6.1 HYDROTOPOGRAPHY, MORPHOLOGY AND METEOROLOGY

Many lakes were formed along major rivers as the irregular main course of the river cuts a channel through the initial portion of the meanders. Deposition of sediments of the main stream subsequently, isolated the loops resulting in oxbow lakes (Hutchinson 1957). Surface contour map evidently exhibits that Baskandi Lake is elongated and oxbow shaped (Figure 2 and 3). It is formed due to the change of the course of the river Barak as it flows through a zig-zag course through the Cachar district. Hydrologically it was an open
lake, but drastic interferences caused by construction of embankment (Plate 6) across the East-West shore line at the southern margin converts it into a closed type lake and so the spillway of water especially during monsoon months does not take place. As in the case of other limnetic bodies of North East India (Dey 1981, Lahon 1983, Kar 1984, Goswami 1985, Nath 1987, Agarwala 1996, Goswami et al. 1999), the present lake is also in the process of gradual sedimentation effected through allochthonous detritus washings from the abounded catchment areas. The process is more severe especially during the rains when the lake practically acts as a collecting chamber for all such debris, silt and litters. Severe anthropogenic interferences (Plate 6) are caused by the sewage discharge by the inhabiting people on the northern bank of Baskandi Lake and erosion of shore line of sandy loam soil surface resulting from the paddy cultivation and construction of walkable road over the southern periphery of the lake. All these conditions are favourable for the process of eutrophication in the lake as observed by the excessive growth of *Eichhornia crassipes* during later part of the third year of study. Eutrophication is characteristically high in the closed lake condition than in the open lake condition (Goswami et al. 1999).

Baskandi Lake (24°10'N and 93°15'E) is influenced by the subtropical climatic changes. Subtropical climate occurring in India is characterised by spells of "no rains" and "plenty of rains". With the onset of monsoon, heavy downpours sweeps across the land and
Construction of embankment across east-west shoreline at the southern margin of the lake which acts as the village road

Cultivation at the south-western periphery of the lake causing extensive damage to the shoreline

Sewage discharge to the lake by the inhabitants on the northern bank of the lake

Excessive growth of *Eichhornia crassipes* observed in the northern bank of the lake later part of the year 2000 – an indication of eutrophication process

Plate 6  Anthropogenic interferences to the Baskandi Lake ecosystem
towards the end of the monsoon the rain ceases both in amount and frequency. However, Baskandi Lake is a perennial water body exhibiting considerable low fluctuations in water level during different seasons. It is also observed that the volume development of the lake fluctuates within a narrow range (1.19 to 1.26) which implicates that water loss from the lake is less and water gain is sustained to maintain a hydrologically stable condition.

The interaction of different meteorological parameters like air temperature, atmospheric pressure, rainfall, relative humidity and sunshine hours has a tremendous role to play in the formation of the regional climate and seasonal differentiation. The air temperature fluctuates from 8.6°C to 37.9°C, however, in the winter months (December to February) it ranges within 8.6°C to 11.7°C [(Figure 4(a-c)]. But during these colder months the water temperature (18°C to 24°C) (Figure 5) is found to be much higher than air temperature which justify that heat received during the day hours is enough to warm the water column of the lake basin. This was also recorded as the general thermal characteristic of the shallow lentic bodies of Assam (Goswami 1985, Lahan 1986, Yadava 1987, Goswami 1997).

6.2 WATER AND SOIL CHARACTERISTICS

Temperature, an important physical parameter has a great bearing upon the productivity of any aquabody (Sugunan 1980, Goswami
1985, Hernandez et al. 1999). Incidentally, the water temperature of the studied lake portrays a narrow amplitude of 1-2°C between surface and bottom values to indicate practically no thermal stratification. The uptake of atmospheric heat per unit area entering the lake water get immediately circulated by the overlying effect of the wind to exhibit such trend.

The water pH of Baskandi Lake exhibits quite a steady state (6.4 to 7.6) demonstrating a circumneutral condition. The relationship of pH with free CO₂ has been well established (Zafar 1964). Increase of free CO₂ (FCO₂) result in the decrease of pH due to the formation of carbonic acid. Consequently, an inverse relationship between pH and free CO₂ (Mathew 1975, Nath 1986, Agarwala 1996) is also observed in the present study (r = -0.3240).

Inverse correlation between FCO₂ and Dissolve Oxygen (DO) have been observed in the studied lake (r = -0.3070) corroborating with the findings of Goswami (1985), Agarwala (1996). Lower values of DO have been observed during the hotter months and higher values during the colder months in Baskandi Lake indicating significant seasonal fluctuations, which is also characterised by the shallow Indian fresh water bodies (Michael 1969, Kaushal et al. 2000). Similar condition has been reported by a number of workers in Assam (Singh et al. 1997, Hazarika and Dutta 1999 and Acharjee et al. 1999). The colder water holds more oxygen than the warmer water (Welch 1935, Hutchinson 1957).
Total alkalinity (TA) is considered as a measure of productivity. It is well established that water bodies having TA above 50 mg l⁻¹ can be considered as productive. The TA of Baskandi Lake ranges from 81.0 mg l⁻¹ to 105.0 mg l⁻¹ during the study period which corroborates with the findings of Bhuyan (1970), Dey (1981), Kar (1984) and Goswami (1997) in water condition of Assam.

Turbidity restricts the penetration of light and reduces the productivity at its lowest trophic level. A more or less steady state of turbidity of the water of the lake have been observed. However, a marginal exposition of allochthonous turbidity is observed in the lake during monsoon months due to influx of silt laden water from the catchment area. It is in conformity with studies of Nath (1987), Jain et al. (1999) and Kaushal et al. (2000).

Phosphate is one of the major nutrients required for plant nutrition and is essential for life. It is observed in the present study that the phosphate content in lake water is higher during the winter months from November to February (Figure 5). Exposition of low phosphate concentration during monsoon months may be attributed to the dilution of lake waters (Mathew 1975, Yadava 1985, Agarwala 1996). An inverse relation (r = -0.7290) between rainfall and phosphate content of the lake water is observed.

Nitrate content is low during pre-monsoon and monsoon (4.80 μg l⁻¹ to 17.50 μg l⁻¹) but high in post monsoon and maximum in winter (43.90 μg l⁻¹). A more or less similar trend has also been
reported by Das (1998) and Jain et al. (1999) in water bodies of India and the contributing factor is supposed to be the runoff water from fertile catchment area.

Bottom soil of the studied lake is slightly acidic (pH 5.5 to 6.1 in 1998, 5.4 to 5.8 in 1999 and 5.6 to 6.0 in 2000) and it is considered as normal feature of the wetlands of Assam (Banerjee 1967, Lahon 1983, Goswami 1985, Acharjee et al. 1998). Bottom soil has been found to be rich with respect to organic carbon, fluctuating within the range from 0.80% to 1.95% during the study period. It suggests seasonal sedimentation of the organic particles autochthonously originating from decomposed macrophytes intermingled with allochthonous silt particles (Agarwala 1996).

The available nitrogen (mg 100⁻¹g) (4.25± 0.82 in 1998, 5.0 ± 0.85 in 1999 and 4.26 ± 0.80 in 2000) and available phosphorous (mg 100⁻¹g) (1.4 ± 0.25 in 1998, 1.20 ± 0.21 in 1999 and 1.18 ± 0.21 in 2000) recorded during the three years in the Baskandi Lake soils (Table 3) can be put under low production group as the medium productivity range for available nitrogen is 25-60 mg 100 g⁻¹ and that of available phosphorus is 3.0 to 6.0 mg 100 g⁻¹ (Sugunan 1990).

6.3 LIMNOPLANKTON

The hydroclimatic conditions of a lake control its plankton density and composition. During monsoon due to the influx of large volume of water, the planktonic concentration gets diluted (Nath 1987, Sharma
Phytoplankton density is found to dominate over zooplankton, a feature also reported by Goswami (1985) from Chandubi Lake of Assam, Nath (1987) from Itanagar Lake of Arunachal Pradesh and Agarwala (1996) from Tamranga wetland of Assam.

Among phytoplankton, Chlorophyceae is found to be the dominant group having 21 taxa followed by Bacillariophyceae with 15 taxa and Myxophyceae with 7 taxa [Table 4(a-c)] in the studied wetland. Bacillariophyceae and Chlorophyceae are also found as dominant groups of phytoplankton by Gurbuz et al. (2000).

Dinophyceae is poorly represented in the studied lake. Only two genus Ceratium and Peridineum have been recorded during the study period with very low numerical density. The low occurrence of this group was also reported earlier by Yadava (1985) in Dhir beel of Assam and Agarwala (1996) in Tamranga wetland of Assam. Euglenophyceae have been reported to be virtually absent in Baskandi Lake.

Among zooplankton Rotifers have been found to be the most abundant group having 19 taxa, of which the Brachionus spp. is found to be predominant [Table 5(a-c)]. This feature was also observed by Dutta et al. (1990) in freshwater ponds of Guwahati, Assam and Sharma (2000) in tropical flood plains of Assam. The other zooplankton groups recorded are the copepods, cladocerans and the protozoans. Bimodal peaks of zooplankton density are observed in May and November in 1998. However, in 1999 and 2000 no such
characteristics peaks are recorded. Observation of bimodal peaks are also reported earlier by Lahon (1983) in some commercial beels of Assam.

6.4 AQUATIC MACROPHYTES

Aquatic macrophytes of Baskandi Lake are represented by 6 free floating, 2 rooted submerged, 6 rooted with floating leaved and 2 rooted emergent species. The dominant macrophytes of Baskandi Lake are *Eichhornia crassipes*, *Salvinia cucullata*, *Trapa bispinosa*, *Azolla pinnata*, *Hydrilla verticillata* and *Jussiaea repens* occurs throughout the year (Table 6). These dominant species exhibit seasonal vegetative growth during monsoon to autumn in most wetlands of Assam (Goswami and Goswami 1999, Kar and Barbhuiya 2001). The wet biomass of aquatic macrophytes fluctuates form 4.4 kg m\(^{-2}\) in winter to 11.4 kg\(^{-2}\) in post monsoon months (Figure 7). Significant positive correlation of Aquatic macrophyte biomass with water temperature (r = 0.1820) have been observed. Inverse correlation of phosphate and nitrate with macrophytic biomass (r = -0.1255, r = -0.2261) observed in the present study corroborates with the findings of Acharjee *et al.* (1997) in Dighali beel of Assam.

6.5 FISH DIVERSITY AND YIELD

46 ichthyo species have been recorded in Baskandi Lake during the study period. Of the 8 orders of ichthyo species observed in the
lake, Cypriniformes is the dominant group represented by 17 species followed by Perciformes represented by 9 species and Siluriformes by 9 species. Similar trends are also observed in different water bodies of Assam (Kar 1984, Yadava 1985).

Considering the abundance of the fishes, the minor fish group species *Puntius* spp. and *Chanda* spp. are the dominant groups, while individually there is a significant abundance of the shad *Gudusia chapra* noticed in the studied wetland. This findings corroborates with the observations of Agarwala (1996) in Tamranga wetland, another oxbow lake in Assam.

The intermediate group of fishes comprising of the *Mystus* spp., *Channa* spp., *Notopterus notopterus*, and the live fishes have been found to share the major percentage (42.20% in 1998, 41.96% in 1999 and 42.90% in 2000) of total fish yield of the lake, followed by the minor group (38.12% in 1998, 37.83% in 1999 and 37.60% in 2000) and major group (19.68% in 1998, 20.21% in 1999 and 19.50% in 2000) [Table 8(a-c)].

The Indian Major Carps are recorded with a length range of 12.0 cm to 64.8 cm suggests that the lake habitat support to grow the IMC species and it is quite congenial for natural breeding of these highly priced fishes. Incursion of fresh water in monsoon, influence of subtropical climatic conditions, abundance of macrovegetation may be the contributing factors for creating the favourable habitat. Similar trend has also been reported in other freshwater bodies of North East
India (Kar and Dey 2000, Biswas et al. 2001). However, the percentage composition of fish yield of IMC do not reflect the favourable situation as it contributes merely 10.79%, 11.41% and 11.11% of the total fish yield during 1998, 1999 and 2000.

Irregular occurrence of the Indian shad *Hilsa ilisha* is observed in the studied lake. No definite trend can be interpreted from these observations. Occurrence of *Hilsa* in water bodies of Assam have been reported earlier by Yadava et al. (1989). However, in the studied lake a mean length of 23.7 cm to 26.5 cm and mean weight of 495.02 gm to 548.60 gm of *Hilsa* have been recorded during the three years contributing annually less than 1% of the total fish yield of the lake.

6.6 MULTIPLE CORRELATION ANALYSIS

Interaction among the different parameters studied in Baskandi Lake can be analysed by multiple correlation studies (Table 10). Among the meteorological parameters, air temperature, rainfall and relative humidity have a significant effect on the dynamicity of the wetland ecosystems. In the present study it is observed that air temperature has a significant positive correlation with water temperature \((r = 0.9041)\), water turbidity \((r = 0.6897)\), free carbon dioxide \((r = 0.5747)\), zooplankton density \((r = 0.2514)\), biomass of aquatic macrophytes \((r = 0.7130)\) and fish yield \((r = 0.1495)\). Rainfall
interacts directly with relative humidity ($r = 0.6066$) and atmospheric temperature ($r = 0.5852$).

Dissolved oxygen (DO) is inversely correlated to free carbon dioxide ($\text{FCO}_2$) ($r = -0.3070$), water temperature ($r = -0.4394$), atmospheric temperature ($r = -0.3993$), rainfall ($r = -0.3792$) and aquatic macrophyte biomass ($r = -0.3189$). The inverse correlation of DO with free $\text{CO}_2$ was also established earlier by Michael (1969) and Sennayya (1971). Positive correlation between DO and water pH ($r = 0.9995$) as observed in the present study corroborates with the findings of Mori et al. (1999), suggests a parallel change of DO and pH. DO and total alkalinity (TA) shows a positive interaction ($r = 0.4102$) as observed in the studied lake which was also reported earlier by Sreenivasan (1964).

A definite positive correlation is observed between DO and phytoplankton density ($r = 0.0494$) and DO and zooplankton density ($r = 0.0095$) which reflect the importance of dissolved oxygen in the primary and secondary trophic levels. Direct relationship of phytoplankton density with phosphate ($r = 0.6684$) has been observed; which portrays the importance of phosphate in plankton ecology (Agarwala 1996).

Water pH and TA shows negative correlation ($r = -0.3146$, $r = -0.3865$) with the fish yield of the lake. However, due to multifaceted interactions of the meteorological, water, soil parameters and biotic
communities, aggravated by severe anthropogenic interferences, it is practically impossible to predict the specific fish yield of the lake.
Table 10  Correlation matrix among the different parameters of Baskandi Lake during the study period

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0.5852</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.5476</td>
<td>0.6066</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.9041</td>
<td>0.7363</td>
<td>0.8959</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-0.4201</td>
<td>-0.3968</td>
<td>-0.2867</td>
<td>-0.4607</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.6897</td>
<td>0.7073</td>
<td>0.5697</td>
<td>0.7789</td>
<td>-0.4035</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-0.3993</td>
<td>-0.3792</td>
<td>-0.2872</td>
<td>-0.4394</td>
<td>0.9995</td>
<td>-0.3811</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.5747</td>
<td>0.5192</td>
<td>0.4047</td>
<td>0.5909</td>
<td>-0.3240</td>
<td>0.8401</td>
<td>-0.3070</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-0.3892</td>
<td>-0.4892</td>
<td>-0.2735</td>
<td>-0.4465</td>
<td>0.4224</td>
<td>-0.8403</td>
<td>0.4102</td>
<td>-0.7819</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>-0.7731</td>
<td>-0.5957</td>
<td>-0.4855</td>
<td>-0.6163</td>
<td>0.2934</td>
<td>-0.6485</td>
<td>0.2732</td>
<td>-0.6102</td>
<td>0.5787</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>-0.7018</td>
<td>-0.7290</td>
<td>-0.6097</td>
<td>-0.8473</td>
<td>0.8292</td>
<td>-0.7485</td>
<td>0.8292</td>
<td>-0.5813</td>
<td>0.4316</td>
<td>0.7372</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>-0.7526</td>
<td>-0.6625</td>
<td>-0.4709</td>
<td>-0.7502</td>
<td>0.4530</td>
<td>-0.8712</td>
<td>0.4343</td>
<td>-0.8046</td>
<td>0.7780</td>
<td>0.7654</td>
<td>0.7455</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>-0.7143</td>
<td>-0.5899</td>
<td>-0.5816</td>
<td>-0.6535</td>
<td>0.0702</td>
<td>-0.8633</td>
<td>0.0494</td>
<td>-0.5828</td>
<td>0.4448</td>
<td>0.7413</td>
<td>0.6844</td>
<td>0.6940</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>0.2514</td>
<td>0.1854</td>
<td>0.1864</td>
<td>0.1959</td>
<td>0.0051</td>
<td>0.2595</td>
<td>0.0095</td>
<td>0.3646</td>
<td>-0.4175</td>
<td>-0.5343</td>
<td>-0.2051</td>
<td>-0.5472</td>
<td>-0.4150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.7130</td>
<td>0.5582</td>
<td>0.6103</td>
<td>0.7785</td>
<td>-0.3384</td>
<td>0.5353</td>
<td>-0.3189</td>
<td>0.3020</td>
<td>-0.2031</td>
<td>-0.3721</td>
<td>-0.6458</td>
<td>-0.3766</td>
<td>-0.4780</td>
<td>-0.1571</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>0.1495</td>
<td>0.1879</td>
<td>0.0153</td>
<td>0.1820</td>
<td>-0.3146</td>
<td>0.2943</td>
<td>0.3117</td>
<td>0.4981</td>
<td>-0.3865</td>
<td>-0.0495</td>
<td>-0.1255</td>
<td>-0.2261</td>
<td>0.0960</td>
<td>0.0119</td>
<td>0.3031</td>
</tr>
</tbody>
</table>