Chapter IX

DISCUSSION
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Chittaurgarh dam is one of the famous tourist center of district Balrampur situated at north-east Tarai region of Uttar Pradesh. This dam represents different types of water bodies which are lotic and lentic in nature. These water bodies receive the water coming out from hillside of Nepal region. The ecological studies of Chittaurgarh dam reveals the deteriorating environment due to eutrophic condition of the water body fully enriched with aquatic micro and macrophytes with disturbed nutrient dynamics. The monthly as well as seasonal fluctuation in the physico-chemical and biological characteristics of the dam has been analysed and already described in the preceding chapters. These analyses and their findings are discussed as follows-

Ecology of Chittaurgarh dam:

The various physico-chemical characteristics of water and mud sample of Chittaurgarh dam in relation to periodic changes have been described earlier in the chapter V. Their interrelationships, interdependence and modifications with particular reference to the biology of the dam are discussed here.

Water conditions:

A very close exists between the depth and the transparency on one hand and the depth and the volume on the other hand. Both of them proceed hand gradually up to some extent. They are inversely proportional
to the temperature of water? Further, the greater fluctuation water level of the dam favours the formation of large littoral regions.

An intimate relationship exists between the air and water temperature (Table V.A.2) as both differ slightly and tend to rise and fall together. Sometimes they show a wide divergence when the bright sun heats up the water surface and the accompanying cold wind lowers down the air temperature. So diurnal fluctuation is common trend which has been noticed in air and water temperature.

Fluctuation of water temperature of any aquatic habitat leads little disturbance in species composition, but it does influence the physico-chemical characteristics of the habitat. The high temperature from March onward initiates rapid decomposition of the organic matter in the substrate and consequently the mineral content also rises in the dam water during the next following months (Table V.A.16).

Recent investigation suggested that the pH is less important as a limiting factor for the life in aquatic environment. Present investigation indicate high that pH value (Table V.A.5) obtained coincided with the winter having maximum dissolved oxygen, while concentration of several other factors like chloride, calcium, nitrate and phosphate were minimum. The pH consequently can not be considered as an index of chemical factors prevailing in the water. Abbasi et.al. (1996), Allen and Kramer (1972), further, an inverse correlation was found between the pH and the temperature which is contrary to the observations of Lande and Sinha (1996) and Vyas and Kumar (1968).
Juday (1940) have pointed out, with respect to the lakes of north eastern Wisconsin, that the annual variation in the pH value of the lake was usually less than 3 and the difference between the pH of surface and bottom waters was also 3. In the present findings, where as the annual change in pH was up to 2.4, the maximum difference between the surface and bottom water was 1.85 only.

Although the amount of air dissolved in water is richer in oxygen than that of atmospheric air, yet under normal condition the amount of oxygen dissolved in a unit volume of water does not exceed more than 5% of that present in an equivalent volume of the atmosphere, because the total amount of air held in aqueous solution is very small. Moreover, the rate of diffusion of Oxygen in water is several times less than that in air. Oxygen concentration, therefore, is a much more critical factor in aquatic environment than in the aerial one. Hence poor oxygen supply influences negatively both planktonic & benthic organisms generally.

Rawson (1939), while reviewing data involved in the metabolism of lakes, reported that changes in dissolved oxygen concentration of a given volume of water which receives no tributaries, are mainly caused by three processes, (a) an interchange of oxygen between the atmosphere and water, (b) consumption of oxygen by the direct chemical oxidation and by aerobically respiring bacteria, plants and animals in water and substratum and (c) production of oxygen by the photosynthesis of plants in water and on the surface of the substratum.
In present investigation the dissolved oxygen (Table V.A.7), was plentiful during winter season, when submerged macrophytes were luxurient, while during rainy season there was luxurient macro and micro plankton and due to addition of excessive oxygen supply from intensive rainfall. The oxygen production during these periods exceeded many a times the oxygen consumed by the organisms as has also been observed by Ganpati (1941) and Sreenivasan et.al. (1964) during analysis reservoirs of Madras.

As stated earlier, the difference in the values of dissolved oxygen in the surface and bottom waters was more during winter months than the summer months, when due to high temperature and fast blowing hot winds the diffusion of gases were more rapid. This caused an uniform distribution of dissolved oxygen.

The free carbon dioxide was detected mainly from the polluted region during the winter and monsoon months. Its absence from the littoral and pelagic waters of the dam suggested that probably all the carbon dioxide produced during the respiration of living organisms was either utilized in photosynthesis of the autotrophs or form converted in to the mono and bicarbonates as bound form (Rawson, 1939).

The free carbon dioxide varies according to the photosynthetic activity of autotrophs occurs in the water body of the dam. These organisms are able to utilize the free as well as bound form of carbondioxide when only the free form is utilized, while bound form get precipitated (Rawson, 1939). The low amount of carbonate in the bottom
water of the dam was probably due to the availability of insufficient amount of free carbon dioxide for photosynthesis.

The alkalinity of water (dissolved carbonate and bicarbonate content) is often used as an arbitrary basis for classifying waters into nutrient types (Chatrath, 1992) observed that the in south Scottish lakes, 40% had 1 to 15 ppm- a class he regarded as nutrient poor, 40% had 16 to 60 ppm-which he considered as moderately rich and only 20% had more than 60 ppm which he deemed as nutrient rich. Since in the present water bodies of the dam 102 to 310 ppm of alkalinity obtained during different months through out the year, hence it could be classified as fully nutrient enriched water bodies of the dam.

Its alkalinity, calcium is also of fundamental importance for the plant nutrition. Usually in some water bodies, it undergoes an active circulation and may be lost either temporary or permanently by precipitation as lime or calcium carbonate. Ward and whiple (1959) considered lakes with less than 10 mg/l of calcium as poor, with 10 to 25 mg/l as medium and with more than 25mg/l as rich. West lake (1960) made an useful observation that if no macroscopic lime on encrustations are visible on plants, etc. the water is poor in calcium. If they are in visible medium, with abundant encrustation occur the water is rich in calcium. In the Chittaurgarh dam, there was an abundant growth of macrophytes and a few of them had deposits of calcium oxalate crystals inside their stem. In addition, the macroscopic encrustations were fairly distributed on the floating leaves, submerged stems and shells of molluscs. This indicates that the dam water is rich in calcium.
The significance of calcium content in determining the tropic nature and the classification of lakes has been stressed by Rawson (1939). According to him the typical eutrophic lake is rich in calcium and the typical oligotrophic-lake poor in calcium. In the present investigation the calcium content ranged between 66.0 to 235.0 ppm which is fairly high and thus indicates the eutrophic nature of the lake. More calcium deposition occur in macro and microphytic flora of the dam (Table V.A.13).

In the present investigation, an inverse correlation was found between the transparency and the organic content of the water. The former is to some extent also dependent upon the temperature of the water.

A direct link was observed between the chloride content and the water temperature, since both of them fluctuated identically. Further, with the increase in the chloride content, the nitrate and phosphate contents also increased which is in agreement with the findings of Sahai and Sinha (1969). The high concentration of chlorides is indicator of richness in organic matter in water or substratum. The latter on account of its rapid decomposition during the summer months brings about an immediate increase in the inorganic nutrients, like nitrates and phosphates in water (Reid, 1961).

The nitrate and phosphates act as major raw materials for the protein synthesis. Rawson (1939) has pointed out that the quantity of available nitrogen and phosphorus in any water is indicator of its productivity. The amount of nitrate and phosphate occur in present water bodies of the dam was relatively less (Table V.A.12, 14). During summer season when
these nutrients were maximum, the diurnal and annual circulation brought about their uniform distribution in the surface and bottom waters. While in monsoon season, the phytoplankton in the upper layer began to consume it, due to which their values started to decline considerably. Due to the death and decay of these macro and microplanktons large amount of their organic remains get deposited in the bottom of the dam in the next successive months.

The increase in quantity of these nutrients from the onset of summer months in the dam, was mainly due to rise in the water temperature which caused decomposition of the organic remains by saprophytic organisms, The latter were abundantly distributed in the highly organic polluted areas of the dam which had the maximum organic wastes.

**Edaphic conditions:**

During sediment analysis of the dam (Table.V.B.01 to 10). It is evident that there exists an intimate relationship between the total organic matter and the nitrogen content of the bottom deposited in the dam. It was maximum during rainy season and minimum in winter months. It is mainly on account of the fact that with the onset of summer season, the plants inhabiting the dam, margin start dying due to high temperature of the season and their organic remains were washed into the dam with the the surface run off from the surroundings areas during the monsoon season. This increases the organic and total nitrogen content in the littoral and polluted regions of the dam.
Present observation seems that dam is rich in organic matter. The organic matter and total nitrogen contents are inversely proportional to the nitrate and available phosphorus contents because during summer months the organic matter present in the substrate undergoes a rapid decomposition causing, thereby, an increase in the nitrate and phosphate contents. In the other successive months, these chemical constituents get dissolved into the water and due to diurnal circulation, get distributed. The gradual rise in the nitrate and phosphate contents in the dam water with the onset of summer season also express the same results as above (Table.V.B.5.7.9).

The calcium content (Table.V.B.8) of the mud does not show any distinct relationship with other constituents present there because of its multipurpose functions. It is mostly utilized by the autotrophic and heterotrophic organisms. Its trend of fluctuation shows up to some extent a correlation with the rise and fall of the organic matter and total nitrogen.

Calcium is required in large amounts to micro-and macroproducers and in lesser amounts to consumers. The diatoms and molluscs accumulate it in their shells and certain macrophytes possess calcium oxalate crystals in their bodies. After the death and decay of these organisms large amount of calcium is released to the substrate again. The high calcium content found in the littoral region is primarily because the free-floating macrophyte are abundant in the shallow regions of the dam as compared to the deeper regions and planktonic organisms also get accumulated bank of dam through wind and water currents and after their death and
decay their calcium content is released and deposited to the mud of the littoral region (Nishi, 1990).

Sediment is an independent and dynamic body of nature that acquires properties in accordance with the forces which act upon it. Considerable work has been done on morphometrics and physico-chemical properties of sediments of different water bodies. But no work has been reported on seasonal variation and sediment interrelationship. Before this dam has been done by Sahai & Sinha (1968) reported during the analysis of Ramgarh lake of Gorakhpur. That sediment of Ramgarh lake can be categorized under mineral sediments as it was less them 35% of organic matter. The soil is slightly alkaline due to presence of more alkalis. Break down of humus results in increased concentration of carbon-dioxide.

Hydrolysis of acid, salt and production of organic acid which add total acidity of the sediment as reported by Sharma and Sharma (2004). The conductivity of sediments has been observed high, while conductivity of sediment gradually decreases from winter to monsoon due to rapid decomposition of dead plants and animals.

Total alkalinity, chloride, organic matter, organic carbon, available phosphorous, nitrate and calcium generally increase from winter to summer. Similar results have been also obtained by Bellamy (1967) in the ephemeral swamp. Chatrath (1992) has reported reduction in total nitrogen, phosphorus and calcium in Dal lake during summer. The reason for this may be due to the exponential growth of macrophytes. The increase in these nutrients in the Chittaurgarh dam is probably due to the reduction in macrophytic biomass and rapid decomposition of humus. Bhatanagar
(1984) has advocated in favour of decomposition of humus during summer. The reduction of water level during summer like in Tarai regions of U.P. causes setting of water minerals on the sediment bed adding to the nutrient availability of sediments. The increase in water table causes rapid growth of macrophytes which utilize the nutrients from the sediment during monsoon. Therefore in monsoon period, the level of almost all the nutrients of the sediments is decreased. Dixit (1987) has worked out the correlation of different physico-chemical factors of the sediment which shows that conductivity is negatively and significantly correlated with organic carbon at 5% level. Chloride shows negative organic carbon and organic matters show positive significant correlation with available phosphorus at 5% level. Organic carbon was found to be highly significant with organic matter at 1% level.

**Phytodiversity of Chittaurgarh dam:**

In the aquatic complex of different water bodies of Chittaurgarh dam shows very unique phytodiversity because the environmental conditions differ considerably from one type of vegetation to other. Therefore, we have analysed and discussed macro and microflora with community composition systematically.

Community composition deals broadly the plant into two categories, one is terrestrial phytodiversity and the other is aquatic phytodiversity. During the study of terrestrial phytodiversity it has been seen that there is full combination of herb, shrub and trees. Seasonal succession reveals that plants adjacent to Chittaurgarh dam are fully enriched during rainy season. However few annual herbs like *Amaranthus spinosus, Dicanthium*
sps., Sida cordifolia, Croton tigilum etc. are rainy season weed survive up to winter season. Few winter annual like Oxalis sps., Eclipta alba etc. are short lived because they disappear in the start of summer. Trees like Acacia nilotica, Azadirachta indica, Mangifera indica occur in few sites which is generally used for picnic spot. Yellowing of leaves with stunted growth occur in annual and perennial herbs indicates adverse effect of miscellaneous type of pollution and carelessness of tourist. Zizyphus jujuba, Acacia arabica, Calotropis gigantean, Amaranthus spinosus act as indicator plant of wetland. Presence of Pleurodendron, Datura alba, Lantana indica and Calotropis gigantea represents light and disturbed soil near by Chittaurgarh dam. Overall, the heterogeneity index shows approaching to homogeneity but not homogenous.

During the analysis of aquatic macrophytes the environment of free floating aquatic plant consist water and air, while submerge aquatic plants related to water and soil in the case of aquatic emerged macrophytics plants environmental condition is related to soil, water and air. Besides these few marshy plants are also found who can survive air and water both i.e. They are able survive aquatic and terrestrial environment both. It is therefore difficult to establish the role of them in the growth and development of these macrophytic communities.

Pearsall (1917, 1918, 1920, 1930, 1932) from his pioneer researches on the dynamic relationship existing between the hydrophytic communities and their environmental conditions. He made observations of English lakes. The succession of communities was controlled primarily by an-allogenic factors and accumulated in silt. Persall’s findings cited that a
significant differences between available phosphorus in soil related to *Potamogeton* sps. and *Hydrilla* sps. He suggested that correlation may exist between the species and the substratum.”

Present investigation represent that plants like *Hydrilla* sps., *Ipomoea* sps. *Typha latifolia*, *Polygonum glabrum* and *Tamarix articulata* etc. having marshy nature distributed throughout the dam show there luxurient growth in the pelagic water. On the other hand plant like *Sagittaria* sps., *Ceratophyllum sps.*, *Ranunculus* sps., *Alternanthera* sps., *Scirpus* sps. and *cyperus* were invariably restricted to the chemical composition of mud resulted the formation of different type of communities like *Tamarix scirpus*, *Typha polygonum*, *Ipomoea cyperus*, *Alternanthera ranunculus*, *Ipomoea sagittaria*. *Ipomoea* is specific because during community formation it accompanied *Cyperus* sps. and *Sgittaria* sps., separately, while *Veronica anagalis*, *Alternanthera* sps. and *Ranunculus* sps. survives together during community formation. *Veronica anagalis* again form community with *Cyperus* sps. and *Typha latifolia*. Such type of communities shows significant difference inorganic matter, nitrogen and calcium contents.

Soulthorpe (1967) has reported that the principal influence of the substratum upon the distribution of rooted vegetation is primarily due to its physical texture rather than its chemical composition. The important physical properties of the submerged soils are the composition and nature of the basin, deposition of washed inorganic and organic sediments and the activities of flora and fauna themselves. In the Chittaurgarh dam,
however, due to low imbalance, the substratum forms a smooth; gently slope with slight variation in its physical texture from the margin towards the center of the dam. Therefore, the chemical composition of the bottom deposits of this dam is more important than its physical texture. A distinct correlation between the mineral coposition of the mud and the mineral solutes in water was observed. The latter are frequently utilized by the micro and macrophytic plants as a nutrient.

In Chittaurgarh dam, it was further, observed that with an increase in the free-floating vegetation, the calcium content of the mud decreased. It was probably due to high requirement of calcium during the rapid organic production of these aquatics (Singh, 1981).

It is an established fact that vascular hydrophytes require the same micro and macro nutrients that essential for the healthy growth of terrestrial plants. The ions of major metabolic significance are those of potassium, calcium, magnesium, iron, ammonium, nitrate, phosphate and bicarbonate. Pearsall (1921) observed an abundant growth of macrophytic aquatics where the water was rich in calcium, magnesium and silicate. In the present findings, a direct correlation has been noticed between the free-floating macrophytes and the nitrate and phosphate contents of water.

In addition to the correlation’s between the aquatic macrophytes and chemical conditions of water and mud, there were certain physical and climatic factors, which influenced the growth and metabolism of these plants up to some extent. In the Chittaurgarh dam, the marshy vegetation was mainly composed of rainy season plants which showed their first
appearance with the commencement of rains. They produced flowers and fruits during the late monsoon or early winter months and started disappearing with the onset of summer months.

**Plankton dynamics:**

There exists a direct correlation in the densities of the bacillariophycean algae and protozoans and an indirect correlation in the densities of rotifers and zooplanktons. The phytoplankton population is always inversely correlated to that of zooplankton population.

The plankton vegetation, on which the entire aquatic animal life depends, directly or indirectly is largely governed by the interaction of a number of factors (Reid, 1661). The correlation between the physico-chemical factors and the fluctuation in the plankton density is a follows—

From the data in the chapter V and VI, it is evident that no single factor, physical or chemical, is responsible for the seasonal growth of the phytoplankton or zooplankton of the dam. Das and Srivastava (1956a) have stressed the need of taking into consideration a number of physical, chemical and biological factors, which act simultaneously, while assessing the seasonal fluctuations of planktonic population in any water.

During the analysis of microphytic flora algal dynamics has been emphasized mainly. In this context, only biological indices are taken into consideration. These indices are aimed at species composition of the sample, the diversity of species, their distribution pattern, the presence or absence of the indicator species or various group etc. *Nygaard’s* trophic state indices indicate that most of the algae are responsible for eutrophic status of water. (Table VII. 8), while only Euglenophycean algae are
showing oligotrophic condition. These indices indicate that water is full of organic load beyond with enriching nutrients. Amongst the physical factors, water temperature is considered to be mostly responsible for the fluctuation in plankton density. Evans (1962), Goulder (1969) and Prasad (1916) have stated that the temperature is the only determining factor in the seasonal distribution of these organisms whereas, Vashisht (1968) has observed that the plankton density changes inversely with it. The water temperature during study exhibited a positive correlation with the plankton density.

Further, the diatom population also showed its peak during the summer and rainy season when the temperature was maximum, while in winter season its occurrence was poor. This finding is in concurrence with that of Venkateswarlu (1969, 1970) and Pahwa and Mehrotra (1966).

As observed earlier, the rotifers were maximum from spring season to winter season and thus they showed an inverse correlation with the water temperature—a feature also observed by Slatyer (1977).

Amongst the chemical factors pH, free carbon dioxide, oxygen, alkalinity, nitrate and phosphate seem to affect the seasonal fluctuation in phyto- and zooplankton populations. Stephen et al. (1964) has stated that pH value of any water is an important factor in plankton development. Kolff (1967) and Srinivasan et al. (1964) have also shown that water maintains a relative high pH when the phytoplankton is rich and well developed. In the present investigation, the maximum populations of phytoplankton was recorded when the pH was comparatively low. Similar observation has also been reported by Vyas & Kumar (1968).
Michael (1984) has observed that the zooplankton density was inversely correlated with the pH value of the water in a pond at Hyderabad. In the present study, however, a direct correlation between the two was observed.

The high oxygen level in the water during post-monsoon months seems to be directly related with the phytoplankton density and thus supports the observations of Arivazhagan and Kamalaveni (1997), Das and Srivastava (1956a). The high amount of dissolved oxygen in post-monsoon months corresponds with the phytoplankton maximum of that season but in summer months the phytoplankton maximum coincides with the low value of the dissolved oxygen.

In the Chittaurgarh dam, the amount of free carbon dioxide and zooplankton population show an inverse correlation, which is in concurrence with the observation of Vyas & Kumar (1968) and contrary to that Das and Srivastava (1956a).

Stephen *et.al.* (1988) has emphasized the importance of alkalinity as a factor determining the nature and periodicity of plankton population in fresh water. They regarded that the water bodies having alkalinity less than 50 ppm as less productive, 50 to 100 ppm as moderately productive and 100 to 200 ppm or even up to 650 ppm as highly productive. On this basis the present dam comes under the last category. It started increasing with the rise in the phytoplankton density and attained their respective maxima during August-September.

Pearsall (1932) has associated the diatom periodicity with the amount of silica, nitrate, and phosphate present in water. In the present
study, a relationship was noticed between the diatom pulse and the chemical factors of the dam water like chloride, nitrate, phosphate and calcium. Vyas & Kumar (1968) have also reported that the relatively high amount of these nutrients in the water of Indrasagar tank promotes the growth of planktonic algae.

The zooplanktonic population, however, shows an inverse correlation with the rise and fall of these nutrients in the dam water. **Influence of Environment on Ecology of Chittaurgarh dam:**

It is established that metabolic activities of aquatic plants and animals are to a great extent controlled by certain physico-chemical conditions of the water in which they grow. Soulthorpe (1967), while dealing with the biology of aquatic vascular plants has stated, “the intricate pattern of environment- community interaction is notoriously difficult to analyse and the various physiographic, climatic, edaphic and biotic factors tend to be somewhat arbitrarily delineated.” He has, further, pointed out that the environmental factors interact amongst themselves and none of them is slightly responsible for controlling the growth and distribution of aquatic plants. In addition, the biota themselves modify the nature of water up to a great extent.

In aquatic complex, the environment of one type of vegetation differs so much from that of the other that it is difficult to establish the role of any one factor alone which it may play in the growth and distribution of these autotrophic organisms e.g. environment of free-floating vegetation consists of water and air; submerged vegetation water and mud; of attached-emerged vegetation-air, water and mud, and of
marshy vegetation-air and mud only. However, during the course of present investigation certain correlation’s between environmental factors and the structure and functioning of autotrophic organisms have been observed.

**Influence of aerial environment:**

The aerial environment has pronounced effect, directly through its interaction with other physico-chemical conditions or water bodies, on the development, metabolism and production of certain plant communities. Hogweg and Brenkert (1969) have reported that in different geographic regions, their respective climatic conditions may be prohibitive or determinative factors. They have shown that while in Netherlands, the aquatic vegetation was poorly developed or even absent during the cold season. It was so during the warm season in many regions of India. They have observed that the atmosphere and /or moisture act as limiting factor(s).

The climatic condition of the study area differ pronouncey from one season to the other and have a direct bearing on the ecology of the Chittaurganh dam.

The percentage cover of attached-emerged and marshy plant communities starts decreasing with the onset of summer and reach their respective minimum by the end of the season. They reappear with the onset of monsson which suggests that they are probably not able to withstand the low air moisture and hot winds of the summer season.

The phytoplankton periodicity shows a positive correlation with the temperature of the dam water as it excess on increasing with the rise
in temperature. On the contrary, the zooplankton population shows an inverse correlation with the temperature.

The aerial environment also affects various abiotic components of the dam. The sufficient increase in alkalinity, chloride, nitrate, phosphate, calcium and organic matter content during summer season seems to be directly correlated with the rise in air temperature since the latter causes a rapid decomposition of the organic remains present in the dam. The sharp fall in the quantity of chemical constituents during the following post monsoon season is mostly due to their dilution by rain water.

Further, the high temperature of summer season accompanied by fast blowing winds brings about a fairly uniform distribution of dissolved gases and ions in the dam water. This helps in the rapid increase all types of planktonic organisms.

**Influence of water environment:**

The physical and chemical nature of water plays a significant role in the distribution, periodicity and productivity of aquatic plants.

The high turbidity of water in summer and monsoon months, while inhibits the photosynthetic activity of the submerged macrophytes, it promotes the growth of the phytoplankton and attached-emerged macrophytes.

The pH value and carbon dioxide of water have some effect on the metabolism of certain aquatic animals, particularly the fishes. The aquatic plants, however, show certain degree of tolerance to these factors. The carbon dioxide available for the photosynthesis of such plants is usually insufficient and to make up this they use the bicarbonate of the dam water.
as substitute. In the present study the amount of free-carbon dioxide shows a close relationship with the phytoplankton periodicity however, it does not do so with that of the free-floating and submerged macrophytes.

The oxygen concentration is a critical factor in any aquatic environment. The low concentration of oxygen is usually responsible for the mortality of a number of heterotrophic lives. The production of oxygen in photosynthesis by aquatic plant communities is usually many a times more than its consumption in respiration by them. The direct effect of submerged hydrophytes on oxygen balance of the aquatic environment accrue from their photosynthesis and respiration, reproduction and decay (Sculthorpe 1967).

For establishing a correlation between distribution of the aquatic plants and the amount of oxygen dissolved in the surrounding water, it is imperative that the oxygen produced by these plants must be liberated to the water and not to the atmosphere. This is not at all possible for all the types of aquatic plant communities because in the free-floating and attached-emerged plants, major amount of oxygen evolved is released to the atmosphere and not to the water. The oxygen concentration in the present dam exhibits two maxima one during winter months and the other during post-monsoon months. Whereas, the former peak coincides with the distribution of submerged plants, the latter with that of the phytoplankton.

In the early part of summer, water hyacinth *Eichhornia crassipes* (Mart.) Solms shows an extensive growth and occupies more than 50% of the total water surface the oxygen dissolved in the water during this
period does not increase in its concentration because much of the oxygen produced in photosynthesis by these plants gets released to the air. Sculthorpe (1967) has rightly said, “since rate of photosynthesis may well differ between serial and submerged parts, as a result of different prevailing light intensities and since some oxygen may diffuse from the serial to the submerged parts, it is impossible to make correlation for assumption based solely on the observed proportion of the crop which is above water. Values of photosynthetic oxygen production calculated from crop data are therefore only very approximate.”

This is true that aquatic plants also require the same micro and macro nutrients that are essential for the healthy growth of the terrestrial ones. The ions of major metabolic significance in the fresh waters are those of potassium, calcium, magnesium, iron, ammonium, nitrate, sulphate, phosphate and bicarbonate. Pearsall (1921) has correlated the growth of macrophytic species with the amounts of calcium, magnesium and nitrate present in water. In the Chittaurgarh dam, a direct correlation has been observed between the nitrate and phosphate contents of water and distribution of free-floating and attached-emerged macrophytes. Further, the amount of bicarbonate, calcium, nitrate and phosphate contents of the water directly influenced the phytoplankton periodicity.

**Influence of edaphic environment:**

The composition of bottom layer of any water body is important because of the possibilities it offers for the anchoring of plants to the substratum and the favorable conditions for the survival.
Pearsall (1921) has observed that in English lakes, the distribution of aquatic plants was primarily governed by an allogenic factor: the net accumulation of inorganic silt. Sculthorpe (1967) has reported that the principal influence of a substrate upon the distribution of rooted vegetation was mainly due to its physical texture rather than its chemical composition.

In the present study the dam basin is more or less saucer shaped *i.e.* has a smooth, gentle slope from its margin towards the center. There is slight variation in the physical properties of the soil beneath the littoral and the pelagic regions. The density of the rooted vegetation is invariably more in the pelagic region rather than the littoral region. On the other hand, the free floating micro and macrophytic vegetation is mostly confined to the littoral region only. The results of chemical estimations of soil from the shallow and deep waters have shown a significant difference in the quantity of major elements like nitrogen, phosphorus and calcium (Table V.B.6,7,8) which agree with the findings of Pearsall (1921), Rawson (1939) and Reid (1961).

These observations further indicate that both the physical and chemical nature of the substratum are equally important for the growth and distribution of micro- and macrophytes in any water. A distinct relationship exists in the present dam, between the mineral composition of the mud and the mineral solute in water. The distribution of the submerged and attached-emerged macrophytes are markedly affected by certain edaphic conditions.
Influence of biotic environment:

In addition to the correlation's discussed above, the organisms also interact amongst themselves and this has a far reaching effect over the general functioning of the ecosystem. As the free-floating vegetation is always maximum in the shallow regions of the dam, the submerged aquatics found there receive comparatively less quanta of light due to which their growth is considerably retarded. Further, certain free-floating macrophytes, like the 'duck-weeds', which form thin cover over surface of the water, interface with the gaseous exchange and adversely affect the growth of submerged plants.

The phytoplanktonic organisms were invariably high during summer and monsoon season but in winter season their density declined considerably due to the rapid increase in the population of zooplankton. This indicates that production of the latter increases at the cost of the former. Other intricate relationships amongst the organisms might also be existing but on the basis of the present findings, be concrete conclusion can be drawn.

Eutrophication Control:

Constructed of pre-reservoirs on the connecting canals to act a bio-reactors construction of contour graded drain all along the dam so, that the run off from th does not enter the dam. It helps in reducing the run off rate and also act as sediment tr impoundment along the river side can be used as bio reactors. The growth of macroplant weed Phragmites karka is great threat. There macrophytes have adversely affected practices
in the dam area and its also creates major problem to the swimming birds. A dozing and grazing method can remove *Phragmites*. In this dam weeds can by culture herbivorous fishes like *Ctenopharyngodon mossambica*, *Orhromus goramy* etc.

Application of natural and mineral fertiliser in a manner that inhabits their transport an water bodies. Fertiliser should be applied at the start of the crop growing period. Use be done in several steps in accordance with specific needs. The crop rotation practice suitable manner, which can inhabits the use of nutrients. The fodder crops can be cult down stream of check dams to reduce the level of phosphorous and nitrates.

**Ecotourism perspective of the dam:**

The ecotourism or nature tourism is of immense importance and multifarious interests involving a number of social, national and international areas. In the recent trends, the tourism has been declared an industrial field of commerce *i.e.* business. This field has been recognized with great potential in developing a healthy economy of the country, state and region concerned. But due to lack of a coherent policy of an agency the tourism industry is not making much headway. The ecotourism, nature tourism and beach tourism along the sea beaches are the very new additions towards the type of the tourism. Although these are attracting the interests of the tourists towards their natural lust but there is great scope in popularizing this aspects of the tourism among the people of this county and foreign also. In the form of the new destinations of the tourism going out for recreation and entertainment. The ecotourism has to be promoted
because it involves a minimum monetary and human resources for the maintenance and up gradation of the dam, hills, garden, parks and sea beaches etc. as lure for the incoming tourists. The dam can be considered as endowments on parks with any other tourist destination only because of its scenic beauty attractions. Ecotourism industry as present need a serious boosting in this area. It is a non-investment area of the tourism industry based on the natural resources, scenic beauty and other ecological attractions with great scope. It is further facilitated by local participation due to local employment generating potential plus environmental conservation. This dam Chittaurgarh can attract national as well as international tourists because it is associated with the other tourists places of this area. Hence, there is strong scope for the development of the ecotourism of this area in a big cull.

A number of studies have been done on the social and cultural impact of tourism development because it is a positive relationship in between “hosts and guests” this all leads towards a development while traveling. The social impact of tourism will vary according to the difference between the visitors and the visited, whether in term number, race, culture or social outlook. The relationship between hosts and tourists establishes a transitory relationship often coupled with language barriers but allow a limited relationship between two. Some time his relationship is restrained because as tourist are on holiday but the hosts are at works usually. The impact to tourism on traditional life style is especially important where as that tradition forms the basis for the development of the tourism. There are certain other related aspects such as economic, environmental besides
social and cultural values. Altitudinal impact of tourists and host are also others very important points to be considered but there is an important role for ecotourism in nation and community, increasing a greater social contact with tourists. These observations are in close agreement with our observation in the present work. Positive cooperation between tourism and environmental authorities is very crucial for future development of ecotourism. There is urgent need to create awareness among the people about the modern trends in tourism sector and the huge potential of the ecotourism sector creating job as well as earning of nation and foreign exchange.

There may be debate upon the importance of tourism. Boon or ban, some people think that glorious contribution of ecotourism upon income and employment while other feel that it has deleterious effects ranging from introduction of drugs, gambling, prostitution, deforestation, psychological, colonialism and so on. Therefore, the ecotourism benefits are at the costs of social values. Ecotourism is a part of the tourism and is a multifaced activity in the area ranging from snow-clad mountains, silky beaches, and verdant forests, it is of two-way exchange between economical value and cultural resources. Just like the example of bird’s watching at Bharatpur, Rajasthan while others prefer to watch birds at the site of Jatingha, Assam. Some way or the other it is detrimental to the environmental concern. Although the ecotourism is smokeless and less exposed to pollution because its development is not like to that of petrochemicals or steel plant which bring about a number of environmental pollution and hazards.