Progressive Deterioration of Water Quality of Hussainsagar Lake, Hyderabad, Andhra Pradesh, and an Assessment of its Impact on Zooplankton Community in the Lake Ecosystem

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ABSTRACT
Nature’s obliteration can be seen more apparent at Hussainsagar, which was once the source of drinking water for the twin cities of Hyderabad and Secunderabad, Andhra Pradesh, India. It is also a part of affliction reflecting on man’s abuse of nature that is leading to ecological disaster. Today, the lake is one of the most polluted, hyper-eutrophic ecosystem. Water of the lake is polluted beyond all the acceptable limits with impacts on aquatic biodiversity.

In the present paper, based on survey of research on Hussainsagar lake in last 30 years, an effort is made to analyse progressive change in the water quality and its impact on one aquatic community i.e zooplankton. The results of such an exercise could be helpful in mandatory Environmental Impact Assessment (EIA) undertaken prior to implementation of conservation and management initiatives on an aquatic ecosystem.

INTRODUCTION
The landscape of historical city of Hyderabad is dotted with a number of small and big water bodies, impounded as a part of scientifically developed irrigation system in this semi-arid region. However, in the last 50 years or so progressive urbanization and industrialization has taken a toll of surface water resources in which a number of lakes have totally disappeared due to massive reclamation by addition of garbage, silt and solid waste, while others are facing progressive destruction due to factors like encroachment, siltation and pollution from domestic sewage and/or industrial effluents. Lake Hussainsagar is a classic example of this process.

Hussain Sagar (78° 30’ E, 17° 30’ N) excavated in 1562, with water spread covering an area of 450 hectares, is one of the major lakes located between twin cities of Hyderabad and Secunderabad, Andhra Pradesh, India. The lake was mainly used for storing drinking water brought from Musi river by Balakpur canal. With passage of time, the lake has undergone a steady environmental degradation mainly due to urbanization and industrialization of its catchment. The lake ecosystem gradually lost its importance as a source of potable water with pollution of is water by domestic sewage and industrial effluents. Nevertheless, it is being extensively used for washing, bathing and recreational activities. In the recent past Hussainsagar lake is in national news due to the persistent massive fish kills and its protection is attracting attention of National and International agencies.

Some important limnological studies on Hussain Sagar Lake have been conducted during 1977-78 (Ahson Mhd. 1982), 1979 (Babu Rao et al. 1981), 1986 (Muley, 1987), 1990-91 (Chandrasekhar, 2002), 1990-92 (Siddiqi and Khan (2002), 1991 (Siddiqi and Rama Rao, 1991), 1997-98 (Malathi et. al 2003) and the latest in May, 2007 (Chandrasekhar, 2007). These studies have shown progressive deterioration in its biotic and abiotic environment due to pollution. Fig. 1 shows the present map of Hussainsagar and Fig. 2 the changes in morphometry of the lake over a period of time.

MATERIAL AND METHODS
In the present paper an effort is made to analyse progressive change in the water quality and its impact on one aquatic community i.e., zooplankton in terms of changes in it’s diversity, density and population dynamics, based on the results of the studies on the lake in the last 30 years. These studies include the water quality assessment with respect to biotic and abiotic factors of the lake during 1977-78 (Ahson Md. 1982), 1979 (Babu Rao et al., 1981), 1986 (Muley, 1987), 1990-91 (Chandrasekhar, 2007), 1991 (Siddiqi and Razma Rao, 1991 and Siddiqi and Khan 2002), 1997-98 (Malathi et. al 2003).
RESULTS AND DISCUSSION

The results of present survey of water quality and zooplankton communities are computed in Table 1 and 2. The water quality parameters include the physical parameters like Temperature, pH, Specific Conductivity, Total Dissolved Solids and Turbidity; titrimetric parameters like Dissolved Oxygen (DO), Total Alkalinity, Chloride, Total Hardness, Calcium Hardness, Magnesium Hardness and the nutrients like phosphates (total), nitrates and sulphates. The review of its limnology clearly indicates a progressive deterioration of water quality of the lake over a period of time. Poor water quality can be directly linked to the nutrient enrichment from domestic sewage, toxification due to industrial effluents and anthropological influences like washing of cloths and immersion of idols.

Physico-chemical parameters

Variations in air and surface water temperatures are due to changing seasons in general and variations at different stations on the same day are due to time lag in the collection of samples from spatially separated sampling stations. The ranges as well as their mean values of atmospheric and water temperatures since 1977-79 to 2007 followed the same pattern with slight differences, but in 1979 a higher range of 40-42 / 37-39º C with its mean values 41 / 37.5 was noticed. Temperature variations could be linked to global climatic changes getting reflected at local level. The pH of the lake waters was generally alkaline (range-7.0 to 10) throughout the period of survey. Despite of massive industrialization of its catchment the lake still is free from acid rains. Specific Conductance indicates richness of ions necessary for organic production in an aquatic ecosystem. The high Specific Conductivity generally found in summer could be due to concentration of domestic effluents containing nutrients, resulting from evaporation and reduced inflow of freshwater. Muley (1987) has reported maximum conductivity of 3780 mho’s / cm in the year 1986. The conductivity values have shown gradual increase from the beginning to the end of the survey with slight differences. The latest study on the lake by Chandrasekhar (2007) shows the range of 2000-2300 with a mean value of 2133. In the studies conducted on the lake in the year 1990-91 by Siddiqi and Khan (2002) the turbidity values were noticed maximum with a mean value of 280 in the year 2007. Generally turbidity will be more in summers due to evaporation and consequent load of domestic sewage in to the water body. In general the parameters like TDS, transparency and turbidity show gradual increase from 1977-78 to 2007.
The Dissolved Oxygen fluctuated without any definite pattern since 1977-78 to 2007. The high content of nutrients leads to eutrophication under suitable conditions of dilution and light penetration, resulting in extremely high DO. The high values of DO are due to high productivity during clear weather seasons. Exceptionally high values viz., 13.4 mg/L during 1977-78 and 17.0 in 2007 are reflection of high degree of eutrophication of the lake. Survey of Total alkalinity indicate that the mean values show an ascending order since 1977-78 up to 2007. The maximum value of Chlorides (920 mg/L) reported in 1990-91 (Chandrasekhar, 2007) indicates that during the period maximum discharges particularly of industrial origin were let into the lake. Total Hardness is influenced by the Calcium and Magnesium ions in the water-body. These, though significant, showed only a little relationship with Total Hardness indicating influence of variation in the inflow and content of other ions like iron, manganese, strontium etc. as well as other discharges into the lake. The mean values of TH more or less increased from 288 to 367 and the other ions also followed the same pattern. The survey on nitrate content helps in measuring trophic status and gives relative picture of decomposable organic matter. An aquatic ecosystem in an urban environment receives excess of nitrates through untreated domestic sewage and along with phosphates, are responsible for the eutrophication. The mean values of nitrate have increased from 0.37 to 5.45 mg/L. However, most of the values since 1991 have fluctuated around five. Though the permissible limit of phosphate as per Indian Standards is 0.1 mg/L, most of the values are more than this figure. Sulphate is involved in biodegradation and is converted to sulphide that may cause obnoxious odour in polluted waters and this is common in sewage contaminated waters. The mean sulphate values have varied between 136 and 159 mg/L.

The magnitude of the nutrient loading into the lake can be speculated from the results of the studies carried out earlier and given in Table 1. of the enormous amounts of nutrients (1041 kg phosphate and 1204 Kg of nitrate / day) entering Hussainsagar lake, most are trapped in the sediment, while fraction of it enters the food chain and webs. In addition to the Kukatpally stream, nutrients from other sources like washing of clothes, in-flux of domestic sewage, etc. are making the water body hyper eutrophic ecosystem over a period of time.

**Zooplanton Diversity**

High diversity of flora and fauna indicates an ecologically balanced state of an ecosystem. Further, an onset of any imbalance (Pollution) due to a variety of natural and anthropogenic factors has a dramatic impact on biodiversity due to changing abiotic environment. In this process sensitive species of biota are the first victims which are gradually replaced by pollution resistant hardy species in the course of time. The literature survey on the lake clearly indicate that Hussainsagar was once rich in biodiversity including migratory birds, but with progressing pollution, lost sensitive species including fishes like common carps.

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Table 1 Physico-chemical parameters of Hussainsagar lake during the different surveys
## Table 2 Showing the occurrence of Rotifer and cladoceran fauna during different study periods on Hussainsagar lake

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Among the rotifers, *Brachionus calyciflorus*, *B. rubens*, *B. quadridentata*, *B. forficula*, *Filinia longiseta*, *F. terminalis* and *Keratella* and among the cladocerans, *Diaphanosoma*, *Ceriodaphnia*, *Moina* and *Alona* are the indicators of water pollution. While *Brachionus diversicornis*, *B. bidentata*, *Asplanchna* among rotifers and *Chydorus sphaericus*, *Simocephalus*, *Sida* and *Bosmina* sp. among cladocerans are the indicators of clean waters. Close scrutiny of Table 2 clearly points out gradual shifting of zooplankton diversity from clean water to polluted water species of rotifera and cladocera. These observations point out to environmental degradation of the lake ecosystem over a period of time.

CONCLUSION

The above study on the biotic and abiotic factors of Hussainsagar lake is indicating the deterioration of its water quality over period of time. One of the important steps in the conservation of Hussainsagar lake which has got immense ecological, cultural and touristic values, is to restore the water quality by controlling the pollution through different remedial measures.

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