IMPACT ANALYSIS OF CONSERVATION WORKS OF HUSSAINSAGAR LAKE IN HYDERABAD

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree
of
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in
CONSERVATION OF RIVERS AND LAKES

By

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CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in this dissertation entitled **"IMPACT ANALYSIS OF CONSERVATION WORKS OF HUSSAINSAGAR LAKE IN HYDERABAD"**, in partial fulfillment of the requirements for the award of the degree of **Master of Technology** in **"Conservation of Rivers and Lakes"**, submitted in Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee, is an authentic record of my own work carried out during the period between July 2009 and June 2010 under the guidance of **Dr.Arun Kumar**, Head of Department, Alternate Hydro Energy Centre and **Dr.Harsh Sinvhal,** Professor, Earth Science Department, Indian Institute of Technology Roorkee, Roorkee..

The matter embodied herein has not been submitted by me for the award of any other degree or diploma.

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CERTIFICATE

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ABSTRACT

Hussainsagar lake, constructed in the year 1562 and situated between twin cities of Hyderabad and Secunderabad of Andhra Pradesh in India, is an engineering marvel and a symbol of traditional wisdom of water conservation in the semi-arid region of peninsular India. The lake receives water from four major feeding drains emerging from 275 sq km highly urbanized and industrialized catchment area.

In the conservation history of India, last half of 20th Century witnessed unprecedented growth of urbanization and industrialization as a result of which natural resources in general and water resources in particular faced the most adverse impacts. It is during this phase the lake Hussainsagar underwent extensive environmental degradation due to unchecked inflow of untreated domestic sewage and toxic industrial effluents. The degradation was evident in the form of shrinkage of lake area due to siltation, encroachments, eutrophication, groundwater pollution, loss of biodiversity, breeding of vectors and recurrent fish kills. The worst sufferers of lake pollution were the communities like fishermen and washer-men earning livelihood from the lake . In recent years the lake has emerged as the major activity centre and become an ecological land mark of the city .

Until now there are four conservation projects undertaken for the improvement of Hussainsagar lake and its catchment area resulted in betterment of the water quality of the lake and has increased recreational facilities around the lake. But due to high urbanization and industrialization compounded with poor maintenance of the conservation schemes, the betterment in water quality has been started decreasing. There is lot of sewage still entering the lake without treatment.

several conservations works are being replaced, planned and executed. There works are the improvement of solid waste management, construction of community toilets, public awareness, public relations, community participation and development and institutional structure. Such works are expected to bring the sustainability of the conservation of lake. The estimated cost for the proposed plan has been worked out as Rs 5.65 crores .

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INTRODUCTION

1.1 ABOUT HUSSAIN SAGAR LAKE

Hussainsagar Lake was built in 1562 A.D.. The lake water was utilized for irrigation and drinking water needs upto 1930. Gradually the lake became receptacle of sewage and industrial effluents from the Catchment areas. Due to eutrophication, algal bloom, growth of water hyacinth and bad odour the water body became redundant for recreation & pisci-culture.

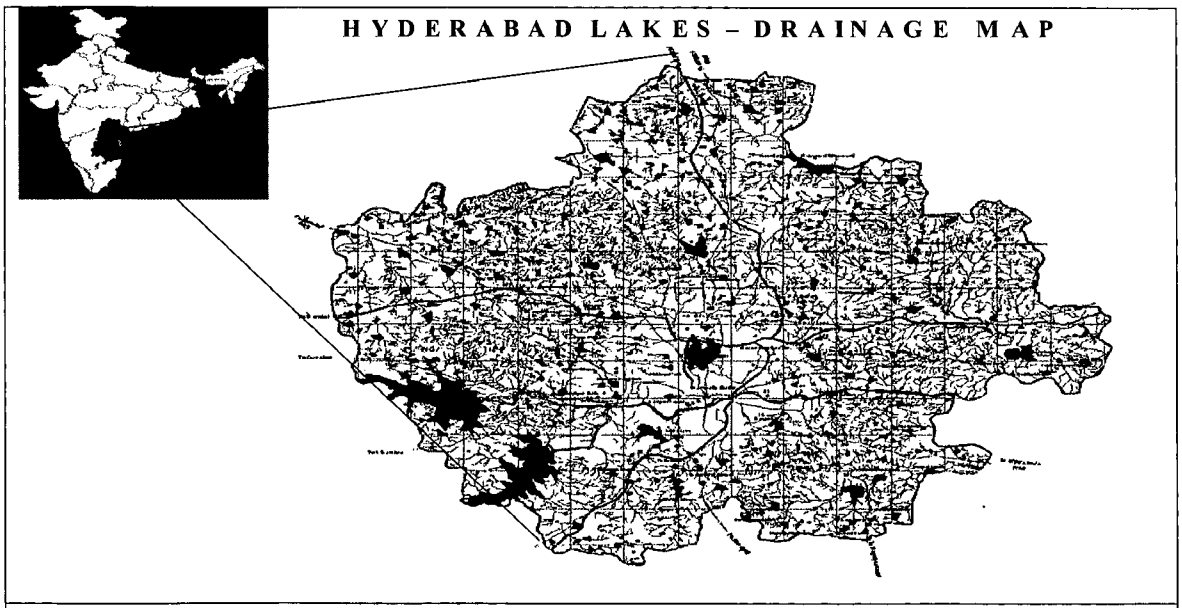


Figure. 1.1. Lake Hussainsagar : Drainage basin of Hyderabad.

Hussainsagar, the picturesque lake situated between the twin cities of Hyderabad and Secunderabad, is an ecological and cultural landmark on the map of state of Andhra Pradesh, India (Fig.1.1). It was constructed in 1562 mainly to store drinking water brought from the river Musi, a tributary of Krishna, one of the major rivers of South India. The lake represents one of the thousands of impoundments on Deccan plateau in peninsular India, developed for storage of surface water run off in this semi-arid region with an average of 800 mm annual rain fall (Table 1.1).

Table 1.1: Physio-graphic features of lake Hussainsagar.

Year of construction	1562	Average depth	5.2 m
Basin area	240 km^2	Depth variable	1 to 12 m
Direct Catchment area	67 km^2	Storage volume (spill)	28.6 X 10^6 m^3
Shoreline length	14 km	Maximum operating level	514.93 m
Maximum water area	5.7 km^2	Normal operating level	513.43 m
Capacity	27.1 million m^3	Road bund level	518.16 m

Located 15°N 78°E, the lake is 510 mt. above the mean sea level (MSL) the lake basin is bounded on west by Banjara hills. The 275 Km^2 watershed of Hussainsagar is divided into four sub basins viz. Kukatpally, Dullapally, Bowanpally and Yusufguda. The highest peak in the catchment is at 642 m north and lowest contour near tank bund at 500 meters, the effective north south drop being 142 m covering a distance of 17 km.

1.2 DEMOGRAPHY

The population of Hyderabad District as per 2001 census is 3.8 million. The population belonging to the Scheduled Caste is 0.3 million forming 8.02 % of the district population. They are mainly concentrated in the slum, and 835 slums exist in the district. It is estimated that 71.5 % of scheduled cast population is living in the slums, the rest being scattered over the twin cities. The population belonging to Scheduled Tribes is 34,560 as per 2001 Census forming 0.9 % of the district total population. They are mainly concentrated in slum areas.

1.3 CLIMATE

The climate of Hyderabad remains fairly warm through most parts of the year and does not receive much rainfall in the monsoon. With the onset of winters in North and central parts of India, temperatures marginally come down in the months of December and January and the nights become quite cool in and around the Hyderabad city. During the summer months, the mercury goes as high as 42° C while in winters the minimum temperature may come down to as low as 12° C. June to November are the months of monsoons, accompanied by rains. During the Monsoons also the temperature goes down at times. Thus, for most parts of the year the weather and climate of Hyderabad remains fairly moderate.

1.4 LITERACY & EDUCATION

The literacy rate is 69 % in Hyderabad District, which is higher than average literacy rate of 61.11 % of India. There are 1,344 Primary, 502 Upper Primary Schools, 936 High Schools, 254 Junior Colleges, 164 Degree Colleges, and 12 Post-Graduate Colleges functioning in the district during 2002-03. Besides this, there are 15 Medical Colleges, 150 Engineering Colleges, and 12 Universities functioning in the district.

1.5 WATER BODIES IN HYDERABAD

Figure1.2 Satillary image of the lake.

It is estimated that there were 932 tanks in 1973 in and around Hyderabad which came down to 834 in 1996. Consequently the area under water bodies got reduced from 118 to 110 sq.km. About 18 water bodies of over 10 hectare size and 80 tanks of below 10-hectare size were lost during that period in the HUDA area (EPTRI, 1996: 23; The Hindu, 25 January 1997). A yet another study on land use/land cover for Hyderabad and a large area

around, reveals that the area under water bodies has come down from 2.51 per cent of the geographical area in 1964 to 2.40 per cent in 1974 and to 1.57 per cent in 1990 (Mujtaba, 1994). The decline during 1974-90 period has been sharp. This was also the period of rapid growth of the city and its environs. Another study based on remote sensing data on 1:50000 scale reveals that the area under water bodies got reduced from 22.79 sq.km in 1989 to 20.84 sq.km in 1999 in the city and the surrounding municipalities. Micro level studies would indicate much more reduction in the area under water bodies (Ramachandraiah, 2002). The studies mentioned above differ in the size of the area covered around Hyderabad but all of them indicate, in varying degrees, that the area under water bodies has been declining over time due to urban sprawl.the main water bodies in Hyderabad are Osman sagar, himayathssagar, hussainsagar lakes.

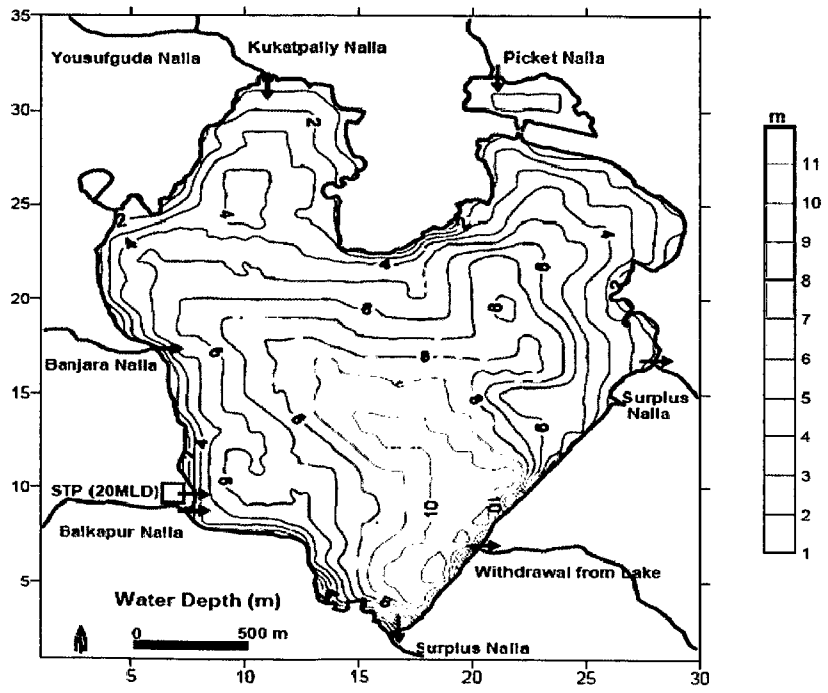


Figure 1.3. Bathymetric Contour Map In-lets and depth profile of Hussansagar lake, Hyderabad, India.

The lake hydrology is sustained by four feeding channels (nullahs); Kukatpally (70 mld), Picket (5.7), Banjara (6) and Balkapur (13.3 mld). Of the four in-lets, Kukatpally with total catchment of 168 Km^2 passes through two major industrial areas viz. Kukatpally and Balanagar and is the main feeding channel of the lake (Table 1.2)

Table 1.2: Dry weather flows in to lake Hussainsagar

Channel	Flow in mld			Remarks
	Sewage	Industrial effluents	Total	
Picket	05.7	-	05.7	Interception and diversion after pumping Proposed STP (30 mld capacity)
Kukatpally	55.0	15.0	70.0	Interception and diversion (I&D)
Banjara	06.0	-	06.0	Interception and diversion (I&D)
Balkapur	13.3	-	13.3	STP (20 mld capacity),
Total	80.0	15.0	95.0	50 mld treatment by 2 STPs

1.6 STATUS OF HUSSAINSAGAR LAKE

In the last few years intensive efforts have been made to restore the lake environment including management of lake basin and water quality. Further, protection of lake Hussainsagar in terms of improved water quality, control of pollution and beautification of its environment has assumed greater significance in view of its socio-cultural and tourism potential. In this context Asia's biggest monolithic Buddha statue standing majestically on the rock of Gibraltar in the center of the lake, has emerged as the major attraction like the Statue of Liberty in USA. The extensive development of lake environment with the help of National and International funding has bought Hyderabad on the tourism map of the world and the lake has emerged as the landmark representing socio-cultural ethos of the historical city and the region.

In view of its ecological, economical and recreational importance conservation of lake Hussainsagar is high on the agenda of the State Government and to achieve the same, a special Buddha Purnima Project Authority (BPPA) was established in 2000 to look after the lake and its environment covering special development area of 902 hectors.

Pollution from sewage and industrial effluents : One of the major impacts of urbanization and industrialization on the lake was in the form of poor water quality due to pollution. Since beginning of the last centaury when lake basin was undergoing rapid change very little attention was paid to this vital issue. Thus, failure of lake basin management in terms of

proper sewerage system and industrial waste disposal infrastructure, was responsible for rapid degradation of lake environment.

1.7 OBJECTIVES AND COMPONENTS OF CONSERVATION WORKS PROJECT

Hyderabad Metropolitan Development Authority (HMDA) has taken up "Hussainsagar Lake and Catchment Area Improvement Project" with financial assistance from Japan Bank for International Cooperation (JBIC) under ODA with an amount of 7729 Million Yen (Rs. 310 Crores). The project period is from 2006 to 2012 . It is an integrated project to be implemented by HMDA, HMWSSB,GHMC and BPP. The total project cost is Rs. 370 Crores whereas the loan component is Rs. 310 Crores and Rs. 60 Crores is GoAP/HMDA share.

Figure 1.4. lake view of Hussainsagar lake

The principal objectives of the project are to improve the lake water quality by preventing pollutants entering into the lake both point source & non-point sources of pollution, besides removal of nutrient rich sediments,Interception & Diversion of dry weather flows, improvement of Nalas in catchment area,to improve the overall lake environment and its surroundings for enriched biodiversity.

The Project is the first phase of the comprehensive environmental improvement in the Lake and catchment area with the ultimate goals of (i) improvement of the Hussain Sagar Lake to Class-B Desirable Level of Central Pollution Control Board Criteria and (ii) full development sewerage network in the catchment area.

Project Components:

The following components of works are included in the Project they are treatment plants like Construction of 30 Mld Treatment Plant with BNR Process at Picket Nalla and up gradation of existing 20 Mld Secondary Treatment Plant to tertiary level.water body improvement like dredging of non-hazardous lake sediment at nalla mouth,development of decentralized idol immersion ponds and withdrawal of hypo-limonitic layer.sewerage network like development of sewerage system in Hussainsagar catchment area , laying of ring sewer along the Hussainsagar Lake, capacity enhancement of I&D works and improvement of Nallas through landscape development.shoreline improvement like development of landscape along the lake shore area and development of eco-tourism activity in the lake surroundings. public awareness & social development like public awareness campaign and support activities like community toilets, Solid waste management etc.

CHAPTER-2

LITERATURE REVIEW

As per one prediction, India sub-continent will be a water stressed region by 2017 with decline of per capita availability of water from 2,200 m^3 in 2000 to 1600 m^3 in 2017. By 2025 water will be the limiting factor for development and sustainability in all the sectors of national activities. On this background there is an urgent need to conserve and manage available freshwater resources in the form mainly of rivers, lakes and reservoirs [5].

Traditionally in India water sector is dominated by the people with engineering and technological backgrounds who often have very less knowledge about the ecological functions that sustain structural and functional integrity of ecosystems like lakes, reservoirs and wetlands. Further, in conservation and management actions cost intensive technological solutions are often over emphasized. This imbalance at decision making and execution levels comes in the way of integrating alternate approaches. The difficulty with ecological solutions is, they are cost effective and benefits generated are invisible in a system where big (budgeted work) is beautiful and politically attractive. On this backdrop, an integrated ecosystem approach has a potential to generate a synergy between technological solutions and solutions based on ecological principles. An emphasis on such an integrated approach by National Government and International funding agencies can certainly make a difference.

Lakes are the most dramatic and picturesque features of ours global landscape, have rich endowment of resource values, and are major component of the hydrologic cycle .they sustain human livelihood, support economic activites ,provide habitat for biodiversity, and offer important aesthetic and spiritual values [6]. They also provide buffering capacities aginst hydrologic and climate fluctuations, as well as being sinks for inflowing materials collected across their basins. To be more specific, it perform recycling of nutrients, purify water ,and serve to provide drinking water and fish, offer recreation to the society. In addition,it acts as a habitate for innumerable aquatic flora and fauna.

2.1 EUTROPHICATION

Eutrophication of lakes is caused by natural and by human factors. Every lake undergoes a temporal change from trophic status from oligotrophy to eutrophy through mesotropic state Eutrophication is sadly the most extensive and pervasive threat to the water bodies, with loss of diversity and value and sometimes an added threat of toxicity problem from blue-green algal blooms. Eutrophication is caused by nutrients, increase in growth of floating plants, blanketing algae at the edges, suspended microscopic algae, deoxygenation, undesirable change in fish community/fish kills [7].

2.2 TROPHIC STATES OF LAKES

A lake's trophic state is a measure of its biological productivity which simply is a measure of how many plants and animals are in a lake. It is help to understand eutrophication in the lakes are classified according to their trophic status or trophic state.
Because it is difficult to count individual algae cells in lake water, these categories are most easily determined by measuring the chlorophyll content of the water. Chlorophyll is a plant pigment found in algae. Measuring chlorophyll indicates how much algae is present in the water, and so provides a clue as to the amount of nutrients present. Lets us classify lakes according to their trophic status .

2.2.1 Natural causes of lake trophic states

It is important to recognize that the four trophic states occur naturally. There are reasons for this:

(a) Geology. The primary determinant of a lake's trophic state is the soil beneath the lake. Regional geology can set the trophic state of a lake.

(b) Phosphorus. A primary nutrient responsible for plant growth is phosphorus. In India lot of areas that are rich in phosphorus in the soils to create very eutrophic water bodies. There is so much phosphorus rock that we mine it for use in the manufacture of fertilizer this is main cause to rapidly naturally eutrophication take place in the water bodies.

(c) Lake depth. Deeper lakes have more volume to dilute the nutrients and algae, so they may be clearer than shallower lakes that have less volume. Also lake depth helps

determine the sedimentation rate of phosphorus and nutrient resuspension from the bottom deeper lakes are less likely to become stirred by wind energy, so nutrients may more easily fall to the bottom, where they are not as likely to become resuspended in the water and be available for algal growth.

(d) Hydraulic flushing rate. If the water flows through a system relatively quickly, and if the water volume is changed in the lake every 7 to 15 days, there is usually insufficient time for the nutrients to be used for algae growth the nutrients simply flow downstream to some other water body. On the other hand, in lakes that have slow flushing rates the nutrients can be used for algae and large plant production.

2.2.2 Human causes of lake trophic states

We have the potential to accelerate the process of eutrophication. We may contribute nutrients through sewage disposal, agricultural practices, internal nutrient loading, urban runoff from yards, golf courses, shopping centers, roads, food proccesing industries etc.

2.3 Stratification

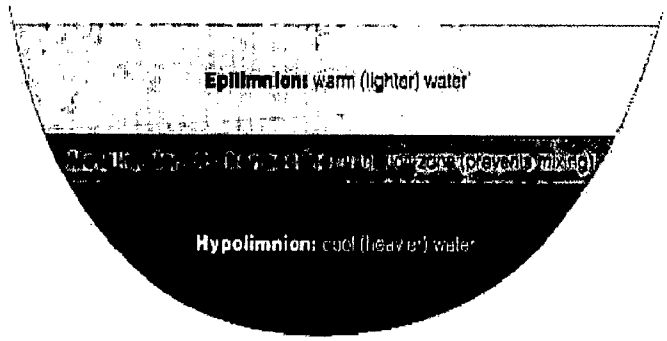


Figure 2.1: Layers of stratification lakes

Layers of a lake water in lakes in temperate climates tends to stratify or form layers,especially during summer, because the density of water changes as its temperature changes . Water is most dense at 39 degrees Fahrenheit. Above and below that temperature, water expand and becomes less dense. Many lakes stratify in winter because ice covers the lake surface. Lakes in areas with milder winters do not stratify during the winter. In spring, as the melts, the surface waters warm, sink, and mix with the deeper water , a process called spring turnover. As the summer progresses, the temperature difference (and density difference) between surface and bottom water becomes more distinct, and most lakes form

three layers. The upper layers, the epilimnion, is characterized by warmer (less dense)water and is the zone of light penetration, where the bulk of productivity or biological growth occurs. The next layer, the metalimnion or thermocline, is a narrow band colder than the upper and warmer than the lower waters which helps to prevent mixing between the upper and lower waters which helps to prevent mixing between the upper and lower layers. The bottom layer, the hypolimnion , has much colder water .plant material either decays os sinks to the bottom and accumulates in this stagnant layer. During the fall turnover, surface waters cool until they are as dense as the bottom waters and wind action mixes the lakes so that water temperature from surface to bottom .

2.4 EFFECTS OF EUTROPHICATION

2.4.1 Algal Blooms

A pervasive result of enrichment of lakes with nutrients is increased growth of algae. Cyano bacteria are an especially troublesome group that can attain high levels and are known to form unsightly surface scum's to cause severe oxygen depletion and fish mortalities upon their die-off and to lead to death of cattle and other animals from ingestion of algal toxins. Gastrointestinal disorders in humans can be associated with the drinking of water that contained blooms of cyanobacteria. Contact with water or even aerosols emitted from cyanobacterial blooms can cause allergic reactions in some people. Cyanobacteria and filamentous species of chlorophytes, or green algae, can cause off-flavors and odors in water and fish, as well as clogging of filters in water treatment or industrial facilities. Dinoflagellates are another group of concern that is known to develop so called red tides which can include toxic strains. One by-product of dense algal blooms is high concentrations of dissolved organic carbon (DOC). When water with high DOC is disinfected by chlorination, potentially carcenogenic and mutagenic trihalomethanes are formed.

Fig 2.2: Water hyacinth in Lake

2.4.2 Algal Toxins

Freshwater toxins are produced almost exclusively by cyanobacteria. Various cyanobacterial genera and species produce different toxic compounds generally classified as neurotoxins, hepatotoxins, cytotoxins and endotoxins. Although neurotoxins are highly toxic, in general, their degradation in water column is rapid. The alkaloid cylindrospermopsin is considered a cytotoxin because it attacks cells throughout the body. Gastroenteritis, renal malfunction and hepatitis have been observed in animals or human population intoxicated by water containing cyanobacteria with cylindrospermopsin production. Lipopolysaccharide endotoxins have been implicated in irritations of skin and allergic responses in human and animal tissues that come in contact with these compounds.

2.4.3 Growth of Aquatic Plants

Dense mats of floating aquatic plants, such as water hyacinth (Eichhornia crassipes), an aquatic fern (Salvinia molesta) and Nile cabbage (Pistia stratiotes) can cover large areas near-shore and can float into open water. These mats block light from reaching submerged vascular plants and phytoplankton, and often produce large quantities of organic detritus that can lead to anoxia and emission of gases, such as methane and hydrogen sulfide. The material derived from these plants is usually of low nutritional quality and is not usually an important component of the food for zooplankton or fish. Accumulations of aquatic macrophytes can

restrict access for fishing or recreational uses of lakes and reservoirs and can block irrigation and navigation channels and intakes of hydroelectric power plants.

2.4.4 Anoxia

A by-product of increases in the abundance of algae and aquatic macrophytes is generation of more organic matter. As this organic matter decomposes in the water column or in the sediments, the concentration of dissolved oxygen decreases. In shallow lakes and where plant production is large complete deoxygenation of the sediments and deeper water can occur. Such conditions are not compatible for the survival of fishes and invertebrates. Moreover under anoxic conditions, ammonia, iron, manganese and hydrogen sulfide concentrations can rise to levels deleterious to the biota and to hydroelectric power facilities. In addition, phosphate and ammonium are released into the water from anoxic sediments, further enriching the lake.

2.4.5 Species Changes

Shifts in the abundance and species composition of aquatic organisms often occur in association with the multifaceted alterations of ecosystems caused by eutrophication. Reduction in underwater light levels because of dense algal blooms or floating macrophytes can reduce or eliminate submerged macrophytes. Changes in food quality associated with shifts in algal or aquatic macrophyte composition and decreases in oxygen concentration often alter the species composition of fishes.

2.5 EUTROPHICATION CONTROL

In the last two decade lakes have become very popular with an increasingly wide variety of people, water scarcity, water born disease and eliminated natural water resources with that the demand for new environmentally friendly techniques for the maintenance and rejuvenation of these lakes. One of the simplest and most economical ways of doing this is to use aeration. Aeration is the process of adding more air or more specifically, more dissolved oxygen into the water. Aeration is frequently implemented with other lake management restoration practices such as applying algaecides and aquatic herbicides to control nuisance quantities of algae and aquatic plants, respectively. Eutrophication is a process whereby lakes excessive nutrients that stimulate excessive plant growth (algae and aquatic plants).

Dissolved oxygen concentrations can severely decline due to aquatic organisms to die, large amounts of algae (algal bloom) and aquatic plants begin to decompose. This decomposition can be carried out in two ways aerobically and anaerobically. Aerobic decomposition requires a continuous supply of oxygen and proceeds more rapidly as dissolved oxygen concentrations near saturation levels. Anaerobic decomposition requires a anoxic condition to degraded organic matter but process is very slow and the end products are organic compounds such as alcohols and foul-smelling.

2.6 IMPACT OF URBAN GROWTH ON WATER BODIES

Being located in the Deccan Plateau region, Hyderabad city has been dotted with a number of lakes, which formed very important component of its physical environment. With the increasing control of the State and private agencies over the years, and rapid urban sprawl of the city, many of the water bodies have been totally lost. Many have been shrunk in size while the waters of several lakes got polluted with the discharge of untreated domestic and industrial effluents. This study makes an attempt to analyse the transformation of common property resources (the lakes) into private property. The adverse consequences of the loss of water bodies are felt in the steep decline in water table and the resultant water crisis in several areas [8]. Further, the severity of flooding that was witnessed in August 2000 was also due to a reduction in the carrying capacity of lakes and water channels. The State has not bothered to either implement the existing laws or pay attention to the suggestions of environmental organisations in this regard. The paper argues that in this process of loss of water bodies in Hyderabad, the State is as much responsible as private agencies in terms of the policies that it has formulated and the lack of ensuring legislation and implementation.

Any discussion on a city's heritage needs to move beyond the conservation of built environment to include its physical environment. The city of Hyderabad, located in the Deccan Plateau, has a distinct physical identity characterized by huge rock formations and water bodies dotting its landscape. The last 50 years of its growth have witnessed large scale destruction of this physical heritage of Hyderabad. Large scale encroachments have lead to filling up of lakebeds and conversion to built up area by both the government and private agencies over the last few decades. One view that seeks to explain the loss of water bodies terms it the 'tragedy of commons' after Hardin (1968). This view argues that water bodies (lakes, rivers, oceans) are resources where ownership is not clearly defined and hence access to them is open to all members of a community. Such a regime of property rights worked well

earlier, but with rapidly growing population and development, is today under tremendous pressure of encroachment and exploitation by the community. Another school of thinking that differs from the former view argues that if resources are commonly owned, shared and used, there is greater sustainability of the resource rather than if the State or private individuals owned it. As the community is dependent on the resource they will ensure its survival and prevent its abuse. While Hardin refers to an open access system where there are no owners and hence no control on use, the second view speaks of resources that are shared by a community in a given area and the resource is available to all members within the community. The lakes of Hyderabad, till independence, were a resource of the local community that took care to conserve it as a water body. But after independence, these lakes were taken over by the State and then by private individuals who were, in many instances, not part of the local community.

Gradually the lakes were encroached and replaced by concrete buildings by the more powerful and wealthy class. This study attempts to understand this transformation of common property resources (the lakes) into private property. The paper argues that in this process of loss of water bodies in Hyderabad, the State is as much responsible as private agencies in terms of the policies that it has formulated and the lack of ensuring legislation and implementation. The impact of the spatial spread of the city on water bodies in Hyderabad agglomeration area is the main focus of analysis in the present paper. In addition to the published and semi-published sources, the paper has relied on notifications/orders issued by government and para-statal bodies, and print media reports (which is known as 'grey literature') to analyse/substantiate the arguments. The information from the latter type is an important source material on issues like encroachment and pollution of water bodies in day-today life. After this introduction, the historic significance of some of the water bodies has been discussed briefly. It is followed by an analysis of the urban sprawl of Hyderabad especially in eighties and nineties. Loss of water bodies has been discussed with a little more focus on Hussainsagar, Osmansagar and Himayatsagar. Pollution of water bodies is the subject of analysis later. Initiatives to protect water bodies by citizens and the legal provisions that are available for such protection have been discussed briefly followed by concluding remarks.

2.7 LOSS OF WATER BODIES

As the city has grown, the urban sprawl has encroached into vacant lands and water bodies due to the increasing pressure on land for housing and other activities. Many water channels that used to carry floodwaters from one lake to the next in a catchment area, have also been encroached by private and government agencies. Discharge of untreated industrial effluents has led to the total degradation of the water quality in many water bodies. Nonimplementation of building regulations and pollution control laws has encouraged encroachment and pollution of water bodies.

It is estimated that there were 932 tanks in 1973 in and around Hyderabad which came down to 834 in 1996. Consequently the area under water bodies got reduced from 118 to 110 sq.km. About 18 water bodies of over 10 hectare size and 80 tanks of below 10-hectare size were lost during that period in the HUDA area (EPTRI, 1996: 23; The Hindu, 25 January 1997).3 A yet another study on land use/land cover for Hyderabad and a large area around, reveals that the area under water bodies has come down from 2.51 per cent of the geographical area in 1964 to 2.40 per cent in 1974 and to 1.57 per cent in 1990 (Mujtaba, 1994). The decline during 1974-90 period has been sharp.

This was also the period of rapid growth of the city and its environs. Another study based on remote sensing data on 1:50000 scale reveals that the area under water bodies got reduced from 22.79 sq.km in 1989 to 20.84 sq.km in 1999 in the city and the surrounding municipalities. Micro level studies would indicate much more reduction in the area under water bodies [9]. The studies mentioned above differ in the size of the area covered around Hyderabad but all of them indicate, in varying degrees, that the area under water bodies has been declining over time due to urban sprawl. Hussainsagar lake has not been used as a drinking water source since 1930 though it was originally constructed to supply drinking water [10]. Located in the centre of the city, the lake area has shrunk from about 550 hectares to about 349 hectares (nearly 40 per cent decline) at present due to encroachments by both private and public agencies over the years.Evidence based on satellite data reveals that the Lake has shrunk by about 300 acres in the last 25 years (www.hyderabadgreens.org accessed on December 2002).

In addition to encroachment, the lake water got polluted severely due to the continuous discharge of untreated domestic sewage and toxic industrial chemicals for several

years. Till a few years ago, the stink emanating from the lake was felt up to distance of several kilometres depending on the prevailing wind direction. About 15 mld (million litres a day) of industrial effluents containing mainly nitrates, phenols and cyanides from about 100 units under hazardous category in the Jeedimetla industrial estate, in addition to 55 mld domestic sewage, are released into Kukatpally Nallah which flows into Hussainsagar lake in the centre of the city. Twenty mld more of sewage enters this lake from three other nallahs (channels) [11]. In course of time, common effluent treatment plants (CEPTs) were set up in some industrial areas and the inflow of toxic effluents into this lake has reduced drastically. In addition, a 20 mld capacity sewage treatment plant (STP) has been constructed right in a corner of the lake to treat domestic sewage. Substantial quantity of untreated domestic sewage still flows into the lake from the nearby colonies.

2.8 POLLUTION OF HUSSAIN SAGAR LAKE

In addition to encroachments, pollution of lake waters by untreated domestic sewage and toxic industrial effluents has been going on unabated over the years. Many lakes which provided drinking water earlier no longer serve the same purpose. While there were six very old industrial areas in the Hyderabad city corporation limits (Azamabad, Musheerabad, Sanathnagar, Kavadiguda, New Bhoiguda, and Lalaguda), eleven new industrial estates have come up around the city in course of time.18 Many of the industrial estates are located in the foreshore areas of the lakes. Of the 38 lakes identified as potential sources of drinking water, bacteriological and chemical tests revealed that the water of only 6 lakes was in a usable condition. The tests showed negative reports for the waters of other lakes.19 Continuous discharge of untreated industrial effluents into the water bodies has turned them into 'toxic ponds' almost devoid of any life. Some of the important polluted lakes/cheruvus are: Kazipalli cheruvu, Gandigudem cheruvu, Nagulal cheruvu, Kistareddypet cheruvu, Muktakanta cheruvu, Aminpur cheruvu, Bollaram cheruvu, Saki cheruvu, Muthangi cheruvu, Isnapur cheruvu, Chitkul cheruvu, Lakadaram cheruvu, Pedda cheruvu, Yerdanur cheruvu, Gummadidala tank, Bonthapalli tank, Jinnaram cheruvu, Kalateleal cheruvu, and Digwal cheruvu etc. Some of the important rivers/streams polluted by the industrial effluents are Bollaram, Isakavagu, Nakkavagu, and Manjeera (upstream of Nakkavagu confluence). Due to seepage and infiltration from these polluted water bodies/drains and other waste dumps, the groundwater in the area is highly polluted. The drinking water sources of many villages in the area are highly polluted [12]. The pollution control board has been ineffective to a large

extent in penalizing the polluting industries despite the provisions of the Environment Protection Act, 1986, the Water Act, 1974 and the Air Act, 1981.. The water of Noormahammad kunta has turned thick red in colour due to the discharge of untreated effluents directly into the lake through the secretly laid pipelines by the textiles mills of Katedan industrial area. Rayakunta cheruvu in Jeedimetla industrial area has practically disappeared due to encroachments, release of effluents and dumping of solid wastes. In several water bodies in the industrial areas, toxic sludge has accumulated to a depth of 2-3 feet. Even as the local farmers try to let out rainwater also from such tanks, lest the accumulated storage further pollute ground water, tankers from industries release fresh loads of effluents secretly in the nights. In a study done for HUDA, it was found that 18 water bodies were identified as the most polluted while 67 were polluted to a lesser extent. While the biological oxygen demand (BOD) should be less than 1 mg/litre for aquatic life to grow, it was 13.25 in Medchal cheruvu, 13.75 in Safilguda cheruvu, 12.0 in Saroornagar cheruvu, 18.4 in Durgam cheruvu, 29.25 in Langarhouse cheruvu, and 6.5 in Kapra cheruvu. While the cheminal oxygen demand (COD) should be less than 5 mg/litre, it was 111, 58.25, 116, 42, 137.5 and 72.5 respectively in the above water bodies [13].

CHAPTER-3

INTERVENTIONS PLANNED UNDER DIFFERENT CONSERVATION SCHEMES

Following are the projects undertaken for the improvement of hussainsagar lake and its catchment area

Table 3.1: Interventions undertaken for Hussainsagar lake

S. No.	NAME OF THE PROJECT	SCHEME	BUDGET (RUPEES)	YEAR OF SANCTIONED	STATUS
1.	Abatement of pollution of hussainsagar lake project.	MCH	40 crores	1998	Completed
2.	GreenHyderbad Environment Programme	HUDA	Not Available	2002	Completed
3.	Musi river action plan	NRCD	344 crores	2004	Project work is in progree
4.	Hussainsagar lake and catchment area improvement project.	HMDA BPPA	370 crores	2006	Project work is in progree till current date.

3.1 ABATEMENT OF POLLUTION OF HUSSAIN SAGAR LAKE PROJECT

Hussain Sagar Lake has been polluted due to discharge of untreated domestic wastewater through Picket, Yousufuguda, Bullakapur and Banjara nallas and Industrial effluents from Jeedimetla, Balanagar and Sanathnagar areas through Kukatpally nalla. Abatement of Pollution of Hussain Sagar Lake Project was implemented at a cost of Rs.40Crores and started in May 1998.

Following works were diversion of dry weather flows from the 5 nallas at six places to stop sewage, laying 15km length of trunk sewers for receiving the dry weather flows, construction of 20 mld capacity Sewage Treatment Plant (extended aeration process) for

treating domestic sewage and after treatment join the lake for maintaining the hydrology of the lake.

3.2 IMPLEMENTATION STATUS OF ENVIRONMENT AND SEWERAGE PROJECTS

(1) Green Hyderabad Environmental Program (GHEP)

The overall objective of the GHEP is "the sustainable improvement of the living environment of the urban population in the Hyderabad Development Area." The Government of Andhra Pradesh (GoAP) has recognized Environment as a key sector for development and took initiative to develop a state-wide policy and strategy document with a focus on Urban Environmental Improvement issues entitled as "Vision 2020". This document aims to reduce poverty, promote local economic activities and to achieve sustainable development of urban areas.

To start with, HUDA implemented the Inception Phase of GHEP from 1 October 2000 to 31 December 2001. The Main Phase of GHEP started from 1 January 2002. The overall programme is being implemented from January 2002, and it will be completed by December 2006. The overall programme focus on two distinct components they are increase the green cover in Hyderabad Development Area by 13,400 hectares and Conservation, treatment and management of 87 lakes in Hyderabad Development area in a sustainable manner. Both of which shall be done with active stakeholder participation, while aiming gender equity and poverty alleviation.

(2) Musi River Action Plan under NRCD

Musi River is a tributary to Krishna River, and emerges from Ananthagiri Hills near Vikharabad town about 90km to the west of Hyderabad city. The river flows through part of Pargi, Chevella, Kalwalcol, Palmakol and Golkonda Mandals before it reaches Hyderabad. Musi River enters Hyderabad near Rajendranagar flowing west to east and bifurcating the old and new city viz. South of Musi and North of Musi respectively. It runs about 20km within the city limits and passes through a length of about 150km before joining Krishna River at Wazeerabad, Nalgonda. Musi River flows on the southern side of Hussain Sagar Lake.

To improve the water quality in Musi River, AP State Government has taken up the Musi River Conservation Plan under NRCP of Govt. of India. Various components include interception and diversion of nalla flows at 18 identified places, priority sewerage mains, and sewage treatment plants at 5 different locations with a total treatment capacity of 592mld.

This project was sanctioned in March 2004 and is under implementation by HMWSSB. This project is scheduled for completion by year 2007. The estimated project cost is Rs. 3,440 Million. The Government of India and Government of Andhra Pradesh will share the capital cost of the project. It is proposed that NRCD under their 10th plan will provide funds to the project to the tune of 70% of the total capital cost and the state government will provide remaining 30% of the total capital costs. In addition to their share in capital cost, NRCD will also share operation and maintenance costs of the plant for first six months. The assets created under the project will be property of the state government and the state government will be responsible for its proper operation and maintenance then after.

3.3 HUSSAINSAGAR LAKE AND CATCHMENT AREA IMPROVEMENT PROJECT

Hyderabad Metropolitan Development Authority (HMDA) has taken up "Hussainsagar Lake and Catchment Area Improvement Project" with financial assistance from Japan Bank for International Cooperation (JBIC) under ODA with an amount of 7729 Million Yen (Rs. 310 Crores). The project period is from 2006 to 2012 . It is an integrated project to be implemented by HMDA, HMWSSB,GHMC and BPP. The total project cost is Rs. 370 Crores whereas the loan component is Rs. 310 Crores and Rs. 60 Crores is GoAP/HMDA share.

3.3.1 Project Objectives and Project Components

The principal objectives of the project are to improve the lake water quality by preventing pollutants entering into the lake both point source & non-point sources of pollution, besides removal of nutrient rich sediments,interception & diversion of dry weather flows, improvement of Nalas in catchment area and to improve the overall lake environment and its surroundings for enriched biodiversity.

The Project is the first phase of the comprehensive environmental improvement in the Lake and catchment area with the ultimate goals of improvement of the Hussain Sagar Lake to Class-B Desirable Level of Central Pollution Control Board Criteria and full development sewerage network in the catchment area.

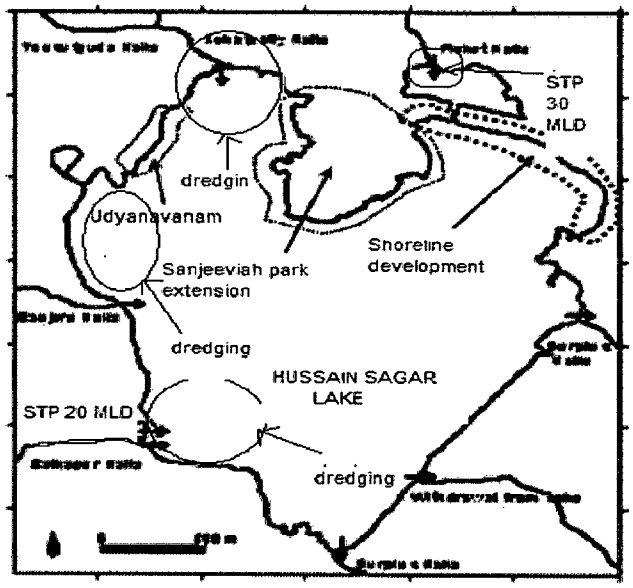


FIGURE 3.1: Location of Project Components in the MAP

Project Components:

The following components of works are included in the Project like sewage treatment plants Construction of 30 Mld Treatment Plant with BNR Process at Picket Nalla andUp gradation of existing 20 Mld Secondary Treatment Plant to tertiary level.water body improvement like Dredging of Non-hazardous lake sediment at nalla mouth,development of decentralized idol immersion ponds and withdrawal of hypo-limonitic layer.sewerage network like development of sewerage system in Hussainsagar catchment area,laying of ring sewer along the Hussainsagar Lake,capacity enhancement of I&D works and improvement of Nallas through landscape development.shoreline improvement like development of landscape along the lake shore area and development of eco-tourism activity in the lake surroundings. Public awareness & social development like public awareness campaign and support activities like community toilets, solid waste management etc.

Table 3.2: Relationship between Works and Project Objectives

Work Item		Initial Proposal Of HUDA	Proposed by SAPROF Team	Project Objectives		
				Lake Water Quality improve	Reliable recycled water supply	Sewerage service
A	**Sewage Treatment Component**					
A1	New sewage treatment Plant	v	v	A	A	A
A2	Upgradation of existing STP	v	v	A	A	A
A3	Supply of Treated Water	v	v		A	
B	**Catchment Area Component**					
B1	Trunk Sewers	v	v	B	C	A
B2	Small STPs		v	B		A
B3	Construction of Ring Sewers And Small Sewers	v	v	B		A
B4	Capacity Enhancement of I&D Works	v	v	A	B	
B5	Installation of Flow Gauging Stations	v	v	B		
B6	Improvement of Sanitation Facilities in Slums	v	v	B		A
B7	Nalla Improvements		v	C		
C	**Lake Component**					
C1	Dredging & Disposal(Non-hazardous)	v	v	A		
C2	Dredging & Disposal(hazardous)	v	v	A		
C3	Investigation and Classification of sediments	v	v	A		
C4	Provision of Facilities for Ganesh/ Durga Idol	v	v	B		
C5	Repairing of Surplus Weirs	v	v	D		
C6	Aeration equipment		v	A		
D	**Shoreline Improvement Component**					
D1	Shoreline improvement	v	v	D		
-	Sanjeeviah park	v		D		
-	Udyanavanam	v		D		

Legend: A;high contribution B;medium contribution C; low contribution D;indirect contribution

3.3.2 Sewerage Related Component

To reduce water pollution load received from various nallas entering the lake, HMWSSB constructed interception and diversion (I&D) works on all the major inflowing nallas, and also constructed a secondary treatment plant at Madarsa Maktha, called as the Hussain Sagar Treatment Plant, of 20mld treatment capacity in 1998. The treated effluent

from the STP is discharged to the lake to meet thehydrological requirement of the lake determined by Safege in 1989. However, recent hydrological studies show that the lake requires an average inflow of 32mld and peak inflow of 40mld to maintain the water level. Further, dry weather flows in the nallas have increased, and the present I&D works are not able to divert all the sewage flow. Therefore, under "the Project," HUDA is interested in constructing interception and diversion works as described below.

Five major storm water nallas drain into the lake, namely, Balkapur nalla, Banjara nalla, Picket nalla, Yousufguda nalla, and Kukatpally nalla. Due to the fast rate of urbanisation and industrialization and also insufficient sewerage facilities in the catchment area of the lake, these natural storm water nallas carry untreated sewage and drain into the lake.

The I&D works built previously by HMWSSB are designed to divert 177mld of dry weather flow, but the recent measurement conducted in 2002 indicated it diverted about 93mld only due to poor construction and improper quality control during construction, and poor operation and maintenance of trunk mains. The nalla flows have also increased since 1992, and are more than 150mld. Therefore, additional diversion capacity is needed due to increased sewage flow in the Nallas. The enhancement of I&D works in the project is essential to stop inflow of sewage into the lake during dry weather period.

In addition to the I&D works, HUDA also plans to lay trunk main interceptors that will tap most of the sewerage currently flowing in the nallas to improve sanitary conditions around the nallas. HUDA has proposed to lay the trunk mains in the nalla bed, Though several options exist, necessity of installation of trunk sewers were recognised by both parties. This component will be effective to reduce dry weather flow in nalla consisting of sewage and its foul odour, thereby contribute to improve living condition in the area along nallas. Even in rainy season, concentrations of pollutants in the rain weather flow in nallas will be much less than those in the present status. As per the discussions and agreement between HUDA and SAPROF, the sewerage component is restricted to INR 70 Crores.

3.3.3 Lake Related component

Hussain Sagar Lake has a volume of 18.6 million meter cube and average daily loss due to evaporation/percolation is estimated to be 32 mld, and the maximum loss (during the

month of May) is estimated to be 40 mld. Further, nutrient-rich sediment has also deposited at the bottom of the lake over the period of many years due to consistent sewage inflow from various nallas, especially after rapid urbanization in the last 30 years. The sewage has about 30mg/l organic nitrogen and about 10mg/l phosphorous content. The estimated annual nutrient load from sewage has been presented in HUDA's "pre-feasibility report," and is reproduced below for ready reference.

Sediment elution needs to be controlled in addition to reduction in influent pollution load to improve lake water quality. Following pollution control measures are proposed under this project.

1. Construction of treatment plant with nutrient removal, and discharge of treated effluent in to the Lake to maintain lake hydrology
2. Dredging of the sediments from partial area of the lake to reduce in-lake store of nutrients
3. Hypolimnetic aeration to reduce nutrient elution from the sediment.

1) Sewage Treatment Plants

HUDA had proposed treatment plants at Picket and Kukutpally nalla (15 mld each). However, for better economy and easier logistics of plant operation, one single plant of 30mld is proposed at Picket nalla. For this treatment plant, sewage will be sourced through Duplicate K&S Main. Based on the available water quality data, it appears that sewage flowing through the Kukutpally nalla, and the K&S Main is mixed with industrial wastewater; however, bio-assay tests done in 100% lake water collected from Kukutpally confluence point show no evidence of acute toxicity. E-coliform concentration in the lake water is less than1600mg/l, indicating ability of bacteria to survive in the prevailing water quality. Further, treatment plants employing biological treatment are working at many large industries such as refineries, dye industries, pesticide manufacturing units; and the biological process works in the industrial effluents because the bacteria get acclimatized to the wastewater quality.

Required capacity of 50mld is to be provided through existing and new plants as described below.

1) A new plant at Picket Nalla of 30mld capacity employing conventional bio-nutrient removal process followed by chemical addition and filtration. This treatment plant will source sewage from the Duplicate K&S Main.
2) A secondary treatment plant of 20mld capacity, called as Hussain Sagar Treatment Plant, exists at Madarsa Maktha. It is proposed that this plant will be upgraded to tertiary treatment of 20mld capacity through an advanced treatment such as membrane bioreactor process for nutrient removal. Treated effluent from the advanced treatment process plant will besupplied to potential consumers as "recycled water."

2) Dredging

HUDA had proposed to dredge the entire lakebed up to a depth of 1.2 meters. However, SAPROF Team suggested that dredging the surface that is deeper than 6 meters would have little effect on lake water quality considering spreading status of pollutant particles inflowing from nallas. Therefore, dredging is proposed for the lake bottom surface that is not deeper than 6 meters. The lake bathymetry indicates that this will reduce the dredging quantity, and the proposed dredge volume will be limited to 1.0 million m3 due to available disposal site capacity. In addition, there are several reasons for recommendation of dredging sediments as discussed Those are 1) Removal of nutrient-rich sediment, 2) Securing of lake capacity, 3) Improvement of living environment, and 4) Prevention of hazardous heavy metal elution.

3.3.4 Environmental and Sanitary Conditions Improvement in Project Area

Sanitary conditions in slums located along nallas are not satisfactory. Especially health problem, represented by infection of Malaria is the major concern of the residents. In this regard, extermination of mosquito is needed to improve sanitary condition in the areas by decreasing mosquito breeding water pool. It will be materialized to some extent by providing sewers along nallas and cleaning-up and improvement of nallas under the project. By implementing those works, foul odour and bad appearance of nallas will be improved considerably, together with dumping of illicit solid waste dumping.

3.4 REVIEW OF SEWERAGE COMPONENT

3.4.1 Projection of Population and Sewage Flow Rates

Municipality, part of Serilingampally Municipality, a part of MCH area and some Gram Panchayat areas fall within the catchment area of Hussain Sagar Lake. The Population projections in these areas have been carried out using method of density by adopting proposed land used plan developed by HUDA in its Draft Master Plan. The residential use has been divided into four categories of low, medium, high and intensive areas. While projecting the ward wise population, variety of factors has been taken into account including the impact of proposed arterial roads, Multi-Modal Rail Transport System (MMRTS) etc. in the wards of municipalities.

The population densities assumed for different categories are as given below:

a) Low Density less than 100 persons/ha
b) Medium Density 100 persons/ha to 250 persons/ha
c) High Density 250 persons/ha to 500 persons/ha
d) Intensive Density 500 persons/ha to 800 persons/ha

The projected growth of population by above method has been arrived and summarised as given below:

Table 3.3: **Population Projections for Municipalities in the Catchment Area**

Municipality	Area KM^2	Population				
		1991	2001	2011	2021	2031
Alwal Municipality	25.73	66,000	109,388	262,933	314,369	354,842
Kukatpally Municipality	48.43	185,000	292,595	513,827	603,588	711,700
Qutubullapur Municipality	47.06	105,000	226,828	365,053	496,507	577,633
Secunderabad Cantonment	40	177,000	207,258	250,987	303,942	368,069

Municipality	Area KM^2	Population				
		1991	2001	2011	2021	2031
Part of Serlingampally Muncipality	----------	10,000	15,500	39,830	49,330	63,500
Part of MCH Area	----------	340,000	409,787	669,409	749,612	780,665

Alwal municipality was constituted as Second grade municipality in 2001. This municipality is divided into 28 municipal election wards. Alwal municipality is spread over an area of 25.73km2, and has population of 109,388 as per 2001 Census. The municipality is well developed with facilities like Parks and open places, Primary and Upper Primary Schools, High Schools Markets etc. Public services like Water Supply, Sanitation, Lighting, Roads, Buildings, Drains etc are provided costing about 465.15 lakhs.

Kukatpally municipality was constituted as second grade municipality in 1987 and was upgraded as special grade municipality in November 1996 and as selection grade municipality in May 2001. This municipality is surrounded by MCH, Qutubullapur and Serilingampally municipalities and is situated in latitude of 17°30' and longitude of 78°20'.

Kukatpally is the fast growing municipality with its proximity to Hyderabad, Hi-tech city and Patancheru, Bollarum industrial areas. National highway #9 passes through the municipality. MMRTS from Lingampally to Nampaly is passing through the municipality, which also gives boost to housing activity in this area.

Qutubullapur municipality is one of the fast growing municipalities. Jeedimetla industrial area is located in this municipality. This municipality growth is mainly linked to industrial activity in Jeedimetla, Balanagar, Kajipally industrial areas.

Serlilingampally Municipality was constituted as second grade municipality in 1987. The municipality is divided into 24 municipal election wards and 23 nos. of revenue villages. The municipality is spread over an area of 101.90km2 with present population of 151,101. Part of Serilingampally Municipality area falls within the catchment area of Hussain Sagar Lake. The areas mainly covered are Beverly Hills area, HUDA Colony, Khanamet area, Ayyappa Co-op Housing Society, etc.

3.4.2 Estimation of Wastewater Volume and Quality

Domestic water supply rate is considered at 150lpcd. Keeping in view the augmentation of water supply schemes under second Hyderabad water supply project. The sewage generated is taken as 80% of the water supplied as prescribed in CPHEEO manual and it is 120lpcd.

3.4.3 Estimation of Storm Water

For estimating the pollution load from the non-point source, it is necessary to estimate the storm water runoff in the main inlet nallas of Hussain Sagar Lake from the watershed area. The storm water is estimated by considering the 14 years average annual rainfall of 806.5mm and the corresponding average monthly rainfalls. The storm water runoff is calculated for each nalla considering their catchment areas assuming number of rainy days in each month and the rainfall duration and intensity to match with the 14 years mean monthly rainfalls.

3.5 Selection of Sewage Treatment Plant

Based on the Selection of STP site, Sewage Treatments schemes and treatment options for use of treated water for irrigation purpose SAPROF team had selected Membrane bio-reactor for the treatment of sewage water which is entering in to the lake.

3.6 AUGMENTATION OF EXISTING INTERCEPTION AND DIVERSION (I&D) WORKS

3.6.1 Existing I&D Works and Required Augmentation

Five major storm water nallas drain into Hussain Sagar Lake namely, Balkapur nalla, Banjara nalla, Picket nalla, Yousufguda nalla and Kukatpally nalla. Due to the fast rate of urbanisation and industrialisation and also insufficient sewerage facilities in the catchment area of Hussain Sagar, these natural storm water nallas carry untreated sewage and drain into the lake.

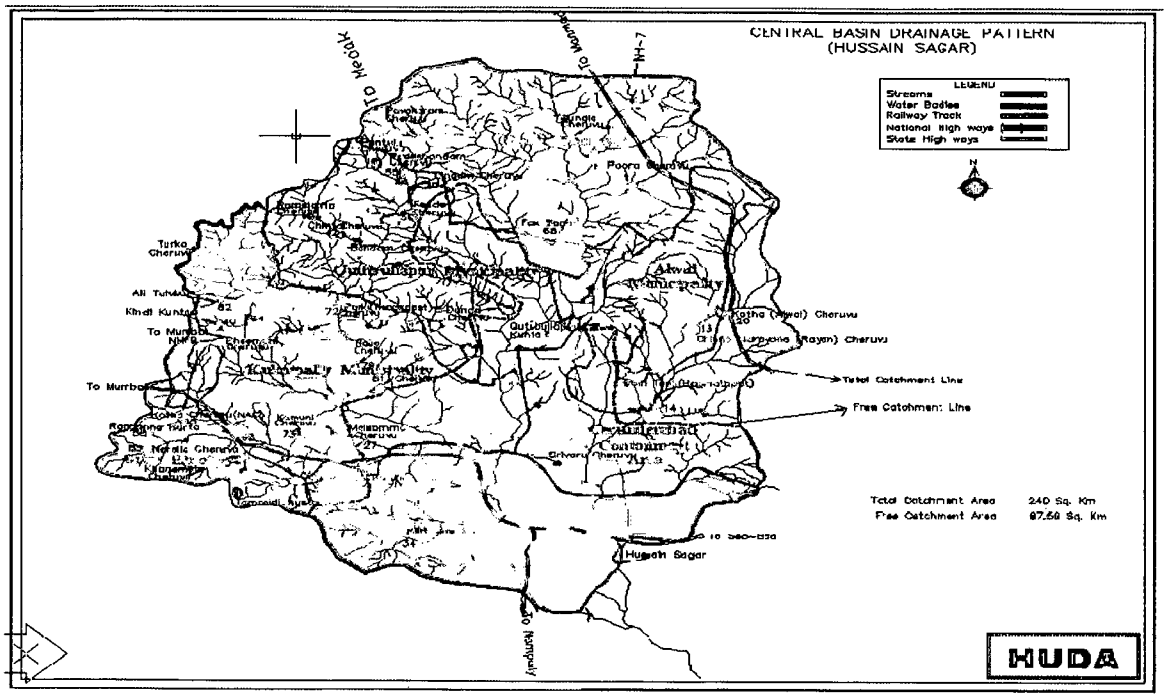


Figure 3.2: Central Basin Drainage Pattern (HussainSagar)

3.6.2 Flow Gauging Equipment

In order to monitor flow of nallas and diverted flow, flow gauging equipment will be provided at nallas upstream of each I&D works and at diversion conduits after each I&D works. Ultrasonic water level monitoring type flow meter will be employed.

3.6.3 Cost Estimates

Breakup of the preliminary cost for augmenting I&D works on all the nallas is presented in Table 3.4 These costs shall be firmed up after the detailed Engineering Survey on all the points of diversion the detailed designs.

Table 3.4: Cost Estimates for I&D Works

S. No.	Particulars	Amount(INR)
1	Interception and Diversion Works	20,600,000
2	Mechanical Screens	12,000,000
3	Pumping station at Picket nalla	16,500,000
4	Conveyance mains	19,650,000
5	Flow Gauging Equipment	4,000,000
	TOTAL	**72,750,000**

3.7 CONSTRUCTION OF INTERCEPTORS ALONG LAKE SHORE (RING MAIN)

3.7.1 Existing System

Along the shore of Hussain Sagar Lake, variety of development took place in last 10 years. Mostly recreation spots, Children Play Grounds, Amusements etc., the road network all round the shore is already developed. It is an important tourist and recreation place to the city of Hyderabad and Secunderabad. All along the shore road small habitants have been developed to a depth of about 150m from the shore road. The sewage effluent, which discharges from these habitants, is directly flowing into the lake through small channels. Though some of the flows are connected to the existing sewer network the other side of the habitants, there is no sewer connecting the effluent, which discharges into the lake all along the shore.The floating population uses the public toilets, etc., which exists at the recreation places, and their discharge goes into the lake directly or indirectly which is polluting the lake water.

3.7.2 Proposals Contemplated

(1) Ring Main

For avoiding the pollution due to newly developed facilities, it is proposed to lay a ring sewer duly connecting from the existing sewer network nearby to collect and discharge sewage effluent from the unserved areas all along the shore. It is suggested and recommended to lay this ring sewer to arrest the effluent that reaching Hussain Sagar Lake directly or indirectly from the habitants all along the shore.

This provision will protect the lake water from further pollution after letting the water from the proposed and existing STPs. Further, the recreation zone all along the shore will be free from any effluent that appears flowing on surface and the hygiene of the area is protected. This will give pleasant atmosphere to the people coming for recreation.

One part of the ring sewer is proposed starting from opposite to Prakash Nagar I&D works to Lumbini Park via Necklace road to length of 4.1 km. The discharge area is considered to a distance of 200 m from the shore road where the ring sewer is proposed. The populations are projected for the horizon year 2031 based on the average density of the area. The floating population is also considered for the calculation of sewer flows.

(2) Small Sewers in Slums

Most of slums have sewer systems. However, a part of area in slums are left unsewerd. For those areas, sewer pipelines will be provided to improve living condition and thereby improve sanitary condition. Detailed plan shall be prepared during design stage and be made based on precise field survey. For budgetary purpose, small sewers are estimated to be 300 mm in diameter and 1,000m long.

3.7.3 Cost Estimates

(1) Ring Main

The cost estimate for laying this ring sewer is prepared based on 2005 rates derived from 2001 HMWSSB rates, which worked out to INR 2.88 crores.

(2) Small Sewers in Slums

The tentative cost estimate for laying this small sewer is prepared based on 2005 rates derived from 2001 HMWSSB rates, which worked out to Rs. 0.50 crores.

3.8 EXPANSION OF SEWERAGE SYSTEM IN CATCHMENT AREA

Expansion of the sewerage facilities is proposed in the catchment area of Hussain Sagar Lake. This will ensure catchment area improvement, better sanitary conditions and act a catalysts role to stop raw sewage entering into the nallas. The nallas shall carry only storm water flow. SAPROF team suggested to lay the sewer lines on roads. After detailed discussions, it was concluded that the proposed alignment should be finalized in consultation with HMWSSB. It was proposed to take up Laying of trunk sewers of 500mm dia. and above in the catchment area in the project due to the following reasons. To keep the nallas at least 5-6 km upstream of Hussain Sagar Lake free from untreated dry weather flows which will also help in better quality of inflows even during wet weathers. Local bodies are laying sewer mains in the habitation areas due to public demand and for improved environment around habitations but are not taking up trunk sewers due to paucity of funds. Nallas are also passing through different local body areas and as such are hesitant to invest for the flows generated in upstream local bodies. To lend a helping hand to the local bodies at the same time to restore

Hussain Sagar Lake providing trunk sewers of size 500 mm dia. and above are proposed for inclusion in the project.

Table 3.5: Cost Estimates for Sewer Component (SAPROF Recommendation)

S. No.	Main Sewers Considered in Municipality	Amount(INR)
1	Kukatpally Municipality	114,187,500
2	Secunderabad Cantonment Board	73,562,500
3	MCH Area	278,593,750
	Sub Total	466,343,750
4	Interconnection Works With existing sewer drain	13,990,313
	TOTAL	480,334,063 say **480,400,000**

3.9 REVIEW OF LAKE COMPONENT

3.9.1 Dredging of Sediment

Until 1930s the lake water was being used, as a source of drinking water for the city and also for irrigation purposes. However, presently, only about 10mld of lake water is used mainly for gardening use because of deterioration of lake water. Dredging of sediment is considered necessary to achieve one of the project objectives, i.e. improvement of lake water quality. By dredging of sediment, nutrient-rich sediment in the lake is removed, and thereby the pollution load originated from elution from sediment will be decreased. Using the prediction model established in the study as described , dredging of sediment, in other words, reduction of pollution load originated from elution of sediment brings an effect on the lake water quality to some extent In addition to decrease of elution from the lakebed sediment, dredging and cleaning of sediment at shallow depth along lakeshore will contribute to lessen the sediments presently exposed during low water level period.

By removal of such sediment, adverse effect caused by exposed sediment such as foul odour and elution of heavy metals by acidic rain will be avoided. This will contributes to not only improvement of lake water quality but also improvement of living condition of residents in surrounding the lake.

As another effect, dredging will increase the depth of the lake, and thereby a marginal increase in the Water-holding capacity of the lakel will be achieved. With this view, an examination of the present requirements of desilting, which is defined as "removal of sediments under dry condition," and dredging was carried out. After discussions with HUDA officials, the SAPROF study team came to the conclusion that desilting work will not be possible because some area requiring deepening will be under water (below the normal LWL of 512.2 m) for most of time and desilting work cannot be carried out in those circumstances.

3.9.2 Outlines of Safe Disposal Site

Name of company: Ramky Enviro Engineers Limited

Salient Features: Concept initiated in early 1990. Established as a result of the bilateral agreement between Govt. of India and Govt. of Australia for Hyderabad Waste Management Project. Designed life of Operations is 25 years.

Outline of disposal site in Hyderabad:

Place: Dundigal Village, Qutbullapur Mandal, It is 26km from Hussain Sagar Lake.

Principal components: Engineering and secure landfill, Stabilization unit, State-of-the-Art Laboratory,

Leachate evaporation ponds, Storage facilities.

Monthly Capacity of Landfill is 20,000 tons, Average amount of landfill received is about 10,000 tons per month during period of September 2001 to October 2004. Thus, the available capacity is enough to handle the part of dredged materials .

3.9.3 Lake Sediment Column Analysis (core sampling)

A sub-contractor of the Study Team (EPTRI) has undertaken lake sediment column analysis to understand the degree of elution of nutrient and hazardous materials from sediments. Based on the results, it may be judged that concentration level of hazardous materials will be kept in safe level. This is because dissolved hazardous elements are within safe limit.

QUANTITY

The dredging quantity was worked out on the following basis. Assuming dredging will be done within a radius of 500 metres from the confluence of 4 nallas, namely Picket Nalla, Kukatpally Nalla, Banjara Nalla, and Balkapur Nalla, the total estimated volume of dredging area comes to about 1,000,000 m2. At these locations, proposed dredging depth is 1m. Therefore, the total quantity to be dredged comes to around 1.0 million m3. Considering spread of sediments from mouths of nallas and efficiency of dredging, dredging should be carried out only in areas with less than around 6 metres water depth, and above-mentioned area to be dredged spreads within such area. Therefore, the total volume of dredging is estimated as 1.0 million m3 against 3.6 million m3 initially proposed by HUDA The plan of dredging and cleaning zone are given in Figure 3.3.

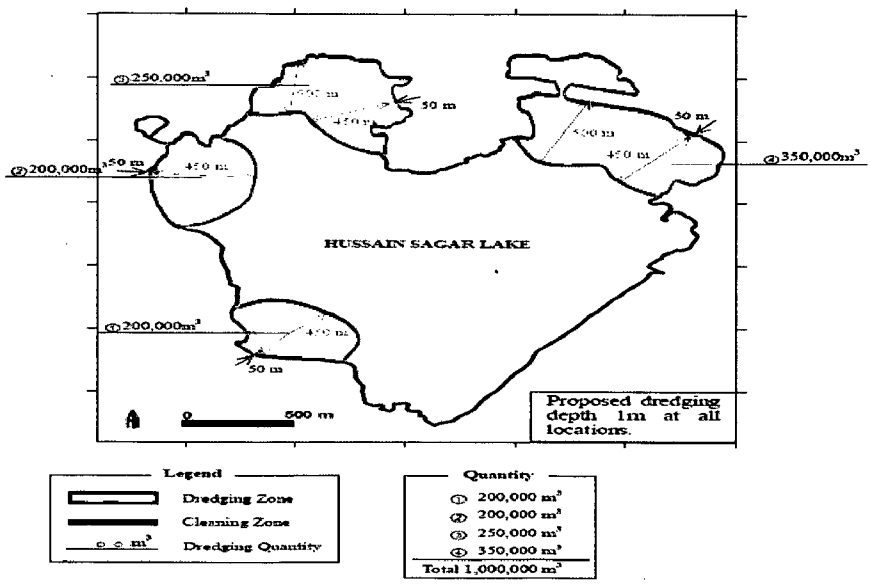


Figure 3.3: Plan of Dredging and Cleaning Zone

3.10 Lakeshore Improvement

3.10.1 Changing Recreational and Eco-tourism Importance of Lake

The Hussain Sagar Lake lies at the heart of the city. Due to its location, dominant presence in the urban setting, and its attraction as a large open space/water body, it has the potential for development for a number of recreation and eco-tourism related opportunities. As is evident from the activities currently happening around the lakeshore and in is close vicinity, the community at large have actively participated in the use of these facilities, brining a lot of increased activity to the Hussain Sagar Lake. While boat-rides and some

lakeshore tourism facilities have been in existence for a number of years, more recent developments have seen the development of Necklace Road, food-courts and boating facilities along necklace road. More activities are emerging along the lake edge in the form of "Jal Vihar", a water-sports theme park, a tennis academy, and a memorial park.

Reviewing documents on the Hussain Sagar Lake, it is evident that the lake has been encroached upon over time and the actual surface area of the lake has declined from its original extent to a current area of approximately 550 hectares (HUDA Master plan). The development of the necklace road and formalization of the lake edge along almost its entire perimeter have been intended to protect the lake area from being encroached upon any further and any actions that might reduce the extent of the lake area.

As a direct extension of the recreation/ tourism opportunities, HUDA is examining the development of additional facilities. These facilities are being planned as eco-tourism developments, commercial recreational developments, and theme parks, along with additional parking, public amenities, and boating facilities. These facilities are planned along the shore edge of the lake as well as across the road around the lake. Among the recreation/ eco-tourism related facilities being considered under the project are shoreline park development and nalla park development

3.10.2 Project Components

In the initial proposal of HUDA, three sub-components were proposed for the project. Those are under shoreline park development beautification of lakefront from sanjeevaiah Park to youth hostel,under sanjeevaiah park enhancement development of family theme parks with major and minor attractionsand under udyanavanam development of land adjacent to rock garden into a theme park

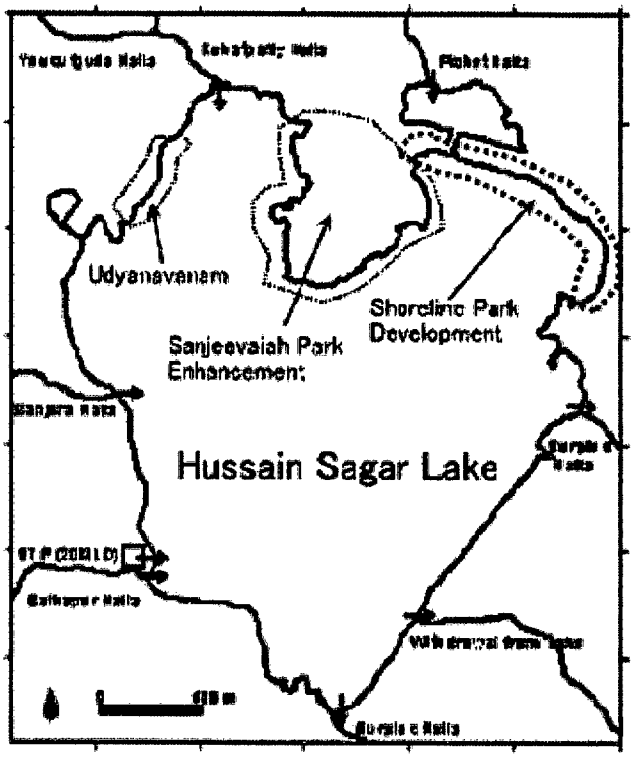


Figure 3.4: Location of Lakeshore Improvement Sub-component proposed by HUDA

Among of these sub-components, HUDA omitted Udyanavanam from JBIC project taking account eligibility for ODA loan of JBIC. Sub-component of Sanjeevaiah Park Enhancement is also cancelled for ODA loan of JBIC because of the same reason, and HUDA intends to implement this sub-component earlier than the implementation schedule of the Project. Therefore, HUDA is in the process of drawing up preliminary plans for the recreation function of this space and the efforts under this project will supplement efforts undertaken by HUDA directly.

(1) **Shoreline Park Development** (from Sanjeevaiah Park to Youth Hostel)

The proposed project area spans a length of approximately 1.2 km. The lake edge of this extent varies in urban character and in physical configuration making it necessary to consider the creation of different design typologies that will collectively comprise the entire project extent.

The main focus of this project component is to provide Pedestrian walkways, complete with street furniture, lighting, and protective rails along the lake edge, Planting and landscape along the walkway as well as along the lake (water) edge,Provision for hawkers at

walkway level and jetties at select locations along the water edge, complete with infrastructure for small craft boating, public safety, and public information facilities, Parking, solid waste management handling facilities, and public toilets, drinking water fountains along the roadside, on the far side of the lake, away from the water body and Pedestrian crossings (underpass/ overpass).

Other benefits that are expected to be derived from this project include revenues from boating facilities, advertising revenues from the public toilets, and possibly advertising panels on the light-posts. It is however expected that visual clutter will be avoided and hoardings and banners will remain relatively limited. With the abundance of people expected to be using the park, hawkers and vendors are likely to find tremendous opportunity along the entire length of the walkway park. It is expected that residents of local/ proximal slums will be direct beneficiaries of this activity, in addition to which increased informal shopping will result in more economic benefit for them.

(2) Nalla Park (Linear Walkway Park along Drains in Hussain Sagar Lake Catchment)

The entire length of natural drains leading into the Hussain Sagar Lake should convey stormwater from the lake catchment area. By proactively addressing the land management of these drains, and converting them into urban landscape assets, there is not only the potential of improving the water quality of the lake, but also providing an environmental asset to the community. Through planned use and protection, the currently decrepit space which is given to encroachment and slum dwellers will become an attractive, sought-after resource providing a stimulus to the urban real-estate and housing developments. The managed use will prevent solid waste dumping and significantly reduce littering, resulting in improved water quality and flows through the drainage paths.

The main focus of this project component is to provide a linear park along the existing drain bed, complete with walkways, limited street furniture, lighting, and protective fencing along the nalla edge,re-grading across the width of the nalla to provide for a clear waterway and landscape on its side slopes and connectivity with contiguous open space to enable the linear park to "balloon" out at specific locations and serve as recreation nodes.

Pictures: visuals of existing site condition.

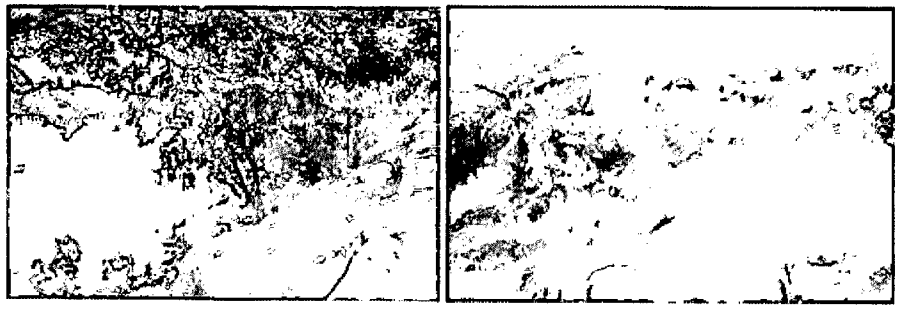


Fig 3.5 & 3.6 Above: Lake edge condition showing relatively steep shoreline near Sanjeeviah Park. Shoreline is not as steep at Ambedkar Nagar, however the need for edge development/ protection is evident to protect lake from dumping/ erosion. This part of the shoreline still provides some opportunity for creating a natural edge.

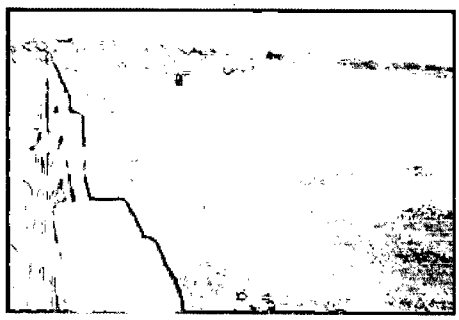


Fig 3.7: Above: Kukatpally Nalla entering the lake. Development of this area will require the cleanup of the water systems flowing into the lake. This interlinking between the lake and the nallas needs to be critically addressed for success of the shoreline park.

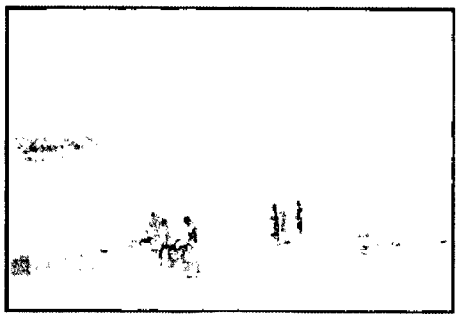


Fig 3.8: Above: Proposed shoreline park extent being used as bathing/ clothes washing area.

Fig 3.9&3.10: Above: Present Nalla conditions which are entering in to Husaainsagar lake

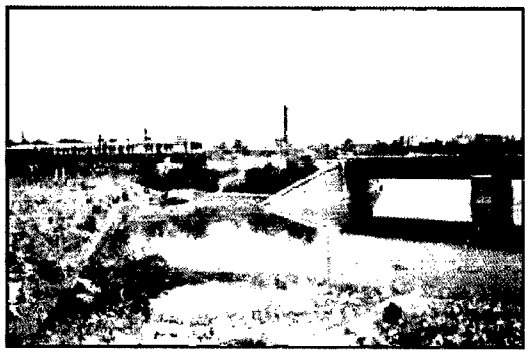


Fig 3.11 &3.12: Above: Picket nalla entering Hussainsagar lake

Create opportunities for floriculture/ horticulture along the length of the nalla ,create opportunities for checkdams for water retention along specific locations, providing water for irrigation, potential for small constructed wetlands for water quality improvement, and pisciculture for local communities, provision for public toilets, access locations to regulate entry, provide information and support O&M activities, limited vehicular parking, bicycle parking, trash and solid waste management handling facilities,Pedestrian crossings over the nalla using small bridges connecting walkways with recreation/ landscaped spaces and visitor/ education centre close to end of nalla, at site of treatment plants/ mouth of lake, at pre-selected sites to encourage people to understand the relationship between urban ecology,

water quality, applied technology (natural/ engineered) and the need to carefully manage the natural resources.

3.10.3 Cost Estimates for Project Components

The estimates of costs have been broadly developed for each proposed project component and are broadly represented below.

Table 3.6: Cost Estimate of Shore Line Development

ITEM	DESCRIPTION	ESTIMATE RS(CRORES)
Shoreline Park Development		11.0
Walkway	Walkways, lighting, public furniture, fountains	2.9
Landscaping	Planting, irrigation system, greening, planting	0.4
Parking	Parking area, fencing, lighting	1.4
PublicAmenities	Toilets, underpass, jetty, public kiosks, solid waste handling fac.	6.3
Nalla Park Development		12.4
Walk ways	Walkways, lighting, public furniture, fencing	7.8
Landscaping	Planting, greening, planting, check dams, ponds	2.0
Parking	Parking area, lighting	0.3
PublicAmenities	Toilets, underpass, jetty, public kiosks, solid waste handling facilities	2.3

CHAPTER-4

PRESENT STATUS AND ANALYSIS OF THE DATA ON HUSSAIN SAGAR LAKE

4.1 OUTLINES OF THE LAKE

Hussain sagar lake is a man made lake.Its year of construction was 1562,its basin area 240 km^2 ,Catchment area 67 km^2 ,its shoreline length is 14 km, maximum water area 5.7 km^2,its capacity is 27.18 million m^3 and average depth of the lake is about 5m.

4.2 PRESENT STATUS OF THE LAKE WATER ENVIRONMENT

4.2.1 Pollution Load Inflow Conditions

Figure 4.1 shows the locations of nallas, sluices and overflow weirs for Hussain Sagar Lake. A total of six major nallas and effluent flow into the lake; five inflow nallas and an effluent from a secondary sewerage treatment plant (20mld). Of these, overflow from diversion facilities (weirs) flows into the lake from the nallas in dry weather and, during rain, rainwater runoff flows into the lake from the catchment area of each nalla, in addition to the overflow. At the same time, there are two surplus weirs through which water overflows when the water level of the lake surpasses the high water level in the rainy seasons, and four sluices (currently under MCH control) through which water is withdrawn for sprinkling, institutional and industrial uses.

(1) Pollution load from the Inflow Nallas

a) Pollution load from the inflow nallas during dry season

The total inflow during the dry season is 48.9 mld, of which the effluent from the secondary sewerage treatment plant comprises about 40%. The Banjara Nalla has the largest inflow of the nallas, followed by the Pickett Nalla. The total inflow pollution load for T-P is 176 kg/day, of which the secondary sewerage treatment plant, Kukatpally Nalla, Banjara Nalla, Pickett Nalla, Balkapur Nalla and Yousufguda Nalla account for 22%, 22%, 20%, 18%, 14% and 4%, respectively

b) Pollution load from the flow-in nallas during the rainy season

The inflow pollution load from the nallas and effluent is greater in the rainy season than in the dryseason. The inflow and the pollution loads for T-P, T-N and COD per day are 5, 1.5, 1.8, and 1.3 times larger, respectively, during the rainy season than during the dry season. However, as for the inflow water quality of the nallas, the T-P, T-N and COD during the rainy season are from tenth part to one-half, from ninth part to one-half, from ninth part to one-half, respectively, of values during the dry season.

c) Annual pollution load from the inflow nallas

Table 4.1shows the annual average water quality and inflow pollution load of each nalla, calculated from the inflow pollution loads in the dry and rainy seasons

Table 4.1: Annual Average of Water Quality in Nallas and Total Pollution Load from Nallas

Pollution Source		Flow		T-P		T-N		COD	
		mld	m3/s	mg/l	kg/d	mg/l	kg/d	mg/l	kg/d
1	Kukatpally	50.2	0.581	0.93	46.88	5.3	264.30	112	5,635
2	Yousufguda	12.3	0.143	0.79	9.72	5.2	64.44	111	1,373
3	Banjara	11.1	0.128	3.22	35.74	20.2	223.61	445	4,935
4	Balkapur	15.1	0.174	1.74	26.18	11.0	166.50	241	3,638
5	Picket	22.5	0.261	1.54	34.82	9.9	222.43	215	4,847
6	20 mld STP	20.0	0.231	1.96	39.12	17.0	339.29	48	958
	Total	131.2	1.518		192.44		1,280.57		21,387

Source: Pre-feasibility report on Restoration and Management of Hussain Sagar Lake(2003)

(2) Pollution by Ganesh/Durga Idol Immersion

In every rainy season, Ganesh/Durga Idol Immersion has been carried out at the side of tank band road. In order to identify influence on pollution by this activity, examination was conducted through the quality analysis of lake bottom sediments. As a result, such influence was not identified for most probable pollutant, i.e. heavy metal like arsenic and lead later, concentration of lead in sediments is slightly high where Kukatpally nalla and Picket nalla enter to the lake. While, concentrations of arsenic are much higher Based on these results, it may be considered that influence on pollution by the immersion is limited at the immersion point, even if it exists. It does not spread to the whole lake water. It may be negligible comparing with pollution by nalla water, and it was not considered specifically in the pollution analysis. The reasons of this judgment are the immersion is conducted in rainy season, polluted water overflows without spreading to the lake. The immersion place will be decentralize to municipalities and its influence will be much less.

4.2.2 Hydrological Condition of the Lake

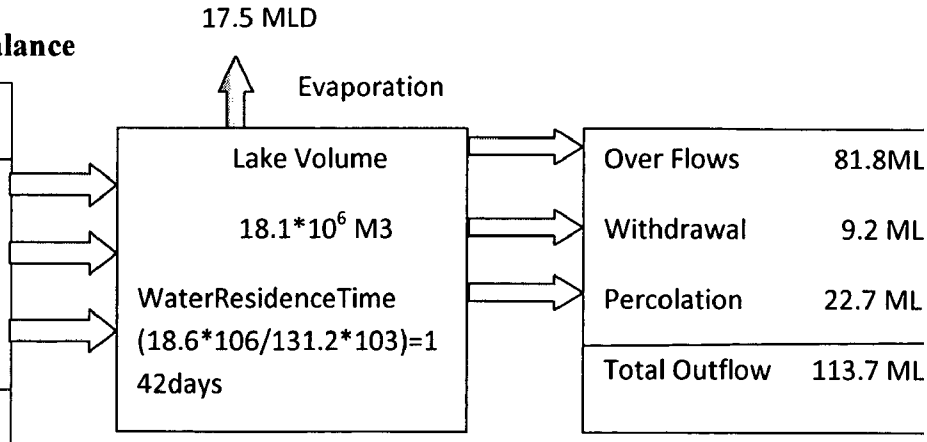
There are three major supply sources contributing to the water balance in the lake they are nalla overflow from the diversion facilities (weirs) in dry weather, rainwater runoff from the catchment area in rainy weather, effluent from the secondary sewerage treatment plant (20 mld).

The following four factors are the major elements contributing to the removal of water.they are evaporation from the lake surface, overflow when the water level of the lake exceeds the high water level during the rainy season.water taken for sprinkling (gardens), institutional and industrial uses and Percolation into the ground

From the water balance data, water retention times in the lake during the dry season, during the rainy season and as an annual average, were estimated at 564days, 76days and 142 days, respectively

Annual Average Water Balance

Inflow	Flow mld
Nalladryweather flow	29.0
Nalla stormwaterflow	82.2
S.T.P	20.0
Total Inflow	131.2



Percolation:Percolation was estimated from water balance of the lake

Water Residence Time: Lake Volume / Water Inflow

Figure 4.1: Water Balance in Hussain Sagar Lake (Source: Pre Feasibility Report 2003) .

4.2.3 Water Quality in the Lake

(1) Water Quality

a) Variations in Water Quality in Hussain Sagar Lake

Table 4.2 summarizes the results of the water quality surveys of Hussain Sagar Lake conducted by HUDA from 2001 to 2004. The DO, COD, BOD, T-N and T-P values are important water quality parameters for measuring water pollution caused by eutrophication. In Hussain Sagar Lake, these parameters fluctuate significantly over the year. The values for all parameters, except DO, tend to be high during the dry season and low during the rainy season. DO, on the other hand, is low during the dry season and high during the rainy season. It is considered that more stagnant water in the lake and poorer water quality from nallas during the dry season exacerbate water pollution in the lake more during the dry season than during the rainy season. In particular, as water stagnation facilitates the creation of a thermocline in the lake, the bottom layer becomes oxygen-depleted because of the lack of DO supply from the surface layer.

H1: location near balkapur nalla entering Lake.

H2: location near Banjara nalla entering Lake.

H3: location near Kukatpally nalla entering Lake.

H4: location near sanjeeviah park .

H5: location near Surplus nalla entering Lake.

H11: location between Balkapur and Surplus nalla entering lake.

H3A: location between kukatpally and banjara nalla entering lake.

Table 4.2: Variations in Water Quality (DO, COD, BOD, T-N and T-P) from 2001 to 2004

Location	DO (mg/ l)	COD (mg/ l)	BOD (mg/ l)	T-N (mg/ l	T- P (mg/ l)
	Average	Average	Average	Average	Average
H1	2.45	65	17	6.63	2.14
H2	3.02	124	35	9.12	3.36
H3	2.77	153	44	8.14	3.14
H4	3.45	126	36	7.10	2.56
H5	4.09	90	25	8.06	1.66
H6	4.33	79	21	8.10	1.99
H7	4.44	82	22	7.21	1.69
H8	3.56	79	21	7.62	1.83
H9	4.90	57	15	5.90	1.79
H10	4.36	95	26	8.10	2.32
H11	4.74	98	24	8.25	2.58
H3A	3.31	91	25	7.78	1.70

All the parameters, except DO, tend to be high in the northern part of Hussain Sagar Lake, into which the Kukatpally Nalla and Pickett Nalla flow. At the same time, DO tends to be low in the northern part of Hussain Sagar Lake.

b) Relationship between COD (BOD) and nutrient salts

COD or BOD is the water quality parameter typically indicating organic pollution in water zones/bodies. It should be noted that, in lakes and closed sea areas, COD (BOD) includes not only organic matter loaded from nallas (organic matter derived from nallas) but also organic matter produced by phytoplankton in the water body (lake and sea areas). In particular, it may be expected that COD (BOD) consists mostly of organic matter derived from phytoplankton in a water body in which blue-green algae grow well, like Hussain Sagar Lake. This production of organic matter by phytoplankton is a phenomenon caused by the intake of nutrient salts, such as nitrogen and phosphorus, into the water by plankton. The higher the concentrations of nutrient salts, the higher the COD (BOD) produced by

phytoplankton T-N, P is considered to be a stronger limiting factor for phytoplankton growth than N in Hussain Sagar Lake.

(2) Sediments

1) Nutrient Salt Content of the Sediments in the Lake

Figure 3.4 shows the summarized results of the sediment survey of Hussain Sagar Lake conducted by HUDA in 2003. The distributions of T-P and T-N in the sediments show a general tendency for high concentrations in the northern part of Hussain Sagar Lake, into which Kukatpally Nalla and Picket Nalla flow, similar to the tendencies seen in the water quality.

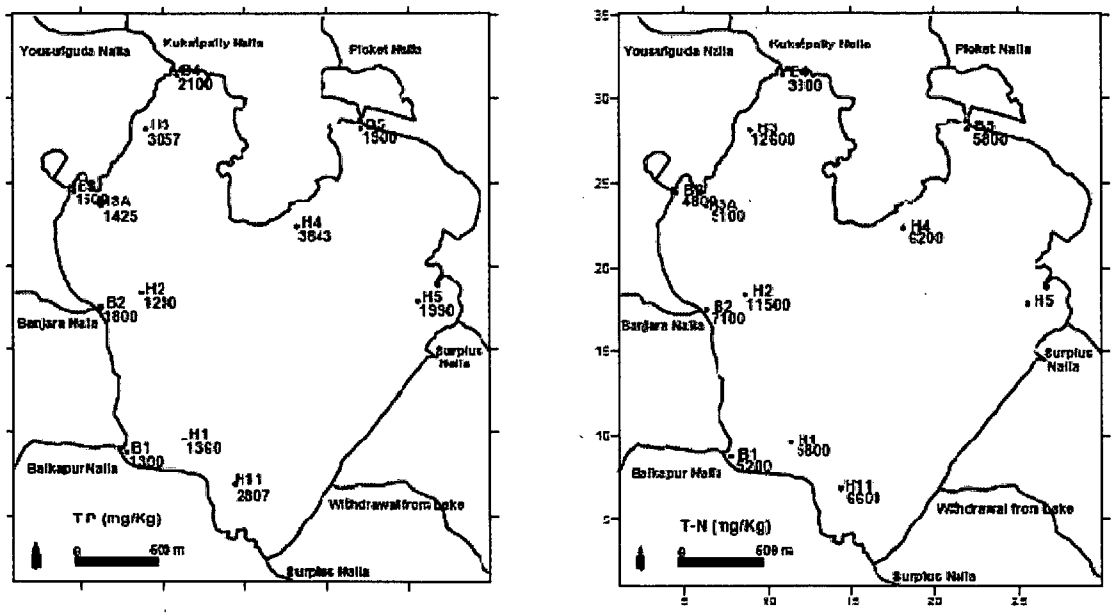


Figure 4.2: Distributions of Average Sediments Contents of T-P and T-N

Source: Hyderabad Urban Development Authority(HUDA) 2003.

4.2.4 Lake Water Analysis

Sampling for lake water analysis was planned by the Study Team. A sub-contractor of the Study Team (EPTRI) took water samples at surface and at 1 metre below surface on the 4th April 2005. Water quality data for the lake indicates high level of pollution, which is reflected as high phosphorous, high nitrogen, and high BOD and COD concentrations. Further, the dissolved oxygen at subsurface is almost nil, which shows anoxic condition of

the lake water. This is harmful for aquatic life and fishes, and results into release of nutrients from the sediment.

4.2.5 Eutrophic Levels in the Lake

The level of eutrophication in Hussain Sagar Lake was compared with that in other lakes, in order to understand the condition of the lake. The lakes used in the comparison are ones in which P is a greater limiting factor for phytoplankton growth than N, as in Hussain Sagar Lake

4.2.6 Total Pollution Load in the Lake

As mentioned above, the major supply sources of the pollution load causing water pollution in the lake are the following four loads.they are inflow pollution load from the overflow from the diversion facilities on the nallas during the dry season dry season load from nallas , non-point inflow pollution load from nallas caused by rainwater runoff during the rainy season rainy season load from nallas, Inflow pollution load from the effluent from the secondary sewerage treatment plant load from sewerage plant and elution load of nutrient salts from the sediments: Elution load from sediments.

Figures 4.3 to 4.5 shows the summarized status of pollution load in the lake based on the calculated pollution load from each of the above-mentioned pollution sources. The Dry season load from nallas comprises 68% of the total annual average pollution load for T-P, followed by the Load from sewerage plant at 19%, the Rainy season load from nallas at 8% and the Elution load from sediments at 5%. For T-N, the Dry season load from nallas comprises 46% of the total load, followed by the Elution load from sediments at 27%, the Load from sewerage plant at 19% and the Rainy season load from nallas at 7%. For COD, the Dry season load from nallas comprises 84% of the total load, followed by the Rainy season load from nallas at 12% and the Load from sewerage plant at 4%. These figures suggest that the largest pollution source causing water pollution in the lake is the Dry season load from nallas.

Annual Average pollution Source

Inflow	Flow mld	T-P mg/l	T-P kg/day
Nalladryweather flow	29.0	4.74	137.4
Nalla stormwaterflow	82.2	0.19	15.9
S.T.P	20.0	1.96	39.1
Nalla +S.T.P	131.2		192.4
Total Load			**203.2**

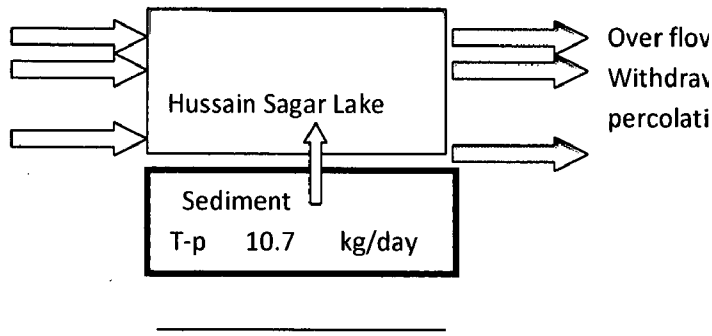


Figure 4.3 Pollution Load of T-P

Annual Average Pollution Source

Inflow	Flow mld	T-N mg/l	T-N kg/day
Nalladryweather flow	29.0	28.0	811.2
Nalla stormwaterflow	82.2	1.58	130.0
S.T.P	20.0	17.0	339.3
Nalla +S.T.P	131.2		1280.5
Total Load		**1760.7**	

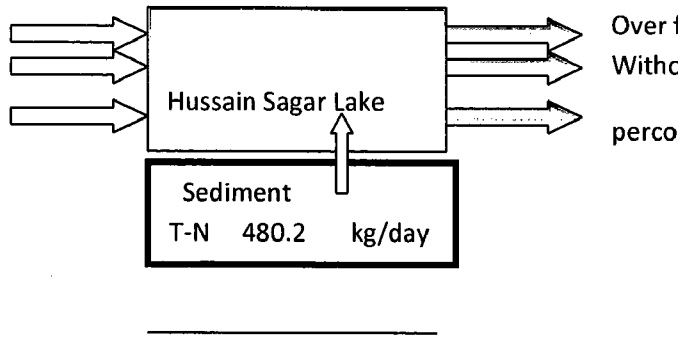


Figure 4.4 Pollution Load of T-N

Annual Average Pollution Source

Inflow	Flow mld	CoD mg/l	COD kg/day
Nalladryweather flow	29.0	620	17961
Nalla stormwaterflow	82.2	30	2467.0
S.T.P	20.0	48	958.0
Nalla +S.T.P	131.2		21386
Total Load			**21386.0**

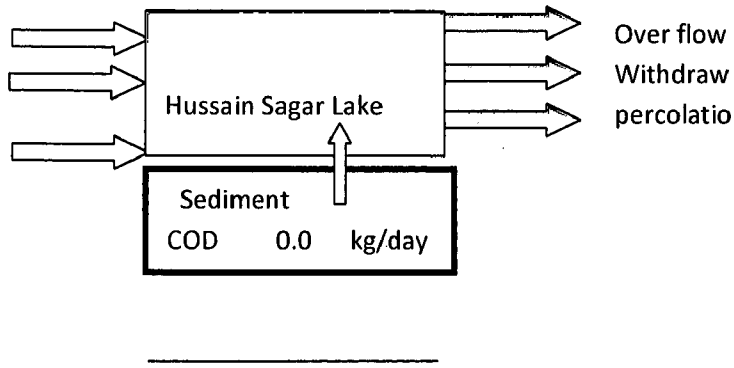


Figure 4.5 Pollution Load of COD

4.3 PRESENT STATUS OF RELEVANT PLANS

4.3.1 National 10th Five-year Plan

Civic amenities in urban areas cover water supply and sanitation, roads and drains, street lights, collection and disposal of solid waste, maintenance of public spaces, burial grounds and crematoria, cattle ponds, registration of births and deaths and also maintenance of markets. These are the functions of municipal bodies along with other regulatory functions. The 74th constitutional amendments has substantially broadened the range of functions to be performed by the elected urban local bodies (ULBs).

4.3.2 National Lake Conservation Plan (NLCP)

The National Lake Conservation Plan was initiated in 1994 for cleaning important lakes with high levels of silting and pollution Though Hussain Sagar Lake has been identified by NLCP as a priority lake, the Andhra Pradesh Government did not take enough initiative. There has been no active communication or effort from the state government for obtaining funding for Hussain Sagar Lake from NLCP. A requirement of the NLCP for funding would be to have a DPR against which funds would be sanctioned. No such DPR has been submitted for approval. Presently, NLCP does not have any funds allocated for Hussain Sagar Lake as DPR is not ready which is a pre-requisite. Hussain Sagar Lake is not part of list of currently funded projects

4.4 SOCIO ECONOMIC PROFILE OF THE STUDY AREA

Socio-economic profile of the study area plays an important role with respect to pollution load on Hussain Sagar Lake. An effort has been made to assess the socio-economic profile of the study area withrespect to city and watershed at a broad level and in the vicinity of lake at a micro level. This assessment has been described below under each head.

4.4.1 Socio Economic Profile of Hyderabad District

Hyderabad (Urban) District came into existence in August 1978 consequent to formation of a new District, Ranga Reddy from the erstwhile Hyderabad District. All the rural areas of erst-while Hyderabad District have been included in Ranga Reddy District, while the area of Municipal Corporation of Hyderabad (Excluding a small part),

Secunderabad Cantonment, Lalaguda and Osmania University are included in Hyderabad District.

1) Demography

The population of Hyderabad District as per 2001 census is 3.8 million. The population belonging to the Scheduled Caste is 0.3 million forming 8.02 % of the district population. They are mainly concentrated in the slum, and 835 slums exist in the district. It is estimated that 71.5

The catchment area falls in the administrative jurisdiction of Hyderabad and Ranga Reddy district.The total catchment area of the lake falls under the jurisdiction of 6 urban local bodies (ULBs) viz., Municipal Corporation of Hyderabad (MCH), Kukatpally Municipality, Qutubullahpur Municipality, Alwal Municipality, Secunderabad Cantonment Board (SCB) and Serilingampally Municipality besides in few Gram Panchayats. Kukatpally, Qutubullahpur, Alwal and Serilingampally municipalities fall in Rangareddy district, while MCH and SCB fall in district Hyderabad. The area of Serilingampally is very small in the catchment area.

However, activities of people living in municipalities with substantial area in the catchment area and more specifically those living in the lake vicinity, influences the lake water quality and environment the most. Besides, the activities of Lake User groups, also significantly influences these parameters. Considering the difference in influence, focus has been much specific on lake user groups and for people living in lake vicinity, for social interventions as compared to for % of scheduled cast population is living in the slums, the rest being scattered over the twin cities. The population belonging to Scheduled Tribes is 34,560 as per 2001 Census forming 0.9 % of the district total population. They are mainly concentrated in slum areas.

2) Literacy & Education

The literacy rate is 69 % in Hyderabad District, which is higher than average literacy rate of 61.11 % of India. There are 1,344 Primary, 502 Upper Primary Schools, 936 High Schools, 254 Junior Colleges, 164 Degree Colleges, and 12 Post-Graduate Colleges functioning in the district during 2002-03. Besides this, there are 7 Medical Colleges, 11 Engineering Colleges, and 6 Universities functioning in the district.

3) Health Facility

There are 12 Allopathic, 2 Ayurvedic, 1 Unani, and 2 Homeopathic Govt. Hospitals functioning in the district during 2002-03. The total strength of the Doctors working in the above hospitals is 627. The total bed strength of these Hospitals is 5,651.

4.4.2 Socio Economic Profile of Catchment Area

Those living in rest of watershed area. Therefore, socio-economic profile of catchment area has been described with respect to slums and in the vicinity of lake & nalla.

1) Social Profile

Analysis of the social group pattern shows that around 46 % of families represent the backward castes followed by the families that represent the general castes (31.5%) SC/ST population (22%). Religious wise, the majority constitutes the Hindus (72.5%), followed by Muslims (19%) and others (8%). 72.6 % is found to be literate which is at par with the literacy rate of Hyderabad (69% as per 2001 census). About 32 % of sampled population have completed their secondary education and 11 % of them even were graduates

2) Economic Profile

Economic profile has been described below under respective heads Occupation Working population (16 to 50 yrs) constituted around 62% of the total residential population both in males and females. 42% of the working population in the lake/nalla vicinity is engaged in private sector as workers in shops, hotels, mechanic shops, rickshaw pullers and auto/car drivers. 26% is engaged as daily wage labourers as vendors, painters, hawkers and maidservants. Most of the women working population are daily wage labourers while majority of the male working population is into private sector.Income Level Most of the households are of low to lower middle-income groups. Average annual household income is in the range of INR 50,000 – INR 100,000. 20% of the households have an annual income in the range of INR 22,000 - INR 36,000.There are few families, residing in pockets of N.B.T. Nagar, B.J.R.Nagar, Mataji Nagar andHussain Nagar, having average annual income below INR 22,000. High-income families are mostly seen in colonies such as Green Park colony,

Singareni colony, Kodandaram Nagar, P&T colony; where most of the households are near permanent employees.

4.5 DRAINAGE NETWORK AND SANITATION

Majority of the areas are covered by underground drainage by the municipal authority except few areas in Mataji Nagar and Ambedkar Nagar. Most of the areas in the lake vicinity have improper storm water drainage and water remains stagnant during rainy seasons. Around 90% of the households have individual toilet facilities connected to sewers. Rest of the households use community latrines mostly in Ambedkar Nagar and NBT Nagar. There are few areas where people resort to open defecation on the lakeshore or in open spaces mostly in Prakash Nagar and Ambedkar Nagar. Only few households of Mahabharat Nagar, Mataji Nagar and Ambedkar Nagar use open spaces for bathing. Indira Nagar and Mataji Nagar are few areas where Integrated Low Cost Sanitation Scheme had been implemented by the government.

4.6 SOLID WASTE

House-to-house garbage collection by tricycles is available in most of the areas but because of unaffordability 52% of the families use community dustbins/open spaces/nallas for garbage disposal according to the results of primary survey. 42 % of respondents are not satisfied by present level of service because of unavailable of dustbins / too far (80%), followed by frequent filling of dustbins (7.2%). During FGDs, families have the opinion that irregular collection of solid waste causes sickness, foul smell and increased mosquito problems in the areas. The frequency of collection of solid waste is once a day. However, it was revealed during FGDs that this frequency is not maintained making it an irregular service.

4.7 MAJOR PROBLEMS FACED BY COMMUNITY DUE TO LAKE/NALLA

The families, who have reported to have some problems, it can be observed that around 96.5 % of them indicated mosquitoes as major nuisance followed by foul smell (61.5%), polluted water (3.5%) and flooding (4%). A majority of them experience these problems seasonally (67%), whereas it is experienced perennially by 32% respondents. Respondents of these slums attribute letting out of sewerage water (46%), industrial pollution (21%), and the solid waste dumping in the lake/nalla (60%) as the other major factors

responsible for the above-stated problems. Major impacts to the families living in the lake surroundings from the above-discussed problems include health problems (98.46%) such as Malaria, Viral fever from the mosquitoes, asthmatic problem from the foul smell and Diarrhea . A small number of respondents informed that due to illness, they are unable to carry out their daily paid works. It affects their income and in some cases has even affected education of their children.

4.8 Community Organization and Participation

74 % of the respondents expressed their willingness to participate in the lake development and conservation activities. Out of these, 57 % are willing to participate in building up environmental awareness, followed by greening around lake (26 %) and in protection of solid waste dumping (12%). Regarding their present status of as member/office bearer of any community organization, only 15 % respondents are members of local residents (colony) associations etc. However, 46 % respondents wished to involve themselves in community development activities and most (93.50%) of them have friends in their neighborhood.

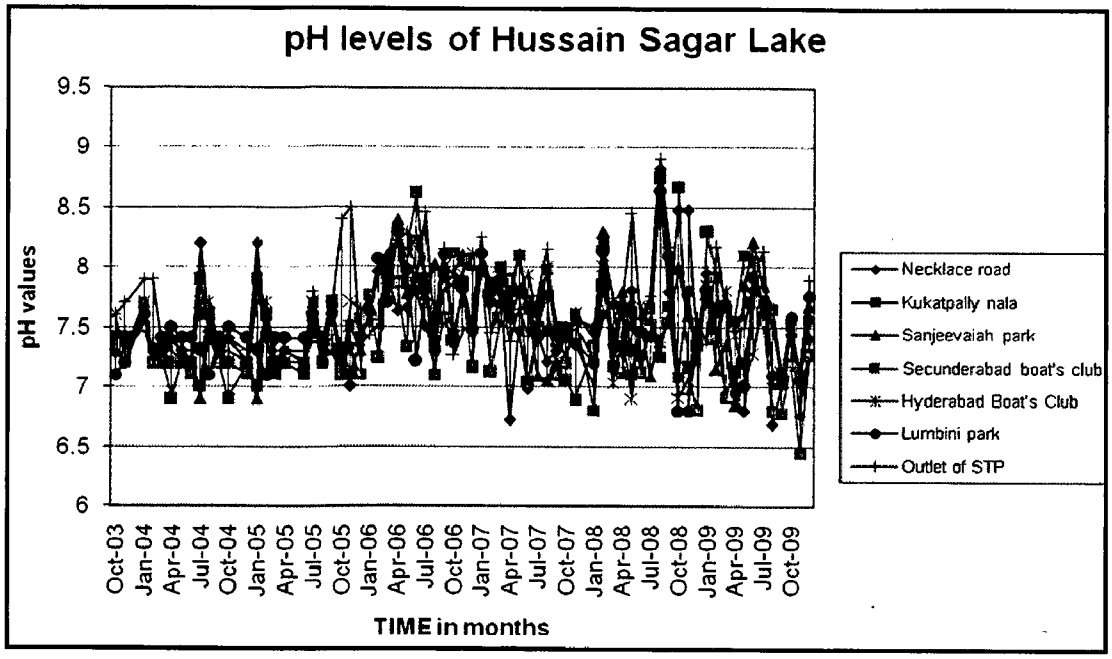
4.9 COMMUNITY DEVELOPMENT PROGRAMMES

Thrift & Credit Group Programme was implemented in NBT Nagar, Mataji Nagar, Brahmanwadi, Old Customs Basthi, Jagjeevan Ram Nagar, Gandhi Nagar, Raj Nagar, MS Makhta and Ambedkar Nagar. DWCUA Scheme was implemented in Jagjeevan Ram Nagar, Allam Tota Bavi and Old Customs Basthi USEP Programme was implemented in Raj Nagar, Mahabharath Nagar, Balkampet, Harijana Basthi (Near Septic Tank), Ambedkar Nagar and Allam Tota Bavi. VGDS scheme is implemented in MS Makhta, Jagjeevan Ram Nagar and Old Customs Basthi .

4.10 WATER QUALITY

4.10.1 PH

The minimum pH of 6.5 occurs at station 2 Kukatpally Nalla and maximum pH of 9.4 occurs at station 4. So the pH at all the stations are within the range of 6.5 to 8.5 .

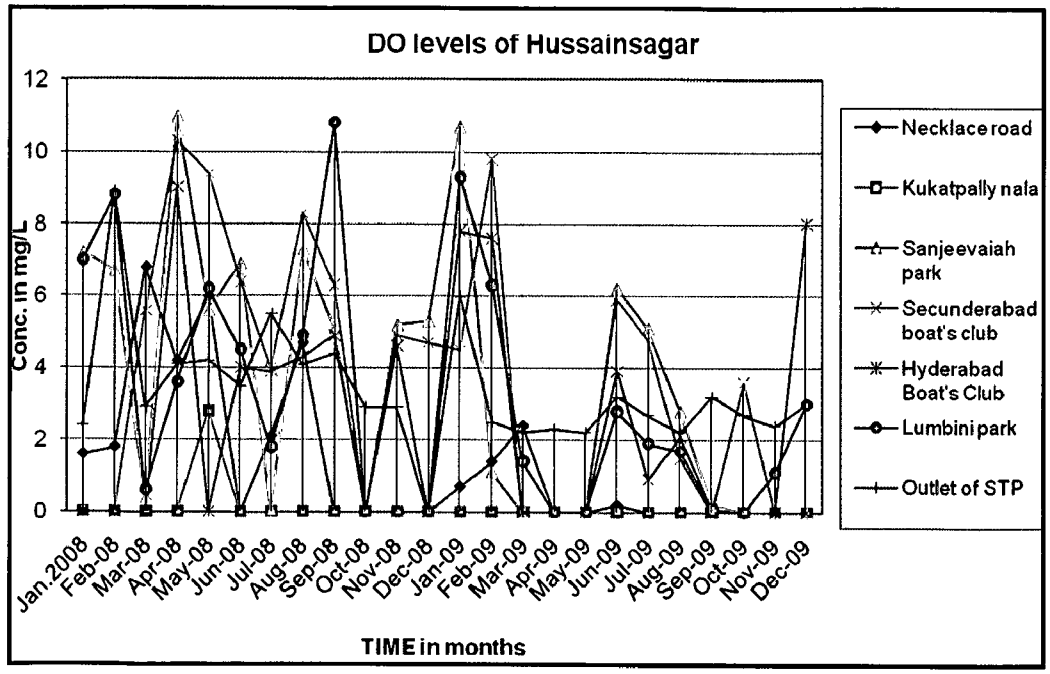


4.10.2 Electrical Conductivity

The minimum electrical conductivity of 1470 µS/cm is observed at centre of the lake and maximum EC of 1500 µS/cm at confluence point of picket nalla. This parameter indicates amount of total dissolved salts or the total amount of dissolved ions in the water and depends upon the pollutants from point & non-point sources as well as urban runoff etc. There is no limit prescribed by any authority in India for EC. But the EC observed is less in all the stations.

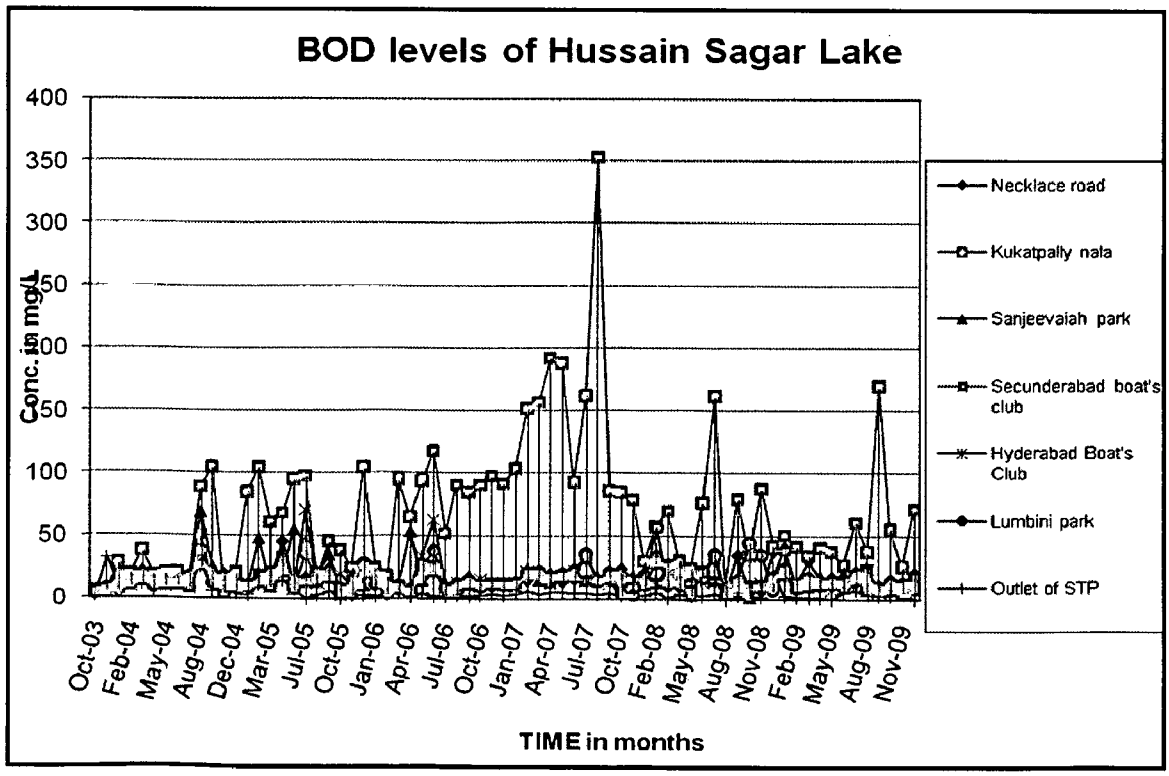
4.10.3 Dissolved Oxygen

The DO at sub surface from 2000 to 2008 is almost nill ,which shows anoxic condition of the lake water. This is harm ful for aquatic life and fishes and results into release from the sediment.



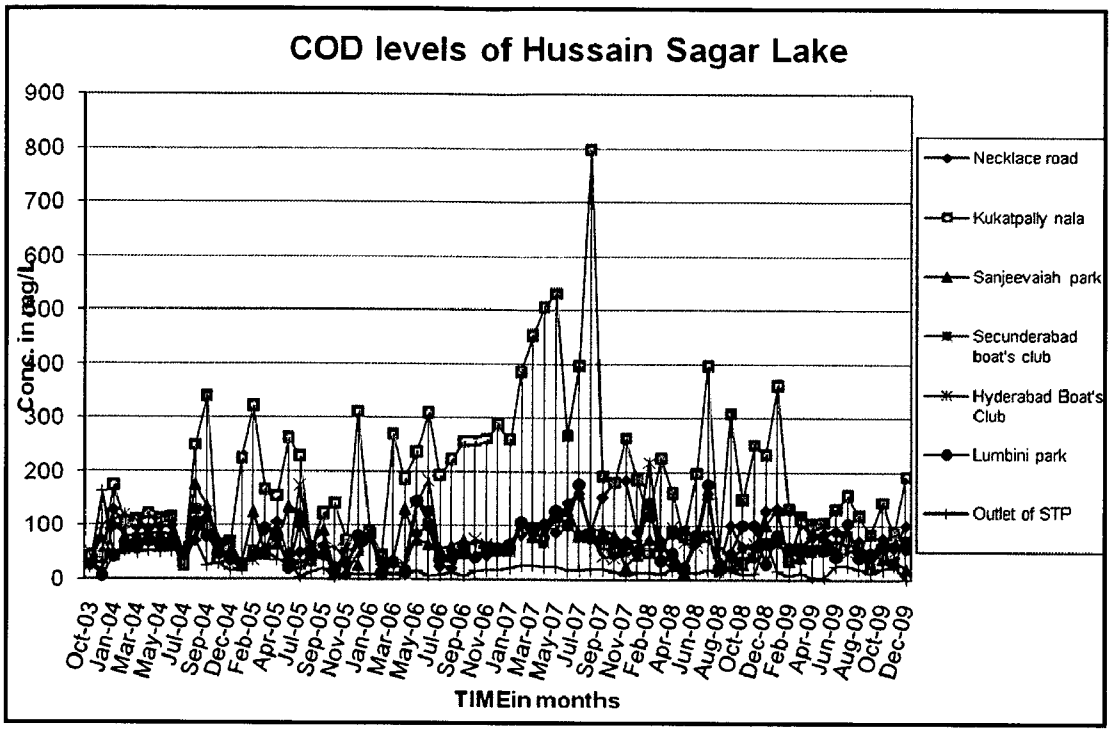
4.10.4 Bio-Chemical Oxygen Demand

The BOD_5 for 5 sampling stations are analysed and for all the stations it is 20 mg/l or less except station 2 kukatpally nalla, where the BOD was 100mg/l. Hence the BOD does not satisfies for class B & C criteria of CPCB.



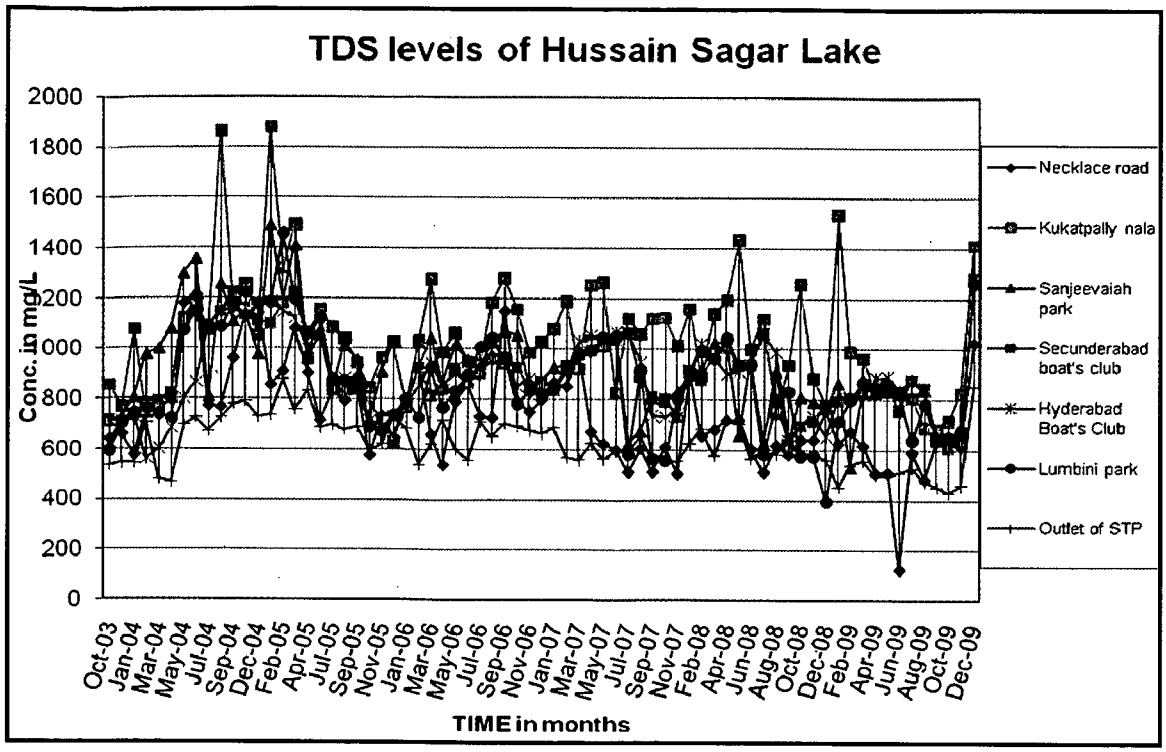
4.10.5 Chemical Oxygen Demand

The COD for 5 sampling stations are analysed and the maximum values of 220 mg/l is obtained at station 2 kukatpally nalla and minimum value of 120 mg/l is obtained at station 4 secunerabad boat club.,



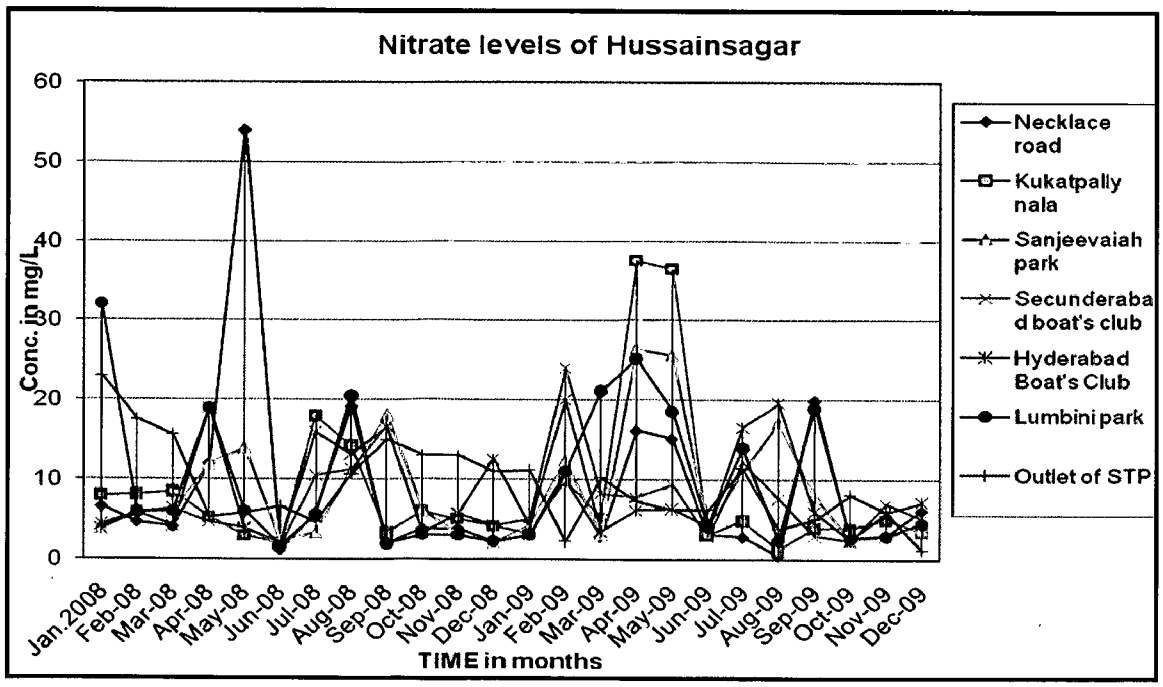
4.10.6 Total Dissolved Solids

The TDS of the water is less around the lake. The minimum TDS of 500 mg/l is observed at necklace road station 1 and maximum TDS of 1400 mg/l is observed at station 3 kukatpally nalla. This indicates high pollution level of lake water



4.10.7 Nitrogen

The NO_2-Nitrogen was above detection limits in all the water samples, however the NO_3-Nitrogen has been detected. The maximum value of 30 mg/l is obtained at station 2 kukatpally nala and minimum value of 0.03 mg/l is obtained at station 6 Lumbini park This indicates that the nitrogen load is more in the lake water during observation.



4.10.8 Phosphorus

The total phosphorus was also above detection limits in all the water samples of the lake which indicate presence of soluble phosphates in the lake.

4.10.9 Sulphate

The sulphate ion was above detection limits in all the water samples of the lake. sulphate is maximum at kukatpally stream 618 mg/l which is crossing WHO limits i.e,400mg/l.

4.10.10 Chloride

The chloride content is moderate throughout the lake, but at Kukatpally nala the maximum average of 358 mg/l is obtained which is more than WHO limits i.e,250 mg/l

4.10.11 Total Coliform

The TC for 5 water samples were analysed and the maximum value of 1600 MPN/100ml is obtained. However the TC for all the stations does not satisfies the permissible and desirable limits for class B & C criteria of CPCB

4.11 BIO DIVERSITY

An exhaustive biodiversity inventory of Hussain Sagar Lake has never been attempted till date.The present study has tried to achieve this. The lake supports several species of microorganisms, migratory and resident birds, freshwater fishes, reptiles, amphibians and other aquatic creatures, and several species of aquatic and terrestrial flora.

The study revealed the existing status of the biodiversity and ecology of the Hussain Sagar Lake. Among the microorganisms about 3 species of phytoplanktons and 30 species of zooplanktons were recorded. In flora about 117 plant species (103 wild and 14 planted) belonging to 40 families were recorded. In fauna a total number of 48 species of butterflies, 7 species of dragonflies, 2 species of damselflies, 2 species of amphibians, 7 species of reptiles, 4 species of fishes, 77 species of birds and 6 species of mammals were recorded from the Hussain Sagar Lake and its environs. Noteworthy findings include a wild herb *Euphorbia sebastinei* (Fig.2) and a rare bird Grey-headed Lapwing *Vanellus cinereus* (Fig.3).

This study endeavors to address certain lacunae in knowledge by gathering comprehensive information on the biodiversity and ecology of the Hussain Sagar Lake and its environs. We are hopefully that the mitigation strategies and recommendations mentioned in this article would be useful for biodiversity management, conservation and research in a long run.

Fig. 4.6 . Euphorbia sebastinei

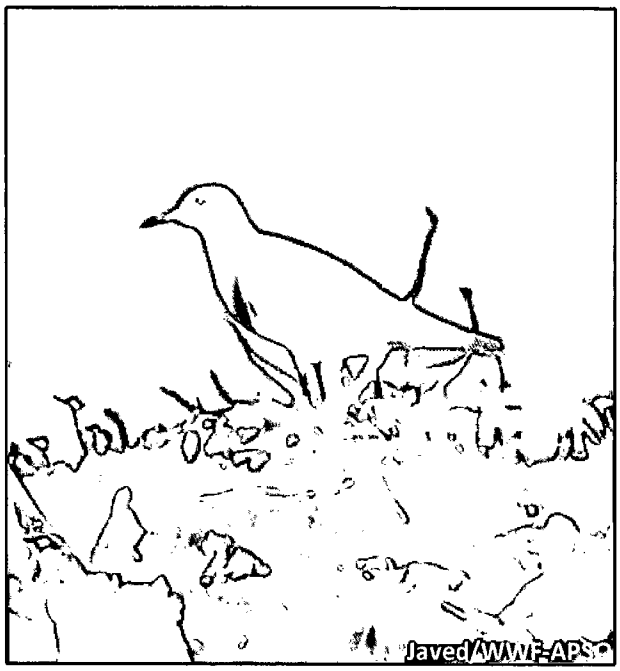


Fig. 4.7. The Grey-headed Lapwing Vanellus

4.11.1 Introduction of composite fish culture :

Fishes constitute very important biotic community in a lake. They not only harvest nutrients and live biomass but also provide much needed proteins. Hussainsagar lake once use to harbour 27 species of fishes (Babu Rao and Siva Reddy,1984)

Table 4.3: Species of fishes

Species	Species
Channa puncctata (Bloch)	Channa marulia *(Ham*
Channa striata *(Bloch)*	Channa orientalis *(Schneider)*
Hetereopneustes fossilis (Bloch)	Clarias batrachus (Lin)
Mystus vittatus (Bloch)	Mystus bleekeri (Day)
Wallago attu (Schneider)	Chela bacaila (Ham)
Amblypharyngodon mola (Ham)	Rasbora daniconius (Ham)
Puntius sophore (Ham)	Puntius ticto (Ham)
Puntius chola (Ham)	Puntius amphibian (Valencinennes)

Puntius sarana (Ham)	Puntius filamentosus (Valenciennes) •
Labeo bogguta (Sykes)	Gerra mullya (Sykes)
Lepidocephalus (Lepidocephallchthys) guntaa (Ham)	Gambusia affinis patruelis (Baird & Girard)
Poecilla reticulate (Peters)	Etroplus maculates *(Bloch)*
Glossogobius giuris *(Ham)*	Osphronemus goramy lecepode
Notopterus notopterus *(Pallas)*	

However, recent survey has reported loss of sensitive species and existence of only few species of hardy cat fishes belonging to the genera Channa, Clarias, Mystus, and Heteropneustes.

Netting operation

***Catfish,* Clarias sp.**

Figure 4.8: Netting Operation and cat fish

Once the lake use to support flourishing fishermen community but with on-set of pollution and reports of contaminated fish, the fishery was banned. There is a need to reassess the situation and introduction of large scale composite fish culture. To begin with some controlled cage culture can be introduced to begin with and based on the results fisheries should be introduced on large scale.

CHAPTER-5

FURTHER INTERVENTIONS

For effective improvement and conservation of the lake, different lake users are to be dealt.Experiences gained on other lakes of the country is also referred.Works for watershed improvement, community participation, institution infrastructure and other interventions for the improvement of hussainsagar lake have been worked out and given below.

5.1 LAKE USER GROUPS

It is very important to identify the lake user group and assess their needs. There are three different groups of lake users in the study area. Firstly tourists/ visitors using the lake for recreation and other purposes like walkers/joggers, secondgroup is the population using the lakeshore for livelihood. However some of these groups like fisherman and washerman have been banned during last few years. Most of such activity is in informal sector like hawkers and vendors. Third user group is the community using services of infrastructural facilities by paying the user fee like boating and restaurant that adds to revenue generation for lake.

The activities of third group of lake users adversely affected the quality of water in the lake. These activities release chemicals, heavy metals, oils and grease, human hairs etc. It has been found that the activities of following types of lake users are not desirable and needs to be strictly monitored to maintain ecology of the lake

- Community living around the lake using the lake for their daily activities like bathing, washing, disposing wastewater and solid waste, for defecation, washing their cattle, vehicles, etc. and even in a few cases for disposing animal excreta (dung).
- Industries and other communities using the lake and feeder nallas to the lake, for disposal of domestic and industrial wastes.

5.2 EXPERIENCES OF PREVIOUS LAKE CONSERVATION PROJECTS

Interventions have been proposed after taking in to consideration the experiences gained from other lake conservation projects on Hussainsagar, Bhopal Bhojwetland and other lakes in the country.

5.2.1 GHEP Experience

The success under Green Hyderabad Environmental Project (GHEP) encourages to build and expand its strategy of public awareness, public participation, and community development. They are about 150 Self Help Groups (SHGs) have been formed with about 1500 members. The same concept was then integrated into the lake development activities. Further, for effective field level operations and create public awareness and public participation (PA/PP), 9 lake volunteers, with background of sociology/social work and the required enthusiasm to work with local communities were hired on a contract basis and trained to perform the desired functions. A number of activities like educational campaigns, community meetings, workshops, competitions on lakes, education on environmental awareness etc. have since been conducted

5.2.2 Bhopal Experience

The lessons learned from Bhoj Wetland project at Bhopal should be implemented for sustainable (BPPA/HUDA's) operations, the retention of staff engaged in public awareness, community development and in monitoring these activities should continue till project period. The efforts made to build their capacity could be better utilized by the project (HUDA/BPPA) if continuity is maintained. Therefore, it is suggested to have an in-house social development expert as part of project implementation unit of HUDA.

5.2.3 Other Lake Development Experiences:

Experiences of lake improvement have been reported from Dal lake, Srinagar: Nainital lake, Nainital; and Loktak Lake, Manipur in India

5.3 INTERVENTIONS PROPOSED

Interventions have been identified and are based on the slum profile, community feedback and project needs These are improvement of solid waste management (SWM) in relation to infrastructure, education,and management; Construction / Renovation of Community Toilets; Public awareness, public relations, community participation and development (environment, environmental protection, lake improvements); Institutional structure

They have been detailed and listed below.

5.3.1 Solid waste management (SWM)

The feedback during public consultation workshop organized by HUDA, FGDs and transect walk indicate that basic solid waste collection and disposal mechanisms were in place in most of the locations. However, for some households, the collection bins were either placed at longer distance (more than 150 m or so) or used to get full very fast (capacity limitations). Sometimes, the solid waste collection from bins was not carried out in time (operational limitation). Due to such limitations, some households were disposing their household wastes in open, which was many a times drifting into open nallas making its way into the lake. Overall, from pollution load considerations, limitations were indicated in the number and capacity of bins and their location. This was considered as one of the bottleneck to be addressed for improved SWM.

The strategy of improved SWM is demand driven and aimed to improve the existing infrastructure support and reduce the problems faced by slum residents in lake vicinity. This is planned to be achieved in an integrated manner i.e. by provision of physical infrastructure, by creating public awareness and by improved management (involving communities). SWM consists of; Provision in 16 slums in lake vicinity with improved solid waste collection infrastructure (2 additional dumper placers on an average in each slum); tri-cycles for transportation; training of rag-pickers in solid waste segregation; Public awareness / community participation.The major effort would be to mobilise communities for improved SWM and generate enough enthusiasm in them so that they start paying for such services.

5.3.2 Community Toilets Works

The basic feedback received during public consultation workshop organized by HUDA, FGDs and transect walk indicate that more than 75% population in the lake vicinity were having individual toilets (both sewered and non-sewered). Besides these, there were community toilets in the area. In spite of these, in some localities, open defecation was practiced. This was observed to be mainly due to limitations in the use of community toilets (including their physical condition as well as availability of water). Open defecation was also practiced by some outside workers, visitors etc. The lack of sanitary facilities combined with their human attitude and general physical conditions of sanitary facilities were considered as major limitations in improved sanitary condition in the area.

5.3.3 Public Awareness and Public Participation (PA/PP)

The major focus of this intervention has been laid on slum population living within lake vicinity (about 25,500)but a different (much broader) focus has been suggested for population living within whole catchment area.

The focus in catchment area would be to create awareness on improved solid waste and sanitation management besides specific watchdog activities. Whereas, focus of PA/PP in lake vicinity would be to create both awareness as well as develop the community for public participation to a level of even management of some of the project interventions (like community toilets etc.). This role will be in addition to the identified watchdog activities, participation in lake protection committees, in Citizen's voluntary committees etc.

In view of the variations in the focus, scope and intensity of PA/PP, the techniques of creating "public awareness" and public participation would be different. In lake vicinity, it would be more intensive i.e. personal contacts using lake volunteers, demonstrations, community awareness campaigns, citizen's voluntary committees, and training to few community members in specific tasks etc. Further, this target group would be involved into extensive public participation than rest of the catchment area. Therefore, lake volunteers have been planned to be used for community development in this area. Whereas, broad based PA techniques using mass-media, pamphlets etc. would be used in the rest of the catchment area.

5.3.3.1 PA/PP Implementation

The PA/PP activities could be grouped into two types considering their implementation: These include activities, which must be undertaken as per timing of the project activities, and others, which could be implemented regularly with a little flexible time frame.

These programs need to be undertaken in accordance with the activity schedule of the project. These include;

Cell Meetings: (Monitoring Cell) Meetings shall take place every month to monitor the progress of work on PA/PP.

Necessary Publicity Programs: The publicity programs shall be planned and implemented to advertise widely the information on the projects as described in the project plan, to the population in catchment area using mass media and printed materials.

Necessary Explanatory Meetings: In Explanatory Meetings, PA/PP activities shall be discussed with communities and stakeholders.

Demonstration Programs: In accordance with the priority projects' schedule, demonstration programmes on the new facilities shall be launched at the start of operation of these facilities to demonstrate and show them to the population

5.3.3.2 Entry Point Activities

To build a platform for initiating the programs in the catchment area/lake vicinity, certain activities have to be undertaken during first year of the project. The slums in lake vicinity will be specifically targeted so as to build faith in the slum communit for carrying out PA/PP activities.

Regular Publicity: Publicity on regular basis is important to keep the community well aware of the needs of lake environment. This effort shall ensure that the much-needed relation between health, sanitation, lake environment and people's role is made clear to the community

Yearly Campaigns: As one of the important actions for the continual efforts, a yearly campaign should be implemented in catchment area in accordance with PA/PP approach. The yearly campaign will set the tone for the entire PA/PP programme of the year. Activities of yearly program will be spread over the year and timings of these activities.

Save Lake Day: Can be conducted twice in a year with specific themes. During public consultation workshop, this was suggested as a strong PA/PP program, which involves inviting contributions (cash and kind) from the community. During the day, various activities could be held around the lake. One such activity to create awareness on lakes was held in Hyderabad through "marathon race" with all participants paying and awards sponsored by industrial houses. Each participant was provided a free cap with save lake campaign slogan printed on it. School Children could be involved into it. One such occasion could be National holiday (15 Aug, 26 Jan, 2 October) or The World Environment day (June 05).

Regular activities in Slums: To overcome various problems of slums, especially for the creation of neighbourhood groups and then CBO's, it is essential that the local NGO/local consultant/lake volunteers visit these areas on a regular basis and keep discussing about the needs and their roles

5.4 PROPOSED INSTITUTIONAL STRUCTURE

In order to implement the watershed improvement works and to have 'Public Participation', intermediation of local governmental bodies is necessary. The Urban Community Development (UCD) Section of MCH and Health Department of other municipalities could work as Implementing Agency (IA) for watershed improvement works. It would also coordinate the PA/PP activities of other municipalities. As multiple agencies are involved, HUDA could continue to be a monitoring and supervising agency besides providing budgetary support.

Local functionaries of each Ministry such as the Hospitals, Primary Health Centres, elementary and secondary schools, and public mass media like the national TVs are expected to work as the intermediate actors.

For solid waste management and community toilets works, as most of lake vicinity falls under jurisdiction of MCH, the engineering cell of the MCH shall be the implementing

agency (IA). HUDA could continue to be a monitoring and supervising agency besides providing budgetary support.

5.4.1 Monitoring Cell

This cell shall monitor / supervise the watershed improvement works including PA/PP activities. Thecell shall Social Development Expert, Chief Engineer of HUDA would be part of the monitoring cell, whereas from other municipalities, the health officer would represent. Wherever, health officer is not available, the Planning Officer would represent the municipality

5.4.2 PMC (Community / Social Development Expert)

The PMC (Community/Social Development Expert) shall be the nodal agency (person) establishingthe much-needed link between HUDA and local level implementation. S/he shall have a reporting relation to Project Manger and shall provide consultation and receiving reports at the local level. Apart from that his office shall be responsible for monitoring work progress in respective municipalities, guiding and ensuring that horizontal co-operation happens. S/He shall also be responsible for technical advice to the Monitoring Cell, whenever required.

5.4.3 Local Consultant / NGO / Lake Volunteers

The body may be hired for watershed improvement works and will execute the work in the municipality under the guidance of Monitoring Cell and PMC. The local consultant/NGO shall work as the link between the authority and people and will be reporting regularly on monthly basis to the Monitoring Cell.

Proposed roles of NGO / Local Consultants are; Door to door collection of solid waste,training and guidance in Operation and Management of Community Toilet facilities, assistance in implementation of PA/PP activities in the catchment area.

Lake Volunteer would be engaged in; Creating public awareness on lake cleanliness, health and hygiene , community mobilization to support lake development works , educating the communities living in lake vicinity to reduce pollution load entering the nearby Lakes.

5.4.4 Local Communities

The people themselves cannot interact with the agency on individual basis but will have to be organised into groups through which the program will be routed. These local communities can work effectively to mobilize the public / residents and enhance the participation

These organizations could include;

5.4.4.1 NGH, NHC, RWAs

They can effectively contribute in solid waste management and community sanitation related activities by developing public awareness, in participatory planning at local level for SWM and community Toilets, in evolving and implementing O&M options for these activities.

5.4.4.2 Sarasu Sanrakshan Samitis

This lake level group can work in the area of public awareness/ community participation for lake conservation and in management of public utility facilities (parks etc.) around the lake.

5.4.4.3 Ganesh/Durga Puja Samities

They could be used in developing awareness on idol and its implications on lake pollution (size, alternate materials of construction and decoration etc.) as well as educating them on use of alternate sites for idol immersion for improved lake environment etc.

5.4.5 Citizens Voluntary Committee (CVC)

The CVC shall focus on the following aspects: Enhancing Community participation in watershed improvement works (guiding no solid waste disposal in lake/nalla, training of rag pickers, encouraging no open defecation, reducing use of polythene bags and encouraging use of biodegradable materials, no disposal of animal excreta into lake/nalla, supporting neighbourhood committees in organizing communities for proper collection and disposal of solid waste).

The major role of CVC shall be a guide and"watchdog" and to report the matter to appropriate authorities.these are improved management of community toilets - avoiding sewerage flow in open drains etc, monitoring of existing effluent treatment plants, management and maintenance of Interception and Diversion Works, feedback for maintenance of sewerage network, monitoring of lake water and sediments, watchdog activities (informing HUDA/local bodies about any actions of community, people having negative water quality effects.

5.5 COST ESTIMATES

The total estimated cost of project interventions under watershed improvement works as presented in Table 5.3 is INR 43.4 million. This consists of INR 1.6 million on solid waste infrastructure, INR 6.8 million on community toilets and related works, INR 35.0 million on public awareness and community participation including training and social surveys etc. It is assumed that cost of Social Development Expert would be part of contribution from HUDA side. Whereas, the engagement of Community / Social Development expert shall be met from the Project Management Consultancy cost. The present PA/PP cost includes hiring of lake volunteers for the project activities.

During project implementation, if additional needs are identified then, a local consultant/NGO could be hired for the purpose. The cost estimates are based on estimates developed by HUDA and historical information available with the HUDA and other organizations. The recent cost data under Green Hyderabad Environment Project for various PA/PP activities was a benchmark for the cost estimation. The activities, for which data were not available with HUDA and other sources, have been used and inflationary costs adjustments have been made.

S.no	Project Activity	Non-Recurring(NR) Estimated Cost	Recurring (R)Estimated Cost	Total (NR+ milli
1	Solid waste Management			
1.1	Improvement	1.12	_	1.12
1.2	Collection Infrastructure	0.12	_	0.12
1.3	Tri-cycles	_	0.36	0.36
	Training of rag-pickers			
2	Community toilet works			
2.1	Community toilet facilities	6.40	_	6.40
2.2	Improvement	0.40	_	0.40
3	Public Awareness, Community participation and development including social surveys.			
3.1	Social Survey	0.6	_	0.6
3.2	PP/PA Activities	_	19.8	19.8
3.3	Consultancy services	6.6	_	6.6
3.4	Organizational	_	3.5	3.5
3.5	Strengthening(local level)	_	4.5	4.5
	Organizational Strengthening(programme level)			
4	Institutional Structure			
4.1	Monitoring Cell	_	2.5	2.5
4.2	Community/Social Development	_	1.5	1.5
4.3	Expert	_	6.6	6.6
4.4	Local Consultant/NGO/Lake	_	1.5	1.5
4.5	Volunteers	_	1.0	1.0
	Local Communities			
	Citizen Voluntary Committee			
	Total	**15.24**	**41.26**	**56.5**

Table 5.1: Proposed Project Interventions Estimated Costs

The project cost for the first year will be 56.5 million. Thereafter, every year a recu expenditure of 41.26 million will have to be made for proposed interventions. suitable provi will have to be made for this amount either in the budget of the agency(ies) involved i execution of proposed intervention or met out of revenue generated by taxes etc, which m levied.

CHAPTER-6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Following conclusions can be derived from the present study:

1. With the long term analysis of water in the lake ,chemical parameters like pH, DO, B(and COD etc were found not suitable for aquatic life in the lake.

2. High value of Total Solids in the water in the lake indicate the high rate of sedimentat and thus indicate gradual decrease in the carrying capacity of the lake.

3. Sediment contains high concentration of heavy metals.

4. Algae are predominant in the lake water and is on the threshold of algal bloom.

5. Inspite of ongoing installations of STPs on the incoming sewage , there is still a gap of mld capacity of STP.

6. It had found that main pollution to the lake is entering from Kukatpally nalla where industries causing most hazardous pollution are located. It is important that adequ arrangements are made to ensure that the industries do not dispose off their waste dire into the lake without appropriate treatment which is responsible for pollution of l waters. This can be done by the industries individually or collectively. The S Pollution Controll Board and other agencies involved in monitoring the quality of w entering the lake through various inlets should ensure that this is effecti implemented.

7. Abatement of pollution coming to the lake is urgently required.

To fill the gaps additional conservation works and programmes like on Solid waste manage improvement, construction of community toilet works, public awareness, comm participation and Institutional arrangement have been proposed. Estimated Cost is 56.5 mill

6.2 RECOMMENDATIONS

1) Present study could not cover the estimation of runoff from the storm, sediment tra rate, water balance of the lake and biological trophic index. Further study may be ca out to cover these themes to arrive at more refined analysis and solutions.

2) Core sampling and analysis of lake and drain bed may be done to assess the thickn the accumulated sediment and its nature to assess sediment rate the loss of volume o sediment required to be desilted.

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