 1995; Cairns 1997; Costanza et al 1997; Daily 1997; Rapport et al 1998). Ecosystem health focuses on the maintenance of ecological integrity, given the impacts of human activity on natural systems and how these systems withstand and respond to change.

In order to assess the ecosystem health quantitatively, various indicators covering different aspects of ecosystem health have been suggested. These indicators range from single species indicators (Kerr and Dickey 1984), composites of species (Karr et al 1986; Karr 1981), measures of biodiversity, system level measures of ecosystem structure, function and organization (Hannon 1985; Ulanowicz 1986; Schindler 1990; Costanza 1992; Jorgensen 1995; Xu et al 1999) to very broad measures which go beyond the biophysical realm to include a number of human socio-economic factors (Rapport 1992).

Ecosystem health assessment requires an analysis of the linkages between the human pressures on ecosystems and landscapes, alterations in ecosystem structure and function, alterations in ecosystem services and service levels, and societal responses to changes in any one or more of these linkages (Daily 1997; Rapport et al 1998; Rapport 1999).

An Ecological Modeling Method (EMM) for the Lake ecosystem health assessment was proposed by Xu et al (2001). The EMM’s procedures are: (1) to analyze the ecosystem structure of a Lake in order to determine the structure and complexity of the Lake’s ecological model; (2) to develop a model having ecological health indicators, by designing a conceptual diagram, establishing model equations, estimating model parameters and being integrated with ecological indicators; (3) to compare the simulated and observed values of important state variables and process rates (i.e. model calibration) in order to evaluate the applicability of the model to Lake
ecosystem health assessment; (4) to calculate ecosystem health indicators based on the developed model; and (5) to assess Lake ecosystem health according to the values of the ecosystem health indicators.

The EMM was applied, as a case study, to the ecosystem health assessment of a eutrophic Chinese Lake (Lake Chao). The simulated results compared quite favorably with the actual current conditions at Lake Chao. The EMM method, therefore, was suitable in assessing Lake Ecosystem health at Lake Chao.

A study by Lauber et al (2008) on social networks and community based natural resources management concluded that collaboration and widespread involvement of local stakeholders are important in natural resources management. The study also explored the requirements for successful collaborative natural resources based economic development focusing in particular on the characteristics of the social networks of stakeholders involved in this process. Pahl-Wostla et al (2008) emphasized the importance of social learning and culture for sustainable water management. It aims to contribute to the new paradigm of integrated resources management by agreeing with some important elements of new paradigm such as participatory management and collaborative decision making, increased integration of issues and sectors, management of problem sources and not effects, decentralized and more flexible management approaches, more attention to human behavior by “soft” measures, inclusion of environment explicitly in management goals, open and shared information sources (including linking science and decision making), and iterative learning cycles.

Biophysical conditions of the Lakes are an important aspect in deciding water use and sustainability. The water quality and its relationship to urbanization have been emerging as an interesting aspect of studies recently.
SURFACE WATER QUALITY

The surface water quality is affected by both the anthropogenic activities and natural processes (Carpenter et al 1998; Mokaya et al 2004; Melina et al 2005; Singh et al 2005) taking place in the watershed. Water pollution is the biggest threat of urbanization, industrialization and modern agriculture practices. Growing population, increased economic activity and industrialization has resulted in an increased water demand. In addition, rapid urbanization is changing the patterns of consumption and has caused a severe misuse of water resources.

The surface water resources such as, rivers, streams and Lakes passing through or situated in the cities are receiving large amounts of contaminants released from industrial and domestic sewage (Kambole 2003; Pekey et al 2004) which have become contaminant sinks, resulting in increasing degradation of fresh water ecosystem mainly through eutrophication.

The main causes for the impaired conditions of the Lakes can be summarized as fixed point sources like waste water from municipal and domestic effluents, organic, inorganic, and toxic discharges from industrial effluents and storm water runoff. The other, pollutants from non-point sources, include nutrients through fertilizer application, toxic pesticides, and other chemicals, mainly from agricultural runoff; organic pollution from human settlements located along the periphery of the Lakes and reservoirs (Reddy and Char 2006).

This is prevailing in most of the developing countries, in particular south Asian countries such as Nepal, India, Pakistan and Bangladesh (Karn and Harada 2001) where pollution of fresh water systems is more severe and
critical near urban stretches due to huge amounts of waste load discharged by urban activities.

This indiscriminate discharge of effluents, containing toxic substances render water no longer fit for drinking, agriculture and aquatic life (Bailey 2005; Fent 2004 and Pandey 2006) and does not meet standards prescribed for public use. This problem has been assessed in the Nullah Aik tributary of the Chenab River, Pakistan. The river passes through the Sialkot city and receives the municipal waste and industrial effluents. The assessment of spatio temporal variations in water quality showed that, dissolved oxygen, hardness, sulphides, K, Fe, Pb, Cr, Zn, EC, total dissolved solids and salinity were the parameters responsible for major variations in water quality of the river. The results signify that, the parameters which altered the water quality reflect the possibility of industrial, municipal and agricultural runoff and parent rock material interactions together. (Qadir et al 2008).

Similarly, Sanganur canal at Coimbatore in Tamil Nadu, has linkage with storm water supply, domestic sewage and industrial effluent disposal. The water quality of this canal and Lakes it supply water is very important. Water quality analysis showed that important parameters (pH, EC, TDS, BOD, DO and COD) exceeded the permissible limits which are mainly due to the sewage contamination (Kumari et al 2006).

2.3.1 Urban Lakes

Shiddamallayya and Pratima (2008) made a study on the impact of domestic sewage on fresh water body in Bhalki. The physico–chemical analysis of Lake water indicated that the high pollution load (nutrients and alkalinity) was due to the increase of domestic waste water discharge in to the Lake which converted it from ologitrophic to mesotrophic state, an increase in eutrophication and nuisance algal blooms. Srivastava et al (2009) conducted
a study on physico-chemical characteristics of Lakes around Jaipur, India, which found that the domestic sewage coupled with industrial effluents, entered into natural water bodies and thus altered the water quality and ecosystem of the Lakes.

Similar kinds of problems were experienced in the European countries as well. A study on the Antua River Basin at North Western Portugal by Cerqueura et al (2008) showed that the water pollution was due to the high discharge of sewage into the river. The river drains to a region with a high population density and a strong economic dynamism. Along with this, it lacks the facilities for appropriate treatment of domestic and industrial sewage, which are increasing pressure on water resources and its quality. The impact of effluent discharges were evident in the upper and middle stream, where the measurements of BOD$_5$, Kjeldahl – N and total phosphorus revealed values well above the minimum quality standards for surface waters.

Along with the urban Lakes, suburban Lakes are also in the process of degradation due to increase in urbanization process. Urban sprawl is the increasing land consumptive pattern of sub urban development characterized by a substantial increase of scattered, low density residential and commercial areas outside of the city limits due to the raising population growth and income (Wilson 2003; Tu et al 2007).

A study was conducted in eastern Massachusetts (Tu et al 2007) to examine the impact of urban sprawl on water quality. High spatial correlations were found between water quality indicators (especially specific conductance, dissolved ions, including Ca, Mg, Na, and Cl, and dissolved solids) and urban sprawl indicators. The impact of urban sprawl on water quality is attributed to the combined effects of population and land use change in this study. Per capita developed land use is a very important indicator for studying the impact of urban sprawl and improving land use and watershed management.
Inclusion of this indicator better explained the temporal and spatial variations of more water quality parameters than using individual land use or/and population density.

2.3.2 Urbanization and Water Quality

Urbanization is an invasive and rapidly expanding land use pattern throughout the world. Due to uncontrolled urbanization, environmental degradation has been occurring very rapidly and causing shortages of housing, worsening water quality, excessive air pollution, noise, dust and heat, and the problems of disposal of solid wastes and hazardous wastes. The population growth has increased the demand on the natural resources which are already diminishing. In addition to land use conversion, urban sprawl will also continue to threaten water resources (Schoonover et al 2005).

The increased population growth and developments of metropolitan cities and urbanization of their suburbs (urban sprawl) have resulted in severe environmental pollution. The most vulnerable during this process are water bodies (Raveen et al 2008).

Fresh water pollution problems and chemistry of surface water are gaining attention worldwide because of their social, economic and health impacts (Kannel et al 2007a; Aitkenhead-Peterson et al 2011). In India, Lakes and reservoirs are experiencing varying degrees of environmental degradation mainly due to encroachments, eutrophication (from domestic and industrial effluents), and siltation (Reddy and Char 2006).

The Lake water quality was studied in various parts of the world. Solanki et al (2010) assessed the magnitude of sewage pollution of Lake Pandu by monitoring DO, BOD, alkalinity, calcium, nitrates and phosphates. The Lake got deteriorated by the anthropogenic activities, with low dissolved
oxygen and high biochemical oxygen demand and nutrients representing the
eutrophic condition of the Lake. Kudari et al (2006) also studied about
physico chemical parameters of 41 lentic habitats to evaluate the recent
limnological changes of the Dharwad and Haveri districts which were highly
polluted with increased concentration of nutrients, BOD, COD, EC and TDS.
The major cause may be the anthropogenic activities, sewage and fertilizers
used in agricultural fields. Xing et al (2005) studied about the spatial –
temporal eutrophic character in the Lake Dianchi. This study shows the
eutrophication of Lake was due to increased industrialization; land abuse, and
uncontrolled discharge of domestic and industrial effluents.

The spatial temporal variations and comparative assessment of
water quality of Bagmathi urban river system in Nepal was studied by Kannel
et al (2007). The study mainly assessed the variation of water quality and
detection of pollution sources along the river. The study revealed that the
upstream river water qualities in the rural area were increasingly affected
from human sewage and chemical fertilizers. In downstream urban area the
river was heavily polluted with untreated municipal sewage and found that the
COD to BOD ratio in rural area was 3.74 and in urban area it was 2.06, which
confirms the increased industrial activities in the rural areas. The DO was
found to be very low in urban (<4 mg/l) and high in rural area (6.2mg/l),
Ouyang et al (2006) also assessed the impact of urbanization on river water
quality in the Pearl River delta economic zone, in China. The analysis of
physico chemical parameters shows that, the urban samples were much worse
than of rural samples. The phosphate (3 mg/l), COD (10 mg/l) ammonia
(3 mg/l) TOC (44 mg/l) and turbidity (80 mg/l) were found to be high in
urban area when compared to rural area. While nitrite and nitrate were found
to be high in rural samples which may be due to the application of fertilizers
in the agricultural fields, the equalized synthetic pollution index also
determined that the urban water was highly polluted when compared to that from rural water bodies.

2.3.3 Land use/ Land Cover Impacts

Another major impact of urbanization, is increase in impervious area, decreased infiltration rate and therefore, increased surface flow causing floods during monsoons. Anthropogenic alteration of global water supply and quality, along with continued population growth, has resulted in a considerable percentage of people being forced to live in ‘water-stressed’ environments. Recent estimates suggest that 10-15% of all annual fresh water runoff is exploited for human use (Vorosmarty and Sahagian 2000).

Land use change has a strong influence on global water yield. Land cover and use directly impact the amount of evaporation, groundwater infiltration and overland runoff that occurs during and after monsoon periods. These factors control the water yields of surface streams and groundwater aquifers and thus the amount of water available for both ecosystem function and human use (Mustard and Fisher 2004).

Changes in land cover and use alter both runoff behavior and the balance that exists between evaporation, groundwater recharge and stream discharge in specific areas and in entire watersheds, with considerable consequence for all water users (Sahin and Hall 1996; DeFries and Eshleman 2004). Monitoring and representation of urban sprawl and its effects on the land use/land cover patterns and hydrological processes of an urbanized watershed are important for water availability in the Lakes as the quantity of inflows would depend on rates of urbanization.

A study of land use land cover changes in the Kucukcekmece water shed (Metropolitan Istanbul, Turkey), showed that urban areas have increased
as much as 46.83 % in a period of one year (1992-1993). Also, the urban sprawl influenced the hydrological components linked to land use patterns (Coskun et al 2008) and run off processes.

Similarly, Mehaffey et al (2005) made a study on links between land cover and water quality in New York City water supply watersheds. There are two reservoirs Catskill (C)/ Delaware (D) which supply 90% of New York City’s drinking water. The study mainly focused on these C/D reservoirs by comparing land use/land cover in relation to water quality. During the study, they found that the agricultural land use was the major contributor to concentrations of total nitrogen and total phosphorus in the streams. The study also found that human use of the landscape has direct consequences on quality of water resources and even changes as small as 5% can have a measurable effect.

Chang et al (2008) studied the relationship between landscape characteristics and surface water quality in Wulin Catchment in Taiwan. The study mainly focused on the curve number which was determined by land use condition and soil type. Slopes of 10, 20, 30, 40, 60 and 80% were assessed for sensitivity analysis of watershed modeling respectively. The hydrographs were similar under all the slopes with peak flow of 150 cm and peak discharge is above but the pollutant export was 1.6 times higher at slope of 80% than with the average slope of 10%. This demonstrates that hydrological responses are higher relative to the curve number value and pollutant exports have large relation to the average slope of the land surface in the catchment.

2.3.4 Impacts of Storm Water Run Off

This urban storm water is one of the leading cause of pollution of fresh and brackish receiving waters, especially through bacterial contamination (Smith and Perdek 2004). A similar problem was faced by the
three creeks (Burnt Creek, Smith Creek and Prince Georges Creek) located in the Southeastern North Carolina, USA, which were located in the urban, sub urban and rural areas. The water quality was assessed in these three creeks, where percent watershed development and percent impervious surface coverage were strongly correlated with BOD, phosphates and surfactant concentrations. Also, fecal coli forms, TSS and BOD were high during seasons of rainfall in the urban areas than in rural areas. This indicates that the urban storm water enhances the pollution load in the surface water resources. The same type of study was also done in lightly and moderately impacted streams at Blue Ridge Mountains, USA (Price and Leigh 2006) where the TSS, TDS, EC, turbidity were higher in the moderately affected stream compared to low impacted streams.

A similar study was done by Schoonover et al (2005) on changes in chemical and physical properties of stream water across an urban rural gradient in Western Georgia. The middle Chattahoochee river watershed in Western Georgia is rapidly urbanizing and altered land use (changes) threatens the water quality of the river. The study mainly focused on the developing relationship among land use and water quality of western Georgia. The physico-chemical and biological examination of water revealed that the faecal contamination was high at highly urbanized area exceeding the USEPA limits of 400 MPN/100mL.

Land use change is one important indicator of urbanization and the migration of people from rural to urban area are increasing rapidly. During this process, the land conversion, economic growth and quality of life improvement are considered as major goals and their influences on ecological system services have been neglected (Dewan et al 2012; Zang et al 2010).
A study was done at HaDaQi industrial corridor, Heilongjiang Province, China (Zang et al. 2010), which examined the trend of land use change during 1990-2005 and quantified their influences on natural ecosystem service values. The results indicated that, human dominated land uses have expanded rapidly at the cost of natural land. These land use changes accounted for 29% of decrease in natural land from 1990 to 2005; moreover the annual rate of ecosystem service value decline during 2000-2005 is about four times higher than that of 1990-2000, indicating severe degradation of ecosystem services.

2.3.5 Water Quality Indices

The quality of water is defined in terms of its physical, chemical and biological parameters and ascertaining its quality is crucial before use for various intended purposes such as potable water and for agricultural, recreational and industrial uses (Sargaonkar and Deshpande 2003). Traditional approaches to assessing water quality are based on comparisons of experimentally determined parameter values with existing guidelines. However, it does not readily give an overall view of the spatial and temporal trends in the overall water quality (Debels et al. 2005). Thus it become difficult in transforming complex environmental data into information that is useful to technical and policy makers and also to the general public.

Internationally there have been a number of attempts to produce a method that meaningfully integrates the data sets and converts them into information (Nagels et al. 2001), an index for water quality. Index development efforts dates back to half a century. In 1965, Horton proposed the first Water Quality Index (WQI) which simplifies the reporting of water quality data (Liou et al. 2004).
Water Quality Index is a mathematical instrument used to transform large qualities of water quality data, into a single number (Stambuk-Gilijanovic 1999) which improves understanding of water quality issues. This is done by integrating relevant water quality data, to generate a score that describes water quality status as well as can evaluate water quality trends. These indices assess quality of the water for specific uses and are also important in terms of water resources management and improvement efforts (Cude 2001). Several authors have proposed the use of water quality index as a means to derive a numerical expression for the general quality of surface water (Ott 1978; Miller et al 1986; Bordalo et al 2001; Hallock 2002) and use them to assess and compare between locations and or different periods of time.

2.4 AQUATIC COMMUNITY HEALTH

The quality and availability of fresh water is one of the most essential determinants for the health of ecosystems. Physical disturbances, point and non point sources of pollution, from both rural and urban activities are responsible for the deterioration of freshwater systems (Dziock et al 2006, Danz et al 2007). To understand the natural ecological functioning of the Lake system, study of biotic community and their interrelations is essential. In biotic community, plankton plays an important role in Lake Ecosystems as they produce oxygen and food and sustains all other forms of life (Fathi et al 2001). Knowledge on their abundance and community composition provides understanding of ecological balance and aids fishery management. Among plankton community, the changes in the phytoplankton have long been recognized as a good indicator of the environmental quality and trophic status of Lakes (Habib et al 1997; Silva et al 2005). Some of the recent studies from urban and sub urban areas are reviewed here.
2.4.1 Biological Diversity and Water Quality

Physico chemical parameters have strong association with the phytoplankton and also control its growth and reproduction (Ha et al 1998; Teubner et al 2003). The annual succession of phytoplankton was mainly controlled by nutrients and these nutrient resources were critical in regulating total species biomass. Since urbanization affects water quality through additional input of nutrients, it is important for their community relationships. Cunqui et al (2010) examined the relationship between phytoplankton succession and their controlling factors, also identified main environmental variables responsible for the greatest phytoplankton community variability by using CCA. The relationship represented positive correlation with COD, TP, TN and NH$_4^+$ - N, while it was negative with DO and Sacchi Disc. Smith et al (1999) documented that enrichment in nutrient concentrations resulted in high algal densities and annual variations in nutrient supply is an important determinant of phytoplankton variability.

Species diversity within aquatic communities is directly related with the trophic state of the water body (Telesh 2004). Identification of variability in structural and functional parameters of plankton communities is able to provide an indicator of the changes in ecosystems under the eutrophication/pollution stress. Among different indices in determining the species diversity, Shannon-Wiener Index is the most widely used among diversity indices (Stirling and Wilsey 2001). Balloch et al (1976) found the Shannon–Wiener Diversity Index to be a suitable indicator for water quality. Hendley (1977) used the Shannon–Wiener diversity index as pollution index in diatom communities.

A study in the Changjing estuary by Gao and Song (2005) examined phytoplankton taxonomic composition, abundance, diurnal variability and spatial distribution and suggested a bloom in abundance of
certain phytoplankton species decreased the species diversity index and evenness values. The index and correlation analysis found that phosphorus is the controlling factor in phytoplankton growth.

The ratio of nitrogen to phosphorus (Kagalou et al 2001) determines the Lake eutrophic condition and phosphorus is the limiting factor in the plankton abundance and diversity. A similar study was done in a shallow Lake Vrana (Gligora et al 2007), where concentrations of inorganic nitrogen and phosphorus were critical in regulating phytoplankton biomass and species dominance.

2.4.2 Impacts on Biological Diversity

Human activities have exploited the natural resources and deteriorated them over the years. To conserve and manage Lake ecosystems, quantitative information on the biological community before anthropogenic impacts is essential. The impact of anthropogenic activities on Lake water quality is more evidenced by palaeoecological studies which deal with ecosystem structure and function covering historical time scales (Lotter et al 1997; Finsinger et al 2006).

Plankton population of Cauvery river in Tamil Nadu was assessed as the river receives industrial effluents containing numerous toxic substances affecting the water quality and in turn affecting abundance and diversity of plankton (Mathivanan et al 2007). The plankton index of this river showed high quantity of phytoplankton and zooplankton population, rotifers and formed the dominant group over other organisms. This is considered as an indication of pollution due to sewage and industrial contamination. A similar study was conducted in the ponds of Turkey where the interrelationship between nutrients and phytoplankton was used successfully in assessing the pollution status of the pond (Demir and Kirkagac 2005).
Lake Biwa is another example of this kind of study, in which the assessment of zooplankton revealed the eutrophication status of the Lake. In the zooplankton community, the group Daphnia numbers increased dramatically and became dominant, which decreased the numbers of unique species of the Lake. The increased Daphnia abundance had a positive correlation with eutrophication status of the Lake.

The present study investigates the impact of urbanization on the Lakes of Southern Chennai. Chennai and its suburbs once boasted of over 100 small and big water bodies. Now majority of them have been gradually destroyed due to a combination of hectic urbanization and anthropogenic interferences (Remyalakshmi 2006). These water bodies played important roles as groundwater recharging units, natural drain-off mechanism during monsoon, natural habitat for fish, birds, other aquatic life and many social relations such as drinking and domestic water sources, washing, bathing, recreation etc., But today, many of these social functions are interrupted mainly due to deterioration of water quality and also cause floods due to spatial reduction of storage. These Lakes face a changing social perception and dependence/interdependence in an urban-rural context and may provide enhanced ecosystem services or can become environmental concerns for the people, which depend on issues of governance.