

## Scenario of Water Bodies (Lakes) In Urban Areas- A case study on Bellandur Lake of Bangalore Metropolitan city

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**Abstract:** Environment is made up of natural factors like air, water and land. Each and every human activities supports directly/indirectly by natural factors. India is facing a problem of natural resource scarcity, especially of water in view of population growth and economic development. Due to growth of Population, advancement in agriculture, urbanization and industrialization has made surface water pollution a great problem and decreased the availability of drinking water. Many parts of the world face such a scarcity of water. Lakes are important feature of the Earth's landscape which are not only the source of precious water, but provide valuable habitats to plants and animals, moderate hydrological cycles, influence microclimate, enhance the aesthetic beauty of the landscape and extend many recreational opportunities to humankind. For issues, perspectives on pollution, restoration and management of Bellandur Lake Falls under Bangalore Metropolitan city is very essential to know their status but so far, there was no systematic environmental study carried out. Hence now the following studies are essential namely Characteristics, Status, Effects (on surrounding Groundwater, Soil, Humans health, Vegetables, Animals etc.), resolving the issues of degradation, preparation of conceptual design for restoration and management.

**Keywords:** Bangalore Lake, Bellandur lake, Degradation, Lakes Status, Urbanisation Trend

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### I. Introduction

The word "Lake" is used loosely to describe many types of water bodies – natural, manmade and ephemeral including wetlands. Lakes are perceived as vast expanse of water in a pristine landscape where one goes for recreation. It is a place of experiencing nature by way of boating, camping, fishing, swimming, bird watching, etc. however, when one mentions 'urban lakes' the picture is soon demystified.<sup>[1]</sup> Global fresh water is the most precious human resource frequently earth is called "blue planet" because water covers about 75% of the globe, but most of the water is saline. Less than 5% of water is fresh and much of this water is in the ice caps, glaciers and ground water. Most of the remainder is in lakes, streams and soil moisture. About 1/3 of this is lost immediately due to evaporation.<sup>[2]</sup>

#### 1.1 Limnology

Limnology is a discipline that concerns the study of inland waters both saline and fresh, specifically lakes, ponds and rivers including their biological, physical, chemical and hydrological aspects. The term 'limnology' originates from Greek word 'limne (lake)' and 'logos (study)'. The lakes are quiet large bodies of fresh water usually deep enough that their beds lay much beyond the photosynthetic zone. Fluctuations in the lake level are because of climate conditions and human water requirements. The rate of water replacement of a lake also depends upon the season. Many lakes are artificial and constructed for hydro-electric power supply, recreational purposes, industrial, agricultural use and domestic water supply<sup>[3]</sup>.

#### 1.2 System of lakes

Water body or a lake, in general forms is a self-sustaining eco-system and maintains more or less a reasonable water quality, if not disturbed, that is, the oxygen level in water remains naturally balanced. The organism present in the benthic layer on the bed releases oxygen while digesting the organic matters. The surface layer on the other hand absorbs oxygen from atmosphere. The surface layer heated by solar radiation is generally warm and is called the Epilimnion while the bottom layer is generally cold and known as the Hypolimnion. The transitory zone between the two is known as the Thermocline, formed at a particular depth. The diurnal heating causes the Thermocline to shift towards the bottom thickening of the Epilimnion zone and decreases the extent of the Hypolimnion zone, which seems to be prominent in shallow lakes. However, it is the seasonal change (ie, summer and winter) that also causes a shifting in the Thermocline, influencing the mixing. The oxygen level would usually remain more or less sufficient for fish and other aquatic weeds and plants for

small lakes or tanks and water bodies in tropical region. The entry of nutrients in a water body results in increase of biological activity, growth of weeds and vegetation or algal boom, they upsetting the ecological balance. The organisms at the bottom layers (Hypolimnion zone) in digesting the added load consume more oxygen and soon the Hypolimnion is depleted of oxygen. Thermal stratification whenever formed in a water body hinders the renewal of oxygen in the Thermocline and thus the lower body of water being deprived of oxygen can no longer sustain the higher life forms <sup>[4]</sup>.

### **1.3 Degradation of lakes**

Source of surface water and ground water have become increasingly contaminated due to increased industrial and agricultural activity. Pollution is one of the most burning problems before the mankind. It causes damages to the human being on the one hand and his property on the other hand. In some of the cases it has become the root cause of the destruction of human beings by producing various kinds of pollution resulting in various types of diseases, deterioration in the quality of the crops, crop failures and so on. Nature is always positive and helpful to human beings still it is being polluted. Pollution is an undesirable change in the physical, chemical or biological characteristic of air, water and soil that have harmful effect on the life or create a potential health hazard of any living organisms. Degradation and pollution in the existing natural balance of ecosystem is known as pollutants. The main type of pollutants domestic sewage and other oxygen demanding wastes, infectious agents, plant nutrients, organic chemicals, which are highly toxic at very low concentration such as insecticides, pesticides, detergents and petrochemicals, minerals and chemicals including chemicals residues, salts, acid silts and sludge, sediments from land erosion, radioactive substances and heat from power and industrial plants <sup>[3]</sup>.

### **1.4 Essentiality of lake water**

Every person depends on water for drinking, washing, carrying-away waste and other domestic needs. The water supply system must also meet requirements for public, commercial and industrial activities. The availability of water is an important factor in the establishment of the earliest settled communities and even today <sup>[5]</sup>. Lakes are important feature of the Earth's landscape which are not only the source of precious water, but provide valuable habitats to plants and animals, moderate hydrological cycles, influence microclimate, enhance the aesthetic beauty of the landscape and extend many recreational opportunities to humankind. The lakes are also used for drinking, fishing, eco-tourism etc <sup>[6]</sup>.

Lakes and surface water reservoirs are the planet's most important freshwater resources and provide innumerable benefits. They are used for domestic and irrigation purposes, and provide ecosystems for aquatic life especially fish, thereby functioning as a source of essential protein, and for significant elements of the world's biological diversity. They have important social and economic benefits as a result of tourism and recreation, and are culturally and aesthetically important for people throughout the world. They also play an equally important role in flood control. However, the remarkable increase in population resulted in a considerable consumption of the water reserves worldwide. <sup>[7]</sup>

## **II. Introduction to Bangalore**

Bangalore, the capital of Karnataka, has a history of over 400 years. A succession of South Indian dynasties ruled the region of Bangalore until in 1537 AD; Kempe Gowda a feudatory ruler under the Vijayanagara Empire established a mud fort considered to be the foundation of modern Bangalore. Following transitory occupation by the Marathas and Mughals, the city remained under the Mysore Kingdom, which is now a part of the Indian state of Karnataka. Bangalore continued to be a cantonment of the British and a major city of the Princely State of Mysore which existed as a nominally sovereign entity of the British Raj. Following the independence of India in 1947, Bangalore became the capital of Mysore state and remained capital when the new Indian state of Karnataka was formed in 1956. The origin of Bangalore city can be traced back to 1537 when it was founded by Late Magadi Kempegowda. Bangalore is the principal administrative, cultural, commercial and industrial centre of the state of Karnataka. The city of Bangalore is situated at an altitude of 920 meters above mean sea level. Geographically it is located on 12.95° N latitude and 77.57° E longitude. The city enjoys a pleasant and equable climate throughout the year. Early 90's boom in the software sector with consequent infrastructure initiatives, has contributed to rise in population, mainly due to migration. It is now home to high-tech companies a part from numerous establishments in manufacturing and processing industries. Bangalore is well known as a hub for India's information technology sector. It is among the top 10 preferred entrepreneurial locations in the world. Bangalore is home to many well-recognized colleges and research institutions in India. Numerous public sector heavy industries, technology companies, aerospace, telecommunications, and defence organisations are located in the city. Bangalore is known as the Silicon Valley of India because of its position as the nation's leading IT exporter. As a growing metropolitan city in a developing country, Bangalore confronts substantial pollution and other logistical and socio-economic

problems. The population of Bangalore as per the 2001 census was 5,686,844 while it was 1,63,091 in the beginning of the last century (1901). As per provisional reports of census of India, population of Bangalore in 2011 is 84,25,970 and is the third densely populated city in India having density of 11,000 per square kilometers. With a booming economic activity, migration in search of livelihood, and availability of land favored by salubrious climate all round the year, sprawl has been prevalent in and around Bangalore. Recently, the city administrative jurisdiction was expanded to 741.0 square kilometers (286.1 sq mi) agglomerating neighboring outgrowth by formation of Bruhat Bangalore Mahanagara Palike (BBMP, Greater Bangalore Municipal Corporation) is in charge of the civic administration of the city. It was formed in 2007 by merging 100 wards of the erstwhile Bangalore Mahanagara Palike, with seven neighbouring City Municipal Councils, one Town Municipal Council and 110 villages around Bangalore. The BBMP is run by a city council composed of 250 members, including 198 corporators representing each of the wards of the city and 52 other elected representatives, consisting of members of Parliament and the state legislature. With the expansion of Bangalore in recent times with concentrated development of industries and commercial establishments, the growth appears to have reached the threshold. <sup>[8, 9, 10, 11]</sup>

### **2.1 Status of water supply to Bangalore city**

In the 16th century, Kempe Gowda I constructed many lakes to meet the town's water requirements, there is no perennial source of water supply to Bangalore city. In the earlier half of 20th century, the Nandi Hills waterworks was commissioned by Sir Mirza Ismail (Diwan of Mysore, 1926–41) to provide a water supply to the city. Currently, the river Kaveri provides around 80% of the total water supply to the city with the remaining 20% being obtained from the Thippagondanahalli and Hesaraghatta reservoirs of the Arkavathi River. Bangalore receives 800 million liters of water a day, more than any other Indian city. However, Bangalore sometimes does face water shortages, especially during the summer season- more so in the years of low rainfall. <sup>[8, 9, 10, 11]</sup>

### **2.2 Climate and Rainfall**

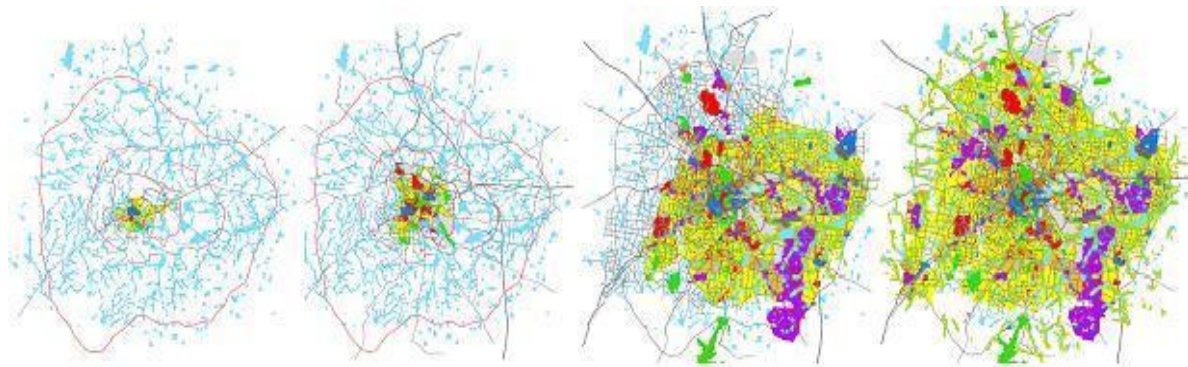
Bangalore experiences a tropical savanna climate with distinct wet and dry seasons. Due to its high elevation, Bangalore usually enjoys a more moderate climate throughout the year, although occasional heat waves can make things very uncomfortable in the summer. The coolest month is December with an average low temperature of 15.4 °C and the hottest month is April with an average high temperature of 32.8 °C. The highest temperature ever recorded in Bangalore is 38.9 °C (recorded in March 1931) and the lowest ever is 7.8 °C (recorded in January 1884). Winter temperatures rarely drop below 12 °C (54 °F), and summer temperatures seldom exceed 34–35 °C (<100 °F). Bangalore receives rainfall from both the northeast and the southwest monsoons and the wettest months are September, October and August, in that order. The mean value of rainfall is about 973 mm. The summer heat is moderated by fairly frequent thunderstorms, which occasionally cause power outages and local flooding. Most of the rainfall occurs during late afternoon/evening or night and rain before noon is infrequent. The heaviest rainfall recorded in a 24-hour period was 195 mm recorded on September 29, 1912. <sup>[8, 9, 10, 11]</sup>

### **2.3 Slums in Bangalore**

According to a 2012 report submitted to the World Bank by Karnataka Slum Clearance Board, Bangalore has 862 slums from total of around 2000 slums in Karnataka. It is estimated that about 20% of Bangalore population reside in urban slums. One third of these slum clearance projects lack basic service connections, 60% of slum dwellers lack complete water supply lines and share BWSSB water supply. <sup>[11]</sup>

### **2.4 Historical Urbanisation Trend - Bangalore**

The stages of urbanisation from the times of the city's 'founder' - Kempe Gowda, to the various phases of development through Tipu Sultan's regime, the British rule, Pre-independence struggle, Post-independence bloom, the era of Industrial revolution and the current decades of IT & BT revolution.



**Figure: 1 (1537-1799) Figure: 2 (1800-1947) Figure: 3 (1960-1980) Figure: 4 (1980-2010)**

As per the gazetteer, the city was founded by an agricultural chieftain Kempe Gowda-I in 1537 AD. The farsighted founder dotted the city with numerous tanks in and around its limits “Fig.” 1, ensure that its citizens would always have abundant water to drink, irrigate their lands and for secondary purposes. The settlements happened along the ridges, and a series of tanks were built in accordance with the natural valley systems. Centuries later, Nawab Hyder Ali and Tipu Sultan, planned Bangalore as a vacation town with the Summer Palace and Lal-bagh. This complimented the ‘Pettah’ area to the north of the Fort, a mixed development with commercial and residential land-use.

During the British rule, the city had more tanks with its urban fabric reflecting a city with two centers (the old city and cantonment) leading to a radical shift in economic, political & social structure of the city, accompanied by British colonial control. The Fort area (Pettah/City Market) developed parallel with the Cantonment area (General Bazaar/ commercial street and its surrounding areas), conjoined by the Majestic area between them. Urban land-use was prone to change with many social and economic forces shaping them. Towards the end of the century, several extensions were added such as Seshadripuram, Chamarajpet, Malleshwaram, Basavanagudi, Richmond Town, Richards Town, Frazer Town, Cox Town, Gandhinagar etc. 1940 onwards, increasing land demands resulted in laying of recreational spaces over the dry tank-beds of parts of Ulsoor and Domlur tank, Dharmambuddhi, Shule and Sampangi tank. Koramangala tank was completely breached to accommodate a vegetable garden. The above citations clearly indicate that the lakes have faced the consequences of Bangalore’s urbanisation. The same is represented in the “Fig.” 2. Where the water-cover is slowly displaced by other land-uses in the phased development of the city.

This Bangalore’s new phase of urbanization witnessed its dawn with India gaining independence, and the merger of the cantonment and the old city. Post 1957, the government embarked on state led industrialization, emphasizing on heavy industrial growth. This encouraged migration of people into the city, increasing the population and thereby the demand for land. Industrialization led to alternate employment, and reduced the dependency on tanks, resulting in negligence and encroachment of tanks, leading to the scarcity of water. In 1963, the ‘Outline Development Plan’ (ODP) proposed to conserve Sankey tank, Hebbal Lake, Nagawara Lake, Challaghatta Lake, Bellandur Lake, Madiwala Lake, Sarakki Lake and Kempambuddhi Lake, which was not approved until 1972. During this decade long lapse, Bangalore showed early signs of accelerated expansion with encroachment of seasonally dry tank beds for alternate uses. Several tanks were replaced by residential layouts, like Jugganahalli tank by Rajajinagar, Sonnenehalli tank by Neelasandra, Kadirenahalli tank by Banashankari extension, Ketamaranahalli tank by Mahalakshmiapuram, Chinnigara kere by Ejipura etc. Also many other lakes were lost for the provision of infrastructure to the growing city’s demands. Like Sunkal tank and Dharmambuddhi tank by bus terminals at Shantinagar and Majestic, Millers tank by offices and hospital, Shule tank and Akkithimmanahalli tank by Hockey stadiums, Challaghatta tank by Golf course, etc. This problem was further compounded in the late 1970’s as the city developed industrial estates at Peenya, Whitefield, Bommasandra, Veerasandra, Kumbalagodu, Jigani, Hoskote and Attibele. Consequently, more tank beds were encroached upon for establishing industries and their townships “Fig.” 3. The number of lakes in the 1960’s was around 280 and with the advent of industrial revolution; the count was reduced to 200 by 1985.

As the city gained an international popularity in 1990’s as ‘Silicon Valley’, Bangalore’s inorganic growth constantly caused its urban areas to merge with the peripheral rural fringes, engulfing the existing water-bodies and settlements, as urban villages. In 1971, the Bangalore urban agglomeration was only 177.3km<sup>2</sup>, which within three decades had tripled in size to an area of 530.9km<sup>2</sup>. During this period, about 421ha of water-cover area was lost due to development. There was also enormous reduction in lake area from 1971 [227.7 sq.km.] to 2001 [105.42 sq.km.], with about 18.3sq.km. getting transformed into built-up area. By 1993, the number of lakes in Bangalore had come down to merely 80. This transformation came as a serious concern, as urbanization had impacted not only the quantity in terms of its count but also the quality of water-bodies severely. The presence of sewage and degrees of eutrophication recorded in 1996 identified about 28% of the lakes as sewage

receptacles. The spread of the city had also blocked the storm-water drains which were the prominent feeders of lakes. Compared to total number of lakes present in 1990-2000, 70% of the lakes had already vanished by 2010 “Fig.” 4. Most of the tanks introduced by Kempe Gowda had been transformed beyond recognition, like Karanji tank to Basavanagudi, Dharmabuddhi tank to Majestic Bus Terminal, part of Halsoor tank to defense land, Sampangi tank to Kanteerava Stadium and Siddikatte tank to K. R. Market, etc.

As a response to the waning number of lakes, the government of Karnataka as a corrective measure set up ‘Lake Development Authority, (LDA)’ to be exclusively responsible for management of lakes. However, even years after the creation of the body, the situation continued to be indifferent, with LDA leasing out lakes to commercial, profit centric bodies, in the name of development and maintenance without any consideration for the ecological values of the lake. It is obvious from the above citations, that with Bangalore’s growth, its lakes have faced most of the consequences of urbanisation, in the name of development <sup>[11]</sup>.

### **III. Lakes in Bangalore**

The earliest history of creation of lakes in and around the city is traced to the founders of Bangalore or Bangalore –the Kempe Gowdas – in the Sixteenth century and later by the Wodeyars of Mysore Kingdom and the British by damming the natural valley systems by constructing bunds. Most of the lakes and tanks were manmade for purposes of drinking water, irrigation and fishing needs and they have also favorably influenced microclimate of the city. The lake waters have also served as “Dhobhi Ghats” or places where washer–men (‘dhobis’ is the locale usage in India), have traditionally used them as a means of livelihood for washing clothes and drying them. The lakes have also served to replenish ground water resources in the vicinity, which are tapped through wells for drinking water.

The effect of urbanization has taken some heavy toll on the Beautiful lakes in Bangalore. The lakes in the city have been largely encroached for urban infrastructure and as result, in the heart of the city lakes getting converted to bus stands, Golf courses, playgrounds and residential colonies, and few tanks were breached under the malaria eradication programme. In the 1960s the number of tanks and lakes was 280 and less than 80 in 1993.

Most of the lakes have vanished due to encroachment and construction activity for urban infrastructure expansion. The city once had 280-285 lakes of which 7 cannot be traced, 7 are reduced to small pools of water, 18 have been unauthorisedly encroached by slums and private parties and 14 have dried up and are leased out by the Government. 28 lakes have been used by the Bangalore Development Authority to distribute sites and build extensions for residential areas. The remaining lakes are in fairly advanced state of deterioration <sup>[11]</sup>.

#### **3.1 Some of the major lakes that disappeared over the years are**

Shoolay lake changed to Football stadium  
Akkithimmanhalli lake changed to Corporation Hockey stadium  
Sampangi lake changed to Kanteerava Sports Complex  
Dharmabuddhi lake changed to Kempegowda Bus Station  
Challaghatta lake changed to Karnataka Golf Association  
Koramangala lake changed to National Games Complex in Ejipura  
Siddikatte Lake has now become KR Market  
Karanji tank is the Gandhi Bazar area  
Kempambudhi is now a sewerage collection tank  
Nagashettihalli lake changed to Space department  
Kadugondanahalli lake changed to Ambedkar Medical College  
Domlur lake changed to BDA layout  
Millers lake changed to Guru Nanak Bhavan, Badminton Stadium  
Subhashnagar lake changed to Residential layout  
Kurubarahalli lake changed to Residential layout  
Kodihalli lake changed to Residential layout  
Sinivaigalu lake changed to Residential layout  
Marenahalli lake changed to Residential layout  
Shivanahalli lake changed to Playground, Bus stand  
Chenamma tank changed to a burial ground, Banashankari 2<sup>nd</sup> Stage  
Puttenahalli tank changed to J.P. Nagar 6th Phase  
Jakkarayanakere has been converted into a sports ground  
Kamakshipalya Lake is converted into a sports ground  
Baalayyana Kere (kamakshipalya) is converted into a sports ground  
Dasarahalli tank is converted into Dr. B.R Ambedkar Stadium

### 3.2 Status of Lakes in Bangalore

The naturally undulating terrain of Bangalore City, with its hills and valleys, lends itself perfectly to the development of lakes that can capture and store rainwater. Each valley at the ridge top gives birth to small streams. These cascade down to form major stream systems in the three Valleys, are shown in "Fig." 5.

1. The Hebbal Valley
2. The Koramangala - Challaghatta Valley
3. The Vrishabhavati Valley.

As the area is part of the semi-arid tropics, the forefathers of the city wisely used streams between ridges and valleys and created man-made lakes by damming the streams at appropriate places. Thus the lakes form chains of reservoirs in each of the three valley systems. Each lake harvests, rain water from its catchments and the surplus flows downstream spilling into the next lake in the chain <sup>[12]</sup>.

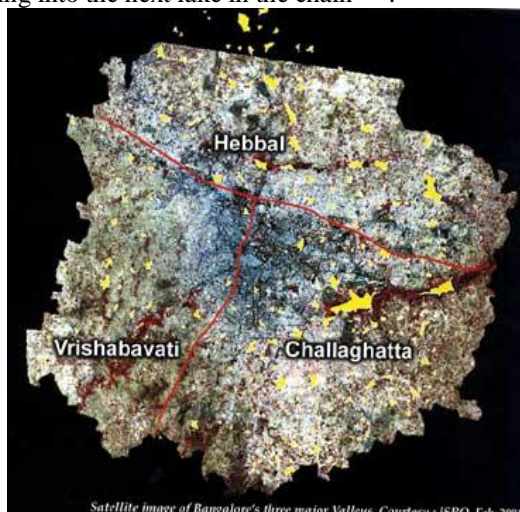


Figure: 5 Satellite image of Bangalore's major valleys

### 3.3 An overview on the status of water quality on Bangalore lakes

A study carried out by lake development Authority, Bangalore during the year 2001 for about selected 37 lakes in all three valley system in the jurisdiction of BBMP area. The result shows that dissolved oxygen content in the water bodies is fall below the tolerance limit of 4.0 mg/l namely (Hebbal Lake, Sankey Tank, Doddabommasandra Lake, Dasarahalli Tank, Yedyur Lake, Madavara Lake, Doddabidarakallu Lake, Kempambudhi lake, Byramangala Lake, Nayandahalli Lake, Varthur Lake, Gangadharaiah Lake, Chikkabanavara Lake, Kodigehalli Lake, Rampura lake, Kalkere Lake, Ulsoor Lake, Basavanapura Lake, Seegehalli Lake, Amruthahalli Lake, Jakkur Lake, Agaram Lake, Allalasanandra Lake, Uttarahalli Doraikere, Allalasanandra Lake , Bellandur Tank etc.) and the Biochemical Oxygen Demand (5 days at 20 °C), Max tolerance limit is 3.0 mg/l, but most of the water bodies are having reached the tolerance limit <sup>[12]</sup>

### 3.4 Lakes help the shortfall of water

In Bangalore Massive urbanization of lake catchments leading to water pollution by direct entry of raw domestic sewage and reclamation and encroachments lead to reduction of water spread area. Water levels have also been plunged below 400 feet in Bangalore City, being declared as grey region in 1994 by Central Ground Water Board (CGWB). Bangalore City Population require about 800 million liters of water per day. This water requirement can be supplemented by proper restoration and management of urban lakes. Though the urban lakes are no longer used for irrigation of agricultural fields there is a need to restore and manage these lakes and render them free from pollution and use them to store rain water and recharge ground water. The water stored in these lakes can be treated and used for the domestic needs and restoration of ecosystems in the lake catchment. The restoration and management of lakes will bring down the water scarcity of the city to a certain extent. <sup>[9]</sup>

## IV. Bellandur Lake

Bellandur Lake, the largest in Bangalore city spreads across an area of 892 acres. It is located at latitude of 12°58' N and longitude of 77°35' E at an altitude of 921 m above mean sea level and has a catchment area of 110.94 sq.miles or 287.33 sqm as per the Minor Irrigation Department. The water storing capacity of Bellandur lake is 17.66 million cubic feet, being 3km in length and 2.75km in Width. It is one of the largest man-made lakes in Southeast Asia, located about 20 km from the city towards the south-east

of Bangalore city which is extremely important ecological zone. It represents what was once a beautiful and wholesome source of water for the city of Bangalore. Storm water used to get stored in the lake, aquatic plants and animals functioned as live treatment plant. Bellandur Lake functioned as the kidney of the city. There was no bioaccumulation of organic waste. The lake was home to a wide variety of fauna and attracted many migratory birds from different parts of the country. The lake also provided drinking water to half the city's population, besides being a major fish trading center in the past. Thus Bellandur Lake formed an extremely important ecological zone of the Bangalore city.<sup>[8]</sup>

Bellandur tank is part of the Bellandur drainage system that drains the southern and the Southeastern parts of the city. The tank is a receptor from three chains of tanks. One chain, originates in the north, from Jayamahal, covers the eastern portion and has been referred to as the eastern stream. Another chain originates from the central part of the city, from around the K.R. Market area and covers the central portion and is called the central stream. The other chain, that reaches the tank is through the southwestern region and is called the western stream. Water from this tank flows further east to the Varthur tank, from where it flows down the plateau and eventually into the Pinakani river basin.

In 1970s people from as many as 18 villages depended on the waters of Bellandur tank to lead their lives. These included Haralur, Aambalapura, Kudlu, Balagere, Hanathuru, Devara bisanahalli, Kadu bisanahalli, Nagasandra, Kempapura, Belur, Ramagondinahalli, Siddapura, Munne Kolalu, Yemlur, Kariyammana Agrahara, Bhoganahalli and Gunjur.<sup>[11, 12]</sup>

Due to urbanization in 1980s, there was breakage of chains of tanks feeding the lake. The breakage in chains, unchecked industrial, residential as well as commercial development, resulted in insufficient rainwater reaching the tank and excess untreated sewerage and effluents laden water flow to the tank. This further led to a decrease in aquatic life, which affected the livelihoods of the fishing community. During the nineties a land near the lake was notified as ring road. This was the period when the city of Bangalore witnessed the growth of Information Technology Industries. Presently a large part of the Bellandur tank is covered by weeds. The colour of the water is dark and opaque in appearance. There is also a foul stench coming from it. There are hardly any birds visible near the tank. At the outlets, downstream of the lake, heavy foaming is visible, indicative of the presence of effluents.<sup>[11, 12]</sup>

#### **4.1 Existing condition of Bellandur Lake**

With years of indiscriminate disposal of various wastes into the lake, it has become an environmental nightmare. Discharge of sewage and other wastewater and dumping of solid wastes into the storm water drains pollute the lake. The lake contains raw sewage, industrial effluents and domestic garbage. The field study revealed that the unplanned areas does not have proper sewerage systems and thus, discharge the sewage into the drains. There are 339 slums within corporation limits containing totally 93,348 hutments having a total population of 5,03,559. Besides, there are many revenue land converted into housing layouts that are yet to be provided with sanitary sewers. The effect of industrialisation, urbanisation, and unplanned growth has clearly made its mark in polluting the Bellandur Lake.<sup>[8]</sup>

#### **4.2 Comments and suggestions for protection of Bellandur Lake in news papers**

1) Statement on Deccan Herald daily news paper on Wednesday on 20th march 2013 states that, the High Court on Wednesday ordered notice to the Union and State governments in connection with the pollution of Bellandur lake in the city.

The petitioner, Kasu Venkata Rajagopala Reddy, a social worker from Bellandur, had moved the High Court seeking directions to the Bangalore Water Supply and Sewerage Board (BWSSB) to prevent pollution of the lake. The petitioner submitted that BWSSB had set up a 400-MLD Sewage Treatment Plant (STP) near the lake to prevent pollution. However, the plant is not even functioning at half its capacity as just 200 MLD of water is being treated every day. "The very purpose of establishing the plant has been defeated as the water released from it gets mixed with untreated water, increasing the pollution," said Dhyana Chinappa, counsel for the petitioner. The petitioner pointed out that the pollution in the lake is so high that water can neither be used for drinking nor for agriculture. Construction workers who came in contact with water from this lake are suffering from scabby and swollen legs, he said. He submitted that the pollution had harmed aquatic life and that the water quality had deteriorated. Seeking directions to prevent further degradation of the water body, the petitioners sought directions to BWSSB to utilize the STP to its full capacity and set up an additional treatment plant.

The Division Bench comprising Chief Justice Vikramajit Sen and Justice B V Nagarathna ordered notice to the State government, BWSSB, Karnataka State Pollution Control Board, Lake Development Authority, Bruhat Bangalore Mahanagara Palike (BBMP) and Union Ministry of Environment and Forests.

2) Statement on Deccan Chronicle daily news paper on Wednesday on 20th march 2013 states that, Oil pollution killing Bengalurus Biggest lake. Discharge of lethal doses of oil is threatening the already polluted

Bellandur Lake in the city. Yet another water body is dying in a city that once boasted having 250-plus water bodies. This time it's the largest lake in Bengaluru, which shows lethal doses of oil pollution, probably from industrial waste, garbage and sewage.

- 3) Statement under the heading "The stinking underbelly of Bangalore" in The New Indian Express daily news paper on Thursday on 21st march 2013 states that the Bellandur lake Spread over nearly 950 acres. In 1996, a PIL was filed by the Bellandur gram panchayat to prevent the pollution of the lake. The sewage treatment plant at the inflow of the lake was upgraded as a result. In 1997, fishermen groups from Yemalur, Kempapura and nearby places petitioned against the then Chief Minister of the state as the polluted lake affected the fish population. The petition was passed on to the fisheries department who released baby fish into lake for increasing their numbers, but these fishlings did not survive due to heavy pollution.

Environmentalist Ram Murthy who was shocked to witness the state of Bellandur lake converting into a filthy swam, approached the High Court of Karnataka with the help of the Bellandur panchayat on July 28, 1999. He had pointed out that most of the underground drainage pipes which carried raw sewage to the sewage treatment plant were either blocked or damaged. Hence, the BWSSB conveniently diverted this sewage into the storm water drain which flows into the various lakes in Bangalore thereby polluting almost all the lakes of the city.

The High Court ordered the BWSSB to supply potable water to Bellandur residents and proper treatment of the sewage in the STP. Following the authorities' lack of compliance to the HC directives, another petition on contempt of court was filed. The case is still pending before the Lok Adalat.

In 2006, RTI activist CH Ram placed an application to the Tashilder East and Minor Irrigation department for cleaning of the lakes. He even applied to the Deputy Commissioner (Urban) of Bangalore district and Karnataka Information Commission (KIC). He did not receive any response.

- 4) By Staff Reporter | Published: February 05 2011; Given the Statement under the heading Bellandur Lake Run: Run for restoration and create awareness states that the

Troubled by the fact that a fairly large water body is disappearing in their backyard, residents and environmental activists are organising 'Bellandur Lake Run' on February 6 to increase awareness. This is their 13 year demand for action to restore a once beautiful lake polluted by untreated Sewage. Bellandur Lake (950 acres) is the largest lake in Bangalore and nearly 500 MLD (million litres daily) of sewage directly flows into the lake from 1/3rd of Bangalore. As of now only a small fraction of sewage is being treated. Currently, most of Bangalore's treated and untreated sewage is let into this lake, severely polluting it.

The conversion of watershed area of the lake to residential and commercial layouts has altered the hydrological regime while enhancing the silt movement – lowering water yield in the catchment, affecting the groundwater recharge. This has altered the integrity of the region, affecting all components of the lake catchment. Due to the severe pollution of the lake, it has become a breeding ground to the mosquitoes and has lead to all sort of problems.

- 5) Statement under the heading "Bellandur: A lake or a drain?" in The Times of India daily news paper on May 29th, 2001 states that

Problems: Severe contamination leading to diseases in people and cattle in the adjacent villages. Sewage from different parts of the city of Bangalore fall into this lake every day. It is also alleged that many industries in the area allow their untreated effluent into the lake. The result is a huge expanse of stagnant water laden with sewage at places greenish foamy water gushes through almost making a pretty waterfall picture. But the unbearable stench gives away any doubts you may have entertained about the nature of the place a couple of months ago, reports about mountains of froth in the lake created a hue and cry. The Karnataka pollution control board which conducted an enquiry into the frothing now says it was the result of the presence of a banned substance used in soaps and detergents. Large quantities of untreated domestic sewage and industrial effluent that flow into bellandur lake every day have led to it. Most of the cattle in bellandur are emaciated and infertile and suffer diarrhea all year round. Some villagers who regularly graze their cattle and cut fodder that grows in the tank also suffer skin infections. The effect of the stink and squalor of bellandur lake is not limited to the neighbouring villages. A huge breeding ground for mosquitoes, the lake is responsible for the swarms of mosquitoes at the Bangalore airport and surrounding areas, all efforts by the airport authority to put an end to the mosquito problem has been unsuccessful.

Work done: Practically nothing, the problem of large scale contamination of the lake came into focus when the bellandur gram panchayat approached the high court with a public interest litigation some three years ago in July 1999 the high court appointed a committee headed by the chief secretary to study the problem of sewage disposal and tank contamination in Bangalore. Following this, the high court issued an interim order directing all the agencies concerned to provide a plan to solve the problems of water and air pollution in Bangalore. January last year the government came out with an 'environment action plan'. The department of urban development also had plans of contacting a mumbai-based organization, to study the problems of



Bellandur lake and suggested measures to rehabilitate it, but since there has been no progress. In February this year, the Bellandur gram panchayat filed a contempt of court petition with the high court against the state government and all the individual agencies concerned. The petition is pending with the court.

Status: In spite of several attempts by the village panchayat to put a stop to contamination of the lake, nothing has changed.

Activities: No pleasure activities. Villagers graze their cattle around the tank and feed them grass and hay that grow in plenty on the tank. Water from the lake is also used for irrigating the fields in and around it.

Remarks: The 950-acre lake is a great health hazard for not only those living in and around the lake but also those as far as Koramangala and airport road. Besides contaminating the inderground acquifers, it is also a hige open breeding ground for mosquitoes. Unless all the agencies concerned come together and devise some concrete measures to stop contamination of this natural water body, no cleaning effort will make any difference.

## V. Conclusion

Environment is made up of natural factors like air, water and land. Each and every human activities supports directly/indirectly by natural factors. India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development. Most of fresh water bodies are getting polluted, thus decreasing the potability of water. All life is depend on water and exists in nature in many forms like ocean, river, lake, clouds, rain, snow and fog *etc.* Due to growth of Population, advancement in agriculture, urbanization and industrialization has made surface water pollution a great problem and decreased the availability of drinking water. Many parts of the world face such a scarcity of water. Most of wastewaters are dumped straight into rivers, lakes and estuaries without any treatment. Lakes are important feature of the Earth's landscape which are not only the source of precious water, but provide valuable habitats to plants and animals, moderate hydrological cycles, influence microclimate, enhance the aesthetic beauty of the landscape and extend many recreational opportunities to humankind.

For issues, perspectives on pollution, restoration and management of Bellandur Lake Falls under Bangalore Metropolitan city is very essential to know their status but so far, there was no systematic environmental study carried out. Hence now the following studies are very essential stage by stage namely Characteristics, Status, Effects (on surrounding Groundwater, Soil, Humans health, Vegetables, Animals etc.), resolving the issues of degradation, preparation of conceptual design for restoration and management.

For the protection of basic needs of various human activities, depend on natural environmental factors they are one time origin, they may not be recycled. Hence when disturb the natural environmental factors like air, water and land beyond their limitations of self sustainable capacity it wills difficulty to various human activities. Each and every human activities supports directly/indirectly by natural environmental factors. Due to degradation of water bodies (lakes), it will directly/indirectly disturb the quality and quantity of natural environmental factors. Hence protection of natural environmental factors, much essential.

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