CHAPTER II

REVIEW OF LITERATURE
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During the last few decades, the wetlands have attracted the attention of workers throughout the world. Tremendous works have taken place in various aspects of the wetlands. An exhaustive literature survey is therefore almost impossible and hence, only a sample of the published literature, having relevance directly and indirectly to our research work is given here.

Thus, in this chapter, a short review of existing literature on wetlands especially on wetland water, soil, plankton, benthic communities, productivity and conservation measures are discussed relating to the objectives of our present work.

2.1 WATER QUALITY

All human civilizations have evolved in close proximity to natural sources of water, especially rivers. Lotic waterbodies like rivers and streams play very important role in maintaining biodiversity and ecological balance in nature. Water resources are essential for existence and development of the global community. River water offers a promising source for domestic, industrial and agricultural utilization. Water is the single most vital component of the earth that made possible for life to originate, evolve, flourish and reach the present form that we have today. Earth is called as a wet planet as two thirds of it is occupied by water. It covers about 71% of earth surface and hence the most abundant resource on earth (Miller, 1991). About 97% of water formed on earth is in the oceans and is not available for human consumption and other uses because of its high salt content. Of the remaining 3%, 2% is locked in the polar ice caps and only 1% is available as fresh water in rivers, streams, lakes, reservoirs and ground water which is suitable for human consumption (De, 2000). Human beings use fresh water available from rivers and streams for cultivation of crops and industrial use. There are many environmental factors that have been linked to the fresh water situation. Forest absorb and intercept about 40% of annual precipitation, delay run off and reduce the flow of pollutants to streams, rivers and lakes (WRI, 1992).
In aquatic ecosystems, water plays the most important recreational and aesthetic value to the nature. Quality of water has great influence on the ability of aquatic plants and animals to exist and grow in streams, rivers, lakes and ponds etc. Polluted water generally carries various disease causing agents and toxic chemicals. Thus they can affect the health of dependent terrestrial as well as aquatic organisms. Moreover, the poor water quality may be the reason for closing of both commercial and sport fishing areas and thus restricting the recreational use of water bodies. Therefore, water must be always of good quality to maintain its aesthetic value in the scenic environment. Various parameters like temperature, conductivity, turbidity, pH, DO, BOD, TDS, TSS, metals etc. determine the quality of water.


2.2 SOIL QUALITY

Soil is a complex dynamic system comprising of physical, chemical and biological substances. It is that indispensable part of earth where life survives. The word ‘soil’ was derived from the Latin word ‘Solum’, which means earthy materials where plants grow. Soil derives its mineral constituents from parent materials, the soil forming rocks by weathering and fragmentation. The organic components of the soil are formed either by decomposition or transformation of dead remains of plants or animals or through metabolic activities of living organisms present in the soil. Soil
serves as a reservoir of minerals and nutrients to satisfy the needs of plants growing on it (Pandit et al. 2004).

Ecologically soil nourishes the crop and other plants. Plants growth depends on the quality of soil. Soil quality has been defined as "the soil's fitness to support crop growth without becoming degraded or otherwise harming the environment" (Acton and Gregorich, 1995). Environmentalists define soil quality as the soil functioning at its potential in an ecosystem with respect to maintenance or enhancement of biodiversity, water quality, nutrient cycling, and biomass production (Bhuyan and Sarma, 2006). The quality of soil, much like air and water, has immense effect on the health and productivity of a given ecosystem and the environments related to it. However, unlike air and water for which we have quality standards, the definition of soil quality is complicated because it is not directly consumed by humans and animals (Doran et al., 1996). Soil quality is frequently defined as: "The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation" (USDA - Natural Resources Conservation Service, Soil Science Society of America). Larson and Pierce (1994) defined soil quality as “the capacity of a soil to function, both within its ecosystem boundaries (e.g., soil map unit boundaries) and with the environment external to that ecosystem (particularly relative to air and water quality)”. Parr et al. (1992) defined soil quality as “the capability of a soil to produce safe and nutritious crops in a sustained manner over the long-term and to enhance human and animal health, without impairing the natural resource base or harming the environment”.

Doran et al. (1998) defined soil health as the capacity of a living soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health. Soil health could change over time due to natural as well as human interference. A soil is not considered “healthy” if it is managed for short-term productivity at the expense of future degradation. The three major functions of soil are to act as a medium for plant growth; to regulate and partition water flow; and to serve as an environmental buffer (Doran and Parkin, 1994).
In an aquatic ecosystem, the analysis of soil for physico chemical characteristics is necessary for judging the relationship between water and soil with respect to their properties (Tiwari and Ranga, 2006). The water quality of an aquatic system depends on the terrain through which it flows and the sediments it carries along (Venkataraman et al., 2006). Das and Borah (2003) noted that the chemical characterization of the sediments in lentic and lotic systems help in measuring the anthropogenic contamination and to assess probable impact on the environment. The information on fresh water sediments also helps in continuous monitoring tracing impact of pollution in the freshwater ecosystems (Metcalf et al. 2000, Chandrashekhar et al., 2003). Besides, the wetland soil plays important roles in several functions like in fish production, mineralization of organic sediments and in storage and release of nutrients in water. Also, it acts as the chief source of nutrients for primary producers in an aquatic ecosystem. The wetland soil is physically composed of stones, plant roots and leaves, sand, silt, shells of molluscs, clay and humus. The potential energy and aquatic organic matter are stored inside the bottom soil of an aquatic ecosystem in the form of humus and organic residue, which maintain the biota in that ecosystem (Lendhe and Yeragi, 2004).


2.3 PLANKTON

Chemical analysis of water provides a good indication of the chemical quality of the aquatic ecosystem, but do not necessarily reflect the ecological state of the system (Karr and Benke, 2000, Ghavzan et al. 2006). Therefore, the biological assessment is needed to know the ecological quality of aquatic ecosystems, as the
biological communities are dependent upon the environmental effects induced by water chemistry.

Plankton population represents the indices of health and productivity of an aquatic ecosystem. They constitute the basic link in the food chain of all aquatic organisms (Misra et al. 2001). Most of the aquatic organisms including fishes thrive on plankton for their growth and development (Baruah and Das, 1997). It is therefore of utmost importance from ecological perspective to study and analyze the plankton communities to focus the health and functioning of an aquatic ecosystem. According to Mir et al. (2007), the seasonal succession among the plankton plays an important role in depicting the trophic status of the aquatic habitat in relation to environmental factors.

All natural waters as well as artificial impoundments like ponds, tanks, reservoirs, irrigation canals, etc. bear planktons. Planktons are broadly divided in to two parts- phytoplankton and zooplankton. Phytoplankton are the plant part of the plankton. They float aimlessly or swim feebly to maintain constant position against water current.

Phytoplankton are the main producers of an aquatic ecosystem by controlling the biological productivity. They not only provide an estimation of standing crop but represent more comprehensive biological index of the environmental conditions (Ravikumar et al., 2006). Phytoplankton community comprises of a heterogeneous group of tiny plants adapted to various aquatic environments. Their nature and distribution varies considerably with respect to seasons and water quality (Harilal, 2005, Homyra and Naz, 2006). Their dominance also leads to qualitative changes of aquatic systems. Phytoplankton play a crucial role in maintaining proper equilibrium between biotic and abiotic components of an aquatic system (Shiddamallayya and Pratima, 2007).

Zooplankton are the intermediate link between phytoplanktons and fish. They are the secondary producers in the aquatic environment. Their role in the trophic dynamics of aquatic ecosystems is highly notable (Venkataraman, 1987).
Zooplankton are good indicators of changes in water quality as they are strongly affected by environmental conditions and responds quickly to changes in environmental quality (Sheeba and Ramanujan, 2005).

Zooplankton contain both herbivores and carnivores. The carnivores belong to the tertiary producers, or even to some higher level of production. The distribution and diversity of zooplanktons in an aquatic ecosystem depends mainly on the physico chemical characteristics of water (Shibu et al., 2006, Sukhija, 2007).

Planktonic organisms have short life cycle with a higher metabolic activity which facilitates them to respond to any pollution stress quickly and significantly compared to benthic or nektonic organisms. The feeding relationship between the phytoplankton, zooplankton and fish play the vital role for the maintenance and stability of the aquatic ecosystem.


2.4 BENTHOS

Benthos refers to organisms living at the bottom of aquatic ecosystems. Benthos occupies an important position in the aquatic ecosystem as it serves as a link between primary producers, decomposers and higher trophic levels. They have significant role in the decomposer food chain which, in turn, affects the cycling of minerals. Gupta et al. (2001) claimed that the macro zoobenthos, which constitute an important component of the biotic community in aquatic ecosystems, play a key role in decomposition process and detritus food chain.
The knowledge about the composition, abundance and distribution of benthos help to evaluate their significance in aquatic environment (Singh and Singh, 2001). The distribution, density and biomass of benthic organisms depend upon factors like, the physico chemical characteristics of water, the nature of sediments and the biological complexes such as food, predation, and other factors (Pandit et al., 1991). Degraded water quality affects macro invertebrates (Hynes, 1962) including benthic organisms (Bazzanti and Bambacigno, 1987) by eliminating many of them and some still remain abundant due to either decreased competition or increased tolerance for adverse conditions (Myslinski and Ginsburg, 1977).

Among the benthic communities, some species can be used to indicate certain type of environmental conditions (Rice and Wohlenberg, 1993). Macrobenthos can serve as excellent diagnostic indicators of aquatic pollution (Gupta and Pant, 1983, Padmanabha and Belagali, 2007). As they spend most time of their life at the same place because of their least mobility, the effect of pollution and eutrophication is clearly evident on them (Gupta and Bhagat, 2005). According to Cairns and Dickson (1971), no two bottom organisms react similarly to pollution because of the complex interaction between genetic factors and environmental conditions. Pani and Misra (2005) also revealed that the benthic organisms react strongly and often predictably to human influences on aquatic body. Hellawell (1986) commented that macro zoobenthos are more informative to long term changes in pollution or eutrophication than the physico chemical characteristics of water in an aquatic ecosystem. Many reports have already been documented on benthic communities in fresh water wetlands -, Adholia et al. (1990), Gupta and Pant (1990), Malhotra et al. (1990), Reddy and Rao (1991), Bais et al. (1992), Bose and Lakra (1994), Ghose and Benerjee (1996), Biswas (1999), Kumar (2003), Sheeba and Ramanujan (2007), Biswas and Konar (2007) and Banerjee and Banerjee (2007).

2.5 PRIMARY PRODUCTIVITY

Green plants capture solar energy and convert a portion of this light energy to chemical energy through photosynthesis. This process of conversion of light energy to
Chemical energy is called primary production. Primary production is thus, the amount of organic carbon produced by the green plants, and the rate at which the production takes place is known as primary productivity. In primary productivity, there are two types of productions-, the total amount of organic matter produced during photosynthesis is called gross production and the amount of organic matter that remains after removal of some of its energy by the respiration process is called net production.

Primary productivity is the basis of metabolic cycle in natural aquatic ecosystems (Kumar and Azis, 1999). During primary production, the radiant energy stored in producer organisms is used as food material at different trophic levels (Alom and Zaman, 2005).

The plankton constitutes the basic food source of any aquatic ecosystem (Sahib, 2005), i.e., most of the organic matter of an aquatic system is produced within the water by phytoplanktons, which are utilized by the consumer (Singh and Singh, 1999). Planktons are generally considered as an index of fertility of the water column (Fraser, 1962).

In any aquatic body, primary productivity gives an information relating to the amount of energy available to support bioactivity of the system (Vollenweider, 1969). In fact, the capacity of an ecosystem to build up at the expense of external energy, both radiant and chemical, could be well evaluated by estimating primary productivity. Estimation of primary productivity of aquatic systems which are adversely affected by anthropogenic activities serves as an important tool in studying the effect of those activities on the system (Saha et al., 2001).

According to Wetzel (1983), primary production of fresh water bodies is a potential index of productivity for many tropical and sub-tropical ecosystems of the world. Productivity of wetlands depends upon the presence of plankton biomass. Enrichment of nutrients and dissolved matter in the water bodies affect the diversity of plankton and also physico chemical properties of water. Diversity in the distribution, abundance and variations in the biotic factors provide information of
energy turn over in aquatic ecosystems (Umavathi et al., 2007). Sahu et al. (1995) and Kumar (1997) noted primary productivity as an important biological phenomenon in the aquatic environment in which phytoplanktons act as primary producers, their physiological activities greatly controlled by physico chemical characteristics of water body. Thus phytoplankton plays an important role in maintaining ecological balance and quality of water (Pandey et al., 1994).


2.6 CONSERVATION MEASURES

Wetlands are highly diverse ecosystems amongst the most productive in the world so that they and their products have been a lure to mankind. They are truly internationally important habitats and impacts on them can occur through events at considerable distance from wetland areas often beyond national boundaries (Kulkarni et al., 2002). Cowardin et al. (1979) described wetlands as the transitional zones between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water.

According to Ramsar Convention 1971, wetlands are the “resource of great economic, cultural, scientific and recreational value” and need for their conservation with “coordinated international action”.

Wetlands provide an array of beneficial functions and values (Sinha and Mohanty, 2002). Some of the functions most widely ascribed to wetlands are ground water recharge and discharge, flood storage, desynchronisation, shoreline stabilization through dissipation of erosive forces, sediment trapping, nutrient retention and removal, flood control, recreation (Barbier et al., 1997), and habitat for fish as well as
wild life (Kumar and Singh, 1996). People use wetland soil for agriculture, catch fish for food, cut wetland trees for timber and fuelwood and wetland reeds to make mats and thatch roofs (Ramachandra and Sreekantha, 2006).

As per estimates of Rodin et al. (1975) the contribution of wetlands to the global primary productivity is 24%, though wetlands occupy only 6.4% of earth surface (William, 1990). Moreover they provide tremendous economic benefits to the mankind through production of various types of fishes. In general two thirds of world's inland fish harvest comes from the wetlands (Jhingran, 1991).

Potential benefits associated with wetlands can be categorized based on their functions, uses and attributes (Howe et al., 1991). Various functions and values of wetlands could be categorized as socio-economic values, environmental quality values and fish and wildlife values. In the recent past, non consumptive benefits of wetlands such as recreation, archaeology, education and science were usually given lower priority in management plans than directly consumptive values as they are highly authentic and their values are difficult to quantify.

The very existence of natural wetlands has been threatened by human activities in recent years. People have failed to recognize the tremendous values of wetland ecosystems and are exploiting them at a very fast rate. According to Dugan (1994), about 50 percent of the wetlands throughout the world have been lost due to conversion of the wetlands in to agricultural lands. Construction of dams and bands affects the water flow and modifies the characteristics of wetlands (Narayanan, 1992). Bhat (2001) pointed out that encroachment is a major threat to the sustainability of the wetlands. The destruction of the wetlands results in the decrease of biodiversity, increase in salination, decrease of fertile top soil, damage to nutrient cycling and upset the hydrological cycle of the globe (Devi, 1998).

Wetland management deals with almost all the aspects of wetland and inspirations from wetland. Planned work needed to sustain and restore wetlands, their perspective resources and biodiversity for future generations through research information exchange and conservation activities. Kant and Vohra (1989) rightly
suggested that the management of any aquatic ecosystem is the conservation of habitat with an aim to maintain its physico chemical quality of water.


The study of literature revealed some scattered information on the structural, functional and management aspects of wetland ecosystem. There is no integrated work covering ecological aspects of wetlands to draw an effective action plan for sustainable development of wetlands particularly in national parks and wild life sanctuaries. Therefore, the present work has been undertaken to study some of the ecological aspects for better understanding of the ecological status of the selected wetlands of Kaziranga National Park. The findings will certainly help in determining measures for development of the wetlands to obtain perpetual ecosystem services by the dependent wild life population of the park.