CHAPTER – 2

GEOENVIRONMENTAL SETTIN GS

2.1. Introduction

Lakes are more or less closed, but mostly dynamic ecosystems. Lake water and life, thriving in it, are subjected to several natural and man-made threats. Lakes are under the direct influence of rainwater, river water, sedimentation, biomass and productivity of organisms. Any attempt to analyse the environmental conditions of lake requires, initially a detailed study of the geomorphology, bathymetry, geology, hydrology, hydroclimatology and the abiotic parameters that are influencing the aquatic ecosystem.

The Geoenvironmental conditions of Dalvoy lake of Mysore have been evaluated with reference to the following aspects.

1. Geomorphology
2. Bathymetry
3. Landuse and landcover
4. Hydromorphic features
5. Climatological stations
6. Urban setting.

2.2. Geomorphology

Lakes are large natural or man-made standing water bodies collected in depressions. Rivers and streams from mountains, overland flow from catchments of watersheds mostly feed the lakes. The lake basins are formed due to endogenous geological process like tectonism, volcanism and exogenous activities like landslides, glaciation, solution, river and wind action.

Lakes differ in size from small ones to very large ones covering thousands of km² area. The depth may be ranging from a few meters to more than 100 m. The depth and spread of water in any lake depends on the catchment area of the basin and the amount of seasonal inflow. Any lake may die, due to the loss of water and
complete siltation. The hydrology of a lake depends on its geomorphic setup. An important feature of lake, is the continuous evaporation of water from its surface. Lake waters meet both the atmosphere and the geological subtraction and interact more closely with each other, depending on their residence time. For more practical purpose, lake morphology is considered to be in equilibrium. Shore erosion, sediment movement, deposition and human induced activities may significantly alter not only the lake bottom topography but also affect many of its ecological conditions.

Lake morphology also controls the physical properties and chemistry of water like turbulence, circulation, thermal properties and thermal stratification. It is also equally important to analyse the area of the catchment zone, its landuse and land cover aspects which always play a dominant role in controlling the lake water chemistry, nutrient input and pH.

The geographic setting, geomorphological conditions, topographic variations, depth of water column, general geology, meteorological and hydrological factors controlling the water mass and a few abiotic parameters that are influencing the environmental conditions of Dalvoy lake are discussed in the foregoing sections.

2.3. The Physical Environment

Karnataka State is in the south-western part of India. It is mainly a table land and an extension of Deccan plateau. It is rhomboid in shape. The state extend 805 km from north to south and to about 283 km from east to west. The total area of the state is 1,92,493 km². Mysore district lies in the southern maidan (Southern Plateau) and is to the southern most part of Karnataka State. Physiographically, the region in which the district is found may be classified as partly maidan and partly semimalnad (malnad hilly lands). The district forms the southern part of the Deccan peninsula with Tamil Nadu to its south-east, the Kodagu district to its west, Mandya district to its north, Hassan district to its north-west and Bangalore district to its northeast. Mysore district forms a distinct land unit, besides being a cultural entity, lying between 11° 30’ N and 12° 50’ N latitude and 75° 45’ E to 77° 45’ E longitudes. It covers an area of 6,854 km², i.e., 3.57 % of the state’s total geographical area. It
holds the sixth place in the state in terms of area with a population of 2.641 million in 2001.

2.4. Location and Area

Physiographically, Mysore lies between maiden and semi-malnad range at an altitude of 610 m from the mean sea level. The district covers a total geographical area of 6763.82 km$^2$ of which 628.51 km$^2$ hectares constitutes the forest land. The net cultivable land is 4864.1 km$^2$ and of this 1140.10 km$^2$ of land is irrigated. The prominent river of the district is the Cauvery. Mysore district is considered as one of the prosperous district of the state based on the development and utilization of irrigation facilities, abundance of forest wealth and sericultural products.

The City has an areal extent of 32 km$^2$ with a population of 6.533 millions. It extends from the centre towards East (Siddarthanagar), West (Bogadi), South (J.P.Nagar) and North (Hebbal Industrial Area). Figure 2.1 shows the projected population details of Mysore City.

![Figure 2.1: Growth of Population in Mysore city (Source: UN 2001)](image)
2.5. Geology

Geologically, this region is mainly composed of igneous and metamorphic rocks of Pre-Cambrian age either exposed at the surface or covered with a thin mantle of residual and transported soil. The rock formation in the district falls into two groups, charnockite series and granite genesis and gneissic granite. The rock types encountered in Mysore and its environs are predominantly of granitic-gneissic complex, which have been grouped together under an ambiguous term Peninsular Gneissic Complex (PGC). The PGC has been described as “Possibly a polymagnatic spanning several episodes.” It is supposed to have had a ‘multitude formational, multi-intrusional, poly-metamorphic history.’ The age of PGC is thought to vary from 2500 to 3300 million years (Balachandran, 1979). Gneissic rocks cover a major part of the Mysore District. The gneisses are weathered, fractured and jointed. The gneisses are weathered up to a depth of 3 to 10 m (Radhakrishna B.P and Vaidyanandan R., 1994). The district is characterized by red loamy soil and is derived from granites and gneisses. The soluble salt contents are normal and the organic matter contents are high. The percentage of phosphorous is poor and soils contain variable amounts of potassium.

2.6. Soil

The soil of the district can be broadly classified into five types as, the laterite, red loam, sandy loam, red clay and black cotton soils. The lateritic soil occurs mostly in the western part of the district while the red loam is found in the north-west. These two account for nearly half the area of the district. The Black Cotton Soil is found mostly in the north-eastern parts of the district. The red sandy loam soils are derived from the granites and gneisses.

2.7. Crops and Irrigational practice

The net sown areas comprise 72% of the total geographical area, of which about 20% is sown more than once. Paddy is the major crop in the district and is grown in favourable area totaling about 1,107 km², followed by pulses and ragi, which are cultivated in 913 and 722 km² respectively. Other major crops grown in the district are cotton, sugarcane, jowar, tobacco and oilseeds. About 17% of the total geographical area is under irrigation in the district, comprising of the command area
of K.R.Sagar and Kabini projects. The right bank high level canal of K.R.Sagar known as the Varuna canal passes through Mysore, T.Narsipur, Nanjangud and H.D.Kote taluks. Out of the total area of 1,190 km$^2$ under irrigation about 11% is irrigated using ground water through dug wells and borewells. While canals account for 81% of the total area under irrigation, tanks account for approximately 7% of the total area irrigated.

### 2.8. Relief of the catchment zone

Relief is the elevation difference between reference points defined in any one of several ways. Maximum relief within a region is simply the elevation difference between highest and lowest points. Schum (1956) measured basin relief along the longest dimension of the basin parallel to the principal drainage line. Relief measures are indicative of the potential energy of a drainage system present by virtue of elevation above the given datum (Strahler, 1964). Fig. 2.2: shows the geographic setting of the Dalvoy lake, Fig. 2.3: shows the catchment zone of Dalvoy lake and its watershed, Fig. 2.4 show the topography of Dalvoy lake and its catchment zone, Fig. 2.5 shows the Hydromorphic setting of Dalvoy lake and its catchment zone and Fig. 2.6 shows the Depth zone of Dalvoy Lake from Ground level.

Figure 2.2: The Geographic setting of Dalvoy lake
Figure 2.3: The Catchment Zone of Dalvoy Lake and its watershed
Figure 2.4: The Topography of Dalvoy lake and its catchment zone
Figure 2.5: The Hydromorphic setting of Dalvoy lake and its catchment zone
Figure 2.6: The Depth zone of Dalvoy lake from Ground level
Figure 2.7: Landuse-Landcover of Dalvoy lake – catchment zone
2.9. Drainage System

Mysore district is endowed with number of perennial and non-perennial rivers. The River Cauvery, which is one of the major systems of the district, drains through the Mysore plateau, from northwest to east along with its major tributaries viz. Kabini, Suvarnavathi and Laxmanathirtha.

The Table 2.1 depicting the sewerage network of Mysore city caters to around 100 km² and comprises of five drainag based on the topography of the city, namely A, B, C, D and E as shown.

The drainage A draws the sewage from RMP quarters and Aravind Nagar. The drainage B draws sewage from an area of 25 km² with a sewer length of 6.5 km. This valley also has some areas in which sewer lines are not connected. The surrounding areas of Kabeer road, Ashokapuram, Dhanwanthri Road, CFTRI, Chamaraja Double Road, JSS hospital, Kanakagirinagar and Gundu Rao Nagar. The drainage C draws the sewage from an area of 2 km². These areas are located at surrounding Yadavgiri, Kumbara Koppal, B.M. Shree Nagar, Metagalli, Pulikeshi road, C.V. Road, Subash Nagar, Kesare, Hebbal, Gokulam. The drainage D draws the sewage from V. Mohalla, Janatha Nagar and the length of sewer is 17.75 km. The drainage A & D are serviced by a common sewage treatment plant (STP). The drainage E which is drawing sewage from an area of 16 km². At present this drainage has no sewage treatment system. This region includes the private layouts and Mysore Urban Development Authority (MUDA) layouts formed at Alanahalli, Sathagally and Yaraganahally and all along the T.N.Pur and Bannur road (MCC-DPR, 2007)

In some parts of these sections, storm water drains draw the sewage output, leading towards the lake.
Table 2.1: Sewage sections of Mysore city.

<table>
<thead>
<tr>
<th>Sewage section</th>
<th>Sewage Capacity (MLD)</th>
<th>Area Covered (km²)</th>
<th>Length of Sewer (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and D</td>
<td>60</td>
<td>41</td>
<td>17.75</td>
</tr>
<tr>
<td>B</td>
<td>67.65</td>
<td>25</td>
<td>6.5</td>
</tr>
<tr>
<td>C</td>
<td>30</td>
<td>2</td>
<td>6.5</td>
</tr>
<tr>
<td>E</td>
<td>22 (proposed)</td>
<td>16</td>
<td>NA</td>
</tr>
</tbody>
</table>

2.10 Dalvoy Lake Profile

Dalvoy Lake was constructed during the rule of Maharaja’s of Mysore (Fig.2.7). The lake can be easily identified in the toposheets No.57 D/11/6 and 57 D/12/NE at 12° 15’ N latitude and 76° 39’ E longitude. The main source of water to this lake is from rainfall, urban runoff from the elevated areas through storm water drains and sewage from Mysore city and also from the irrigation return flow from D.D Urs (Varuna) canal distributaries.

The lake is primarily fed by storm water through drains from the major part of the city. The major quantum of water /sewage generally enters into the lake through one of the major inlet drain. It is primarily used for agricultural purposes, along the eastern side of the lake through a sizable earthen bund along with a slice created on the south east side.

2.11. Hydrography of Dalvoy Lake

Dalvoy Lake is currently a mildly polluted lake with a combination of untreated and partially treated sewage, resulting in a deteriorating ecological system. The area is water logged in almost all seasons covering the entire lake. There are various layouts surroundings the lake area viz. J.P. Nagar, Gundurao Nagar, Datta Nagar, Vidyaranyapuram and Chamundipuram. In view of the fact that many huts have come-up around the lake, there is a threat in terms of encroachment in the near
future, which should be avoided by taking up immediate restoration and preservation program.

2.12. Inlet / Outlet Details

This section focus on the following hydrodynamic process of inflow and outflow. These process are commonly seen and often play significant role in lakes and reservoirs, but they are not limited. These processes may also be observed in other waterbodies, such as rivers and estuaries.

Inflow to lakes and reservoirs include river flows, watershed runoff, groundwater inflow, and discharges from wastewater. An inflow displaces the standing lake water after entering a lake. If there is no density difference between the inflow water and the lake water, the inflow will mix with the lake water very rapidly.

Outflows include natural release from lakes and discharge through canals. Natural lakes often have discharge from the lake surface. Bottom discharge increases vertical mixing and dissipation of bottom materials, whereas surface discharge has a minimal impact on the bottom materials (Zhen-Gang Ji, 2008).

The Dalvoy lake, through two major inlets, receives about 65 MLD of sewage. The lake discharges through two outlets almost same quantum of water (Fig 2.8). Table 2.2 shows the details of each inlet and methodology adopted for measuring the flow at all the inlet locations. The flow measurement was carried out for four days at these locations. The water level of the lake is recorded and the data are maintained by the government (Table 2.3).
Index of the Map:

1. Inflow - Outer Ring Road
2. Inflow - Untreated drain at STP house
3. Inflow - Untreated drain at Compost plant
4. Outflow - east end point of the lake
5. Outflow - east end point of the lake
6. Outflow - south end point of the lake
7. Inflow – northwest end of the lake
8. Inflow – west direction
9. Inflow – south west direction
10. Inflow – Inflow northeast direction

Figure 2.8: Location of inlets and outlets of Dalvoy lake (Ref. Table. 2.2)
Table 2.2: Inflow and Outflow volumes of Dalvoy Lake.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Location</th>
<th>Flow (MLD)</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outer Ring Road</td>
<td>65</td>
<td>Current Meter</td>
</tr>
<tr>
<td>2</td>
<td>Untreated drain at STP house</td>
<td>20</td>
<td>Current Meter</td>
</tr>
<tr>
<td>3</td>
<td>Untreated drain at Compost plant</td>
<td>11</td>
<td>Current Meter</td>
</tr>
</tbody>
</table>

Outflow of Dalvoy Lake

| 4      | East end point of the lake        | 65         | Current Meter       |
| 5      | East end point of the lake        | 20         | Current Meter       |
| 6      | South end point of the lake       | 11         | Current Meter       |

Table 2.3: General particulars of the Dalvoy lake (*Source: Water Resources Department*).

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>District</td>
<td>Bandipalya village/Mysore taluk/Mysore</td>
</tr>
<tr>
<td>2</td>
<td>Location: Longitude &amp; Latitude</td>
<td>76°-39’-0”E / 12°-15’-0”N”</td>
</tr>
<tr>
<td>3</td>
<td>Total extent of the catchment</td>
<td>40.04 km²</td>
</tr>
<tr>
<td>4</td>
<td>Average Annual Rainfall</td>
<td>819.20 mm</td>
</tr>
<tr>
<td>5</td>
<td>Monsoon Rainfall</td>
<td>762.00 mm</td>
</tr>
<tr>
<td>6</td>
<td>Water spread area</td>
<td>0.54 km²</td>
</tr>
<tr>
<td>7</td>
<td>Gross storage</td>
<td>30 Mcft.</td>
</tr>
<tr>
<td>8</td>
<td>Maximum flood discharge</td>
<td>190.00 Cusec.</td>
</tr>
<tr>
<td>9</td>
<td>Irrigable area</td>
<td>1.45 km²</td>
</tr>
<tr>
<td>10</td>
<td>Length and atchkat of RBC</td>
<td>L = 2.7 m</td>
</tr>
<tr>
<td>11</td>
<td>Length and atchkat of LBC</td>
<td>L = 0.7 km</td>
</tr>
<tr>
<td>12</td>
<td>Number of fillings</td>
<td>Full throughout the year</td>
</tr>
</tbody>
</table>

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2.13 Longitudinal profile of Dalvoy lake

The catchment zone of Dalvoy lake (including the lake area) has been discretised into a network of grids with 1 cm ($\Delta x = \Delta y$) = 250 m scale. Figure 2.9 shows the grid network of the catchment zone. It could be seen that the mainstream of the watershed originates at the northern boundary spot of the area. All along the streamline, the elevation values have been evaluated and a longitudinal profile of the stream from origin upto the end of the lake has been drawn and shown as Figure 2.10.

Using the same Figure 2.10 transverse cross sections were drawn to know the slope from the sides of the stream. The sections are referred to as A-A' B-B' C-C' D-D' E-E' F-F' G-G' H-H' I-I'. Sections A-A' through E-E' are shown in Figure 2.11. Similarly, sections F-F' to I-I' are shown in Figure 2.12.

A longitudinal profile and cross sections of the lake are provided in Figure 2.9. The prominent feature in this lake is very large and stable water holding capacity. The Dalvoy lake gets significantly influenced by the morphology of the channel and its interactions with the drains of both upstream side. The streambed is composed primarily of fine sized particles both upstream and downstream of the Dalvoy lake. However, the stream is filled with waste from the domestic and sewage in the upstream of the Dalvoy lake, which may lead to smaller floods which can reach the surrounding areas. The upper watershed is connected to hill slope from where gravel sediments may enter into the lake.

The downstream part of Dalvoy lake tends to be larger and deeper. The Upstream parts of the Dalvoy lake are nearer to the Chamundi hill. The surrounding environment may have water table at deeper level and therefore, it has low vegetation and cover as it is acquired due to urbanisation. The downstream of the lake and stream banks are densely vegetated with grass and agricultural crops.
Figure 2.9: Grid map showing the Dalvoy lake and its boundary.

A-A' Transverse section
- Spots used for computing elevations
Distance from the point of origin ($\Delta x = \text{graph value} \times 250 \text{ m}$)

Figure 2.10: Longitudinal Profile of the stream in the Catchment zone
Figure 2.11: The topographic sections of the watershed (Upstream end)
Figure 2.12: The topographic sections of the watershed (Downstream end)
2.14. Hydrodynamics

The Dalvoy lake was built for the purpose of storing water for the benefit of the villagers to drink, cattle, washing and agricultural activities. During the earlier years the quality of the water was pure and clean. The major source of the water was from the natural drainage, agricultural runoff and groundwater. As the time passed, the growth of urbanisation and industrialisation led to the pollution of the water source by mixing with various municipal wastes. The quantity and the level of the water in the lake was also fluctuating from a few km$^2$ of water spread area which was decreased to 0.54 km$^2$ by reducing the storage to 30 Mcft (MCC-DPR, 2007). The discharge becomes maximum of 190 cusecs by irrigating 1.30 km$^2$.

2.15. Evolutionary trends

The lake is gradually found to be shrinking its size and shape as the population and developmental activities are increasing around. When the old Geological Survey of India maps (Kishori lal Khosla, 1978) are compared with the present Google Earth images (Google, 2008), much difference is noticed in the location and size of the lake. Figure 2.2 shows the actual size of the lake. But in reality, the present size differs from it. In the vicinity of the lake, all the boundary lands are encroached by the humans. There is another activity leading to pollution by the transport vehicles cleaned every day. The cleaning of vehicles using the lake water is one severe threat to the quality of water. Oily substances are also getting into the lake waters. The local people have also encroached by constructing houses and huts in the vicinity of the lake. The western side of the lake is disturbed due to agricultural activities by the nearby villagers. Some are converting the agricultural fields in to barren lands and plan to sell them for constructing new buildings. The northern part is getting filled with sediments and solid wastes. The entry point drainer cum server is from Mysore city is getting filled with grasses and other weeds covering the inlet zone. The southern part of the lake is getting silted. The lake bund is also destabilized for installing the advertisement banners. The southern part of the lake has the deepest zone and found to be around 20-30 meters in those days and it is now only10-15 m deep.
2.16. HYDROCLIMATOLOGY

Hydrometeorology is defined as the study of the atmospheric processes that affect the water resources of the earth. A broader definition of the term was given by the World Meteorological Organization stating that it is concerned with the study of the atmospheric and land phase of the hydrologic cycle with an emphasis on the interrelationships involved.

Lake water hydrodynamics are fully controlled by the climatological parameters. A detailed analysis of the following climatological parameters has been attempted to understand their role.

a) Temperature

The hottest month is April, which has shown an average temperature of 35°C. The mean daily temperature is found to be the lowest, 15.3°C, in January. From the middle of December to middle of January, the weather is very cool. Figure.2.12. shows the temperature details of Mysore City during 1999.

b) Rainfall

The rainfall statistics of Mysore city has been collected from the rain gauge station monitored by the Central Sericulture Research Institute (CSRI), Mysore. The graph prepared from the data (Figure.2.13) shows the Average Annual Rainfall in these locations. Mysore receives an average rainfall of about 670 mm to 888.6 mm in dry zones and from 611.7 mm to 1053.9 mm (MCC-DPR, 2007) in the transition zone. The average annual rainfall is 782 mm. Generally, the clouds begin to mount as the sunset approaches. It first begins with drizzle, which gradually gains momentum and turns into a heavy shower. Sometimes, it continues for the whole night. With the daybreak, the rain stops and the sky becomes clear with the emergence of bright sunshine.
Figure 2.13: Graph showing the average annual Temperature in degree Celsius.

Figure 2.14: Graph showing average annual Rainfall (mm)
c) Humidity

From the Figure 2.14 it is very clear that the moisture content in the atmosphere is maximum in the months of August and October, but the high percentage period continues from July to October. There is a steady decline from November to March after which upto August, the rise is quite rapid. The fall may show as low as 72% at 17.30 hours for any particular day during the former period, while the latter period the highest figure may be as high as 100% in any part of the particular day. Thick fog or mist is common in the early part of the day during winter.

![Figure 2.15: Graph showing average annual Humidity (%)](image)

d) Wind

The two directions that are mainly prevalent are west-south-west and west during the hot wet season and East-North-East and North-East during the cool wet season. In the intermediate period, winds have transitional character; the direction is often varying. The velocity of the wind reaches its peak usually during the month of
June and July, which are also the months of dust and thunderstorms. In the rest of the months the wind speed is average.

2.17. Urban Development (Mysore Gazette)

According to a report of the City Development Plan (CDP), the expansion in future of Mysore city is significant and there is a recorded 70 per cent increase in the total area of the city since 2001. The extent of the urban sprawl in the city is evident from the growth rate over the last five years. The area of Mysore city according to the MUDA has increased from 75.69 Km$^2$ in 1995 to 92.21 Km$^2$ in 2001 representing a growth of 22%. This expansion is expected to continue unabated and the total land area of Mysore is expected to increase to 156.69 Km$^2$ by 2011.

![Figure 2.16 Urban sprawl in Mysore city. (Source MUDA).](image_url)

The corporation limits of Mysore city is being congested, through more developmental works, spread over the sub urban and peripheral areas. Many Ancillary industries are also coming in and around the lake. In the coming years, the
growth expected predominantly toward North-western, North Eastern and Southern regions due to land availability (Figures. 2.15). The areas of expansion are:

- Hebbal Industrial Area, due to IT sector
- North side of Mysore City due to BMIC.
- South of Mysore city towards Nanjagud.

Figure 2.17: Spatial growth and expansion of Mysore towards Nanjagud (Source MUDA)

It could be seen from figure 2.16, the southern part (being close to the Industrial estates of Nanajangud and new coming Airport at Mandakalli) is the potential area for the future developmental activities. The Airports Authority of India (AAI) has taken possession of 0.623 Km$^2$ of the total 0.704 Km$^2$ of land at Mandakalli to develop Mysore airport. The Karnataka Industrial Areas Development Board (KIADB) is also acquiring 26.30 Km$^2$ of land around Mysore in view of the growing demand for land from investors and industrialists (Source MUDA).
2.18 Inference

In this chapter, the geoenvironmental setting of the Dalvoy lake area has been analysed. The lake is influenced by parameters like, geomorphology, hydrology, geology, bathymetry and hydrometeorology. The drainage inflow, outflow, storage and the slope have been studied in order to understand the flow of water and its source of inflow. To understand the downstream and upstream characteristics of the lake basin, a grid system of mapping has been done in order to create longitudinal profile of a lake by drawing the transverse cross section of topography. The study of climate with reference to temperature, rainfall, humidity and wind are very important as it is directly influencing the lake ecosystem.

The topographic gradient of the watershed is gentle to flat. The longitudinal profile of the main stream has shown an elevation difference of 50-75 m, for a total length of 6,250 m.

The catchment zone experiences rainfall inputs from two seasons. The rainy months are April, May, October, November and December. This is a semi-arid climatic zone. If an amount of 40% of rainfall is considered as surface outflow, then for this catchment zone the quantity of water flowing towards the lake may be of the following range.

Catchment Area : 40041214.48 Sq m

\[
Annual \ rainfall : \left( \frac{819 \ mm}{1000} \right) \times \left( \frac{40041214.48}{100} \right) \times \left( \frac{40}{100} \right)
\]

Approximate Annual rainfall = 132117501.8386 m³