SUMMARY

An urban pond is generally described as a water body of a smaller size, manmade or developed naturally. Lakes and ponds are important fresh water habitats throughout the world, although the amount of water in them constitutes only a minute fraction of the total fresh water resources on the earth. Ponds are habitats of great importance as they provide water for domestic, industrial and agricultural activities of human being.

Limnology is a science that deals with fresh water aquatic systems like lakes, ponds, rivers and streams. It provides the tools necessary for understanding how water bodies behave in environment without significant human influences and how they are affected by full range of human activities. It is a discipline that concerns the study of inland aquatic ecosystems reference to the biological, physical, chemical, ecological and hydrological aspects of lakes, ponds, rivers etc. Wetzel (2003) define limnology as the study of the structural and functional interrelationships of organisms of inland waters as their dynamic, physical, chemical and biotic environment affect them.

Urban ponds are also subjected to a different set of stressors like washing clothes, bathing, and sewage dumping etc. at the local scale then the rural counterparts. Countious loading of organic matter, phosphorus and nitrate in these water bodies have lead to eutrophication of lakes and reservoirs. The water of these fresh water bodies are used for various human activities and so becomes necessary to check the physico-chemical characteristics of the same. The study of physico-chemical properties of an aquatic ecosystem is important because fluctuations in its quality have an influence on the biotic communities

(Aher et al., 2007). Biotic factors like presence of organisms and productivity are regulated by physico-chemical status of water and soil. The soil plays vital role as sink and source for inorganic and organic salts and provide substratum for production of hydrophytes. The increasing tendency of these fresh water weed resources may get degraded due to dumping of industrial, chemical, domestic sewage in an uncontrolled manner. This creates potential health hazards and pathogens present in domestic sewage are responsible for diseases such as dysentery, typhoid, cholera etc. So it is necessary to stop such anthropogenic activities in water bodies.

The investigation was carried out to study the limnological aspects of urban ponds with their seasonal variations in response to changing physico-chemical and biological factors of the pond. To achieve the aim of the present study following major objectives were set forth and appropriately approached.

1) Evaluation of physico-chemical status of pond.

2) Assessment of Biotic component.

3) Anthropogenic relationship for water body.

Abiotic and biotic status studies of freshwater bodies have been major component of limnology. Although the size, usage and variability of inputs differentially influence the quality of aquatic body, researchers have mostly investigated routine physico-chemical properties of the aquatic systems. Research reports on ponds highlights the impact of pollution and other factors

on the limnology, however many are lacking the holistic view of the pond as well as the health status of the surrounding slum inhabitants.

There are several ponds in and around Vadodara city within Vadodara Urban Development Authority (VUDA) area. Various urban ponds of Vadodara city were surveyed during the study period; however for this work only two ponds were selected viz., Sama pond and Harni pond. Sama pond was subjected to detailed analysis, as site wise anthropogenic actions and its possible impact were recorded for only this pond. This pond is utilized by surrounding inhabitants for various activities such as bathing, washing clothes, cleaning vegetables as well as vehicle washing and dumping sewage etc. Compared to other ponds of Vadodara city Sama and Harni ponds are under heavy influence of urbanization, and in future the situation may worsen and thus these two ponds were selected for systemic study. Sama pond is geographically located beside a highway; hence immense pressure of transportation is recorded along the site. This easy access made the pond subjected to more activities compared to Harni pond. The Harni pond is away from highway and has comparatively lesser slum inhabitation also. As this pond receives more amounts of general waste and untreated sewage from different sources, it was found having high organic status, visible through more vegetation and greenness of water.

SAMA POND, an urban pond is located in Vadodara district of Gujarat State. It is a perennial urban pond; the geo-location is 22°-20'-554"N and 73°-12'-177"E. Average depth of the pond is 02 meters with water storage capacity of approximately 1.2 lakh cubic meters at Full Reservoir Level (FRL). Three

different sub sites within Sama pond were selected for present study, on the basis of their anthropogenic pressures. Subsite-1 located near Urmi School, is less influenced by the anthropogenic activities. The subsite-2 is along the highway, the activities like sewage dumping and washing vegetables is done regularly on this side. SubSite-3 is near the human residential area where washing clothes; cleaning utensils and bathing etc. are common features.

HARNI POND is located at 22° 20' 266" N, 73° 13' 115" E. Average depth of the pond is 03 meter. Water storage capacity of the pond at FRL is about 3.5 lakh cubic meters. There are around 100 hut settlements on the North-Eastern side of the. The household sewage and domestic waste is diverted directly into the pond. Thereby increasing the organic load on the water and promoting the growth of algae responsible for deterioration of water quality, besides, propagation of microbes causing diseases. Like Sama pond, here on the bank local inhabitants washes their clothes, utensils etc.

The physico-chemical analysis of water and soil samples was carried out to study the ecological status of the ponds. The data is tabulated as monthly, seasonally and annual variations and presented in appropriate graphical forms. All the data was subjected to properly statistical analysis to infere results. The Sama pond was studied for complete two years (2007-08, 2008-09) for water quality status. Whereas as Harni pond was studied for year 2008-2009.

Site specific variation has been observed for few physico-chemical parameters. The highest value of pH was recorded during summer at site-1 and site-3 and the minimum values were observed in winter and monsoon respectively at site-1

and site-2. Acidity was highest in monsoon at site-1 and at site-2. The alkalinity was recorded highest at site-3 in the month of May. The chloride values were highest at site-3 in July and lowest at site-1 in the month of April. The water hardness was highest during monsoon and lowest in winter at site-3 and in summer at site 1 and 2 both. The value of Total Solids was recorded highest at site-2 in the month of May and during second year (2008-2009) maximum at site-1 during summer and at site-2 and 3 in winters. The minimum value of Dissolved Oxygen was recorded at site-2 in the month of November. The value of DO was observed highest in winter at site-1 and 2 and in monsoon at site-3 while lowest at site-3 in (February) winter in second year. The maximum value of Total Phosphorus was recorded in July at site-3 and minimum values observed in winter at site-1 and 2.

Seasonal variation in the water quality status of Sama pond reveals that the pH was alkaline during the entire study period. The range of acidity in water was comparatively lower in first year than in the second year. The alkalinity was high during summer in first year while it was high in monsoon during second year. During first year Calcium hardness was higher in monsoon while Magnesium hardness was low during same season. Total Solids were found above the normal range for both the years. High values of Total Solids were recorded during summer for both the years. Dissolved oxygen was within normal range during both the years. Nutrients like nitrate was recorded high during summer while Total phosphorus was comparatively less in winter during both the years.

During the water quality assessment of Harni pond it was observed that the pH remained alkaline throughout the study period. The value of acidity was low in winter and high in monsoon and that of alkalinity was minimum in winter and maximum in summer. Both the Total Solids and chloride were high in summer months.

The bacteriological analyses of both ponds were done. Total Coliforms include bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste. The presence of indicator organisms (Escherichia coli *or thermo tolerant* coliform bacteria) in water indicates recent contamination of the water source with fecal matter and hence possible presence of intestinal pathogens (Murage and Ngindu, 2007). High levels of nutrients are responsible for the growth of *E.coli* bacteria in the pond and may cause the water borne diseases like gastroenteritis. The content of *E. coli* in open water bodies varies with seasons and their high level sharply increases after heavy rainfall (Voznaya, 1981) as well as the influence of sewage. The higher values of Coliforms in monsoon season at both Sama and Harni ponds may be due to inflow of nutrients with rain water. Considering the density of population settled around the ponds and their continuous usage of resources, very huge bacterial count were noticed is clearly an indication of possible epidemics.

Here in this study comprehensive analysis of soil quality for both the ponds was carried out. For Sama pond the pH of soil for all the 3 sites is alkaline with very less variation during entire period of study. Water retention capacity of soil sample from site 3 shows more fluctuations, this may be due to more exposed

slurring might be allowing atmospheric effect on the sample area. At site 3 dissolved organic matter is high with considerably monthly variations, may be due to more anthropogenic activities surrounding the site. The depletion in soil quality may be due to the influence of anthropogenic activities around the water sheets. Any form of human interventions influences the activity of soil organisms (Carry and Good, 1992). pH of soil is alkaline at almost all the 3 sites and so there is increased in organic matter content and total Phosphorus. Thus due to all this factors nutrient content of the pond will increase. Alkaline soil absorbs more phosphorus from soil so it is the positive factor for productivity. Higher water retention capacity prevents the percolating of water and helps in recycling of humus and maintaining the water level of the pond.

At Harni pond the pH of the soil is almost alkaline, the minimum pH was recorded in January and maximum in the month of June, Maximum water holding capacity was observed during November and the average water retention capacity was recorded above 50%. The availability of phosphorus is important to aquatic productivity owing to the fact that PO_4 ions in soil form insoluble compounds with iron and aluminum under acidic conditions and with calcium under alkaline conditions, rendering the phosphorus ion unavailable to water body. At Harni pond the pH of the soil is almost alkaline, the minimum pH was recorded in winter and maximum in monsoon, so there is a possibility of increasing Organic matter and Total Phosphorus. Maximum water holding capacity was observed during winter and the average water retention capacity was recorded above 50%. Total phosphorus was reported highest during winter.

The biodiversity account for the ponds was reported as taxonomy of various plankton and molluscans etc. Plankton is important component of aquatic ecosystem and has diverse habitats. In the present study, 33 species of phytoplankton and 14 species of zooplankton were recorded from Sama pond. The high density of Bacillophyaceae population mainly consist of Oscillatoria, Ankistrodesmus, Clostridium, Syndrea etc. have been recorded. The presence of Chlorella, Naviculla, Euglena and Oscillatoria species indicates the water is polluted due to presence of high organic matter (Venkataswaru, 1981). Other than Bacillophyaceae, Chlorophyaeae population was represented significantly. The dominance of Chlorophyceace was also recorded by Sakhare and Joshi (2002). This study reveals the presence of zooplankton with copepods as dominating group.

Molluscan diversity was estimated by identification of the collected specimen or shells, class gastropoda and class bivalvia were observed from the study sites. The gastropods were more in number than bivalves. A total of 11 species of molluscan varieties were found. At each site the number of individuals varies from 0 to 35 of different species. Out of 11 species of fresh water mollusca three species viz., Lymnae, Tharia and Planorbis were identified to act as intermediate hosts in several diseases.

The length - weight relationship is an important tool in fish biology (Le Cren, 1951); physiology, ecology and fisheries assessment. This relationship is used for various purposes, like, determination of the mathematical relationship between two variables, the relative condition can be estimated to assess general well

being of the fish and type of growth i.e. whether isometric or allometric and study of fish population dynamics. Average of total length and standard length of fish population of Sama ponds is 15.17cm and 12.89 cm respectively. Correlation between total length and weight and standard length and weight of fish population of Sama is 0.88 (r^2) and 0.92 (r^2).These values indicate that there is positive correlation between two variables. Where length will increase than weight will also increase. Condition factor of fish population is 1.5. It indicates that the growth pattern of fishes of Sama pond is allometric. When "b" is greater than 3 it denotes the stoutness, which would indicate that the growth is allometric (Ahmed et al., 1990: Banu et al., 1992: Ikoni, 1996).

To understand the possible relation of pond quality parameters and overall health condition of inhabitants surrounding the pond, regular data collection was done through health camps and the secondary data were collected from the Health department of Municipal Corporation. During the socio-economic survey it was observed that the locals residing near the ponds are prone to diseases like malaria, gastroenteritis (GE), cholera and diarrhea, skin irritation etc. Among them more cases of GE and skin irritation were reported form the inhabitant population. During June to October such gastroenteritis spread was recorded during study period, this may be related to fluctuations in the water quality due to new water entry. Presence of higher Coliform bacteria during July to September confirms the dwindled water quality. Such biologically unsafe water quality facilitates on set of various water borne diseases. Contact with water containing high amounts of blue green algae can cause skin irritation.

Thus here in this project the limnological assessment of two different urban ponds of Vadodara city was carried out. The environmental assessment of Sama pond was done critically to evaluate the status of the pond and its relationship with anthropogenic interactions. Both the ponds are environmentally balanced and are not showing any negative impact of human activities. Even though there are records of sublevel water quality during certain time frame and occasional incidences of water borne diseases in the population residing around Sama pond, the pond cannot be considered having negative impact. It is suggested that regular environmental assessment of such ponds must be done by Municipal Corporations and must keep check on water and soil quality as well as biotic component of the pond to avoid problems of quality degradation or diseases outbreak.