CHAPTER I

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Wetlands have been commonly viewed as transitional habitat between deepwater aquatic systems and terrestrial systems. They can be considered to occur along a natural soil-moisture gradient between permanently flooded deepwater areas and dry land. "Ramsar Convention (1990) on Wetlands of International Importance defined Wetland as "the areas of marsh, fen, peatland or water, natural or artificial, permanent or temporary with water that is static or flowing fresh, brackish or salt including marine areas where the depth of water at low tide doesn’t exceed to 6 meters". Ramsar Convention Bureau in 1997 recognized the wetlands as an ecosystem which are very much important for bio-diversity conservation. Wetlands with their plant and animal life provide subsistence for millions of inhabitants in the vicinity.

Wetlands play specific ecological role in our environment. The characteristic of wetland hydrology is regulated by the water regime. The biological process of this ecosystem also is a function of several factors namely flooding behaviors, nature of organic and inorganic deposition and resuspension, nutrient cycling, gas exchange, degree of microbial activity etc. As the structure of a wetland community is held in delicate balance by its hydrological environment, any activity
affecting the hydrology of the system disturbs the entire ecosystem. However, a wetland can perform a number of vital functions like flood control, protection and stabilization of storm by way of acting as natural barriers, water storage, erosion control, ground water recharge and discharge, thereby provide water for human consumption, water purification due to the presence of certain plant species in the ecosystem, retention of sediments and nutrients and stabilization of local climatic conditions (Gopal et al 1982, Dugan 1994, Ramsar Convention Bureau, 1997) Besides, wetlands can be used for the conservation of biodiversity. The flora and fauna of the wetlands are highly specialized to adjust with different water levels in different seasons and varied depth of the water mass from the periphery to the centre. The wetlands act as an economic resource base like use of stored water for irrigation, for human consumption. Since wetlands are shallow water areas, they provide ideal habitat for water birds. According to Narayanan (1992), Coto Donana of Spain is the homing ground of the half of the total number of bird species in Europe which include different endangered bird species. The wetlands are not only important for Ornithologists alone, but also for the limnologist, the zoologists, the botanist, the ecologist and the hydrologist to name a few.

The wetlands are unique in maintaining high productivity in nutrient deficient environments. They are most productive communities
of the biosphere. The fresh water macrophytes play an important role in
determining the productive nature of the water body. The macrophytes
are large, predominantly angiospermic plants inhabiting various sections
of aquatic ecosystems and are of considerable important from the
productivity point of view in shallow water bodies or in the littoral
zones of the deepwater bodies. They also play an important role in
cycling the nutrients in the given water body. According to Trivedy et al
(1987), the studies of aquatic macrophytes are important to limnologists
in order to understand the functions of the aquatic ecosystem; to
fisheries personal as inventory of fish and to pollution control personal
for their nutrient removal capacity. Cowardian et al (1979), defined
macrophytes as any plant growing in water or on a substance that is at
least periodically deficient in oxygen as a result of excessive water
content. Most of the plants in wetlands are self supporting vascular
plants that emerge from shallow water or grow in periodically flooded or
saturated soils. Seeds, rhizomes, stolons, tubers, buds, bulbs, bulblets
etc are the primary survival mechanism of the aquatic macrophytes.
Generally the distribution of the aquatic macrophytes are influenced by
climatic, edaphic and hydric condition of the habitat. Likewise,
association of macrophytes is also determined by a number of ecological
factors.
From the point of productivity the wetlands can be compared to that of the tropical rain forests of the world. Gopal (1976), mentioned that the names of a few aquatic weeds like *Salvinia, Wolfia* and *Hydrilla* for the scavengation of some organic as well as inorganic compounds including heavy metals from waste water. *Azolla* in the water body can fix atmospheric nitrogen through the blue green alga, *Anabaena azollae* and is one of the potential nitrogen biofertilizer. Its high nitrogen fixing capacity, rapid multiplication and decomposition rates result in quick nutrient release in an aquatic system. Likewise *Euryale ferox, Trapa bispinosa, Nelumbo nucifera, Nymphaea stettata, Eichhornia crassipes* are the hydrophytes with greater economic values (Thakur, 1997). Most of the hydrophytes are edible and resources of ethnological and medicinal industry, materials for common domestic utility, fodder for animals and rich bioresource for protein rich food for masses (Dutta and Baruah, 1994).

Recent years the wetlands have received a good deal of attention world over. Majority of the wetlands through out the globe are under increasing threat due to various factors connected with agricultural, industrial and other developmental activities. According to Wetlands Inventory and Evaluation in South Ontario (1982), about 160 coastal wetlands were found degraded and declining (Smith *et al*, 1991). Dugan (1994) mentioned that 50 percent of the wetlands of the world have
been lost due to the conversion of these into agricultural lands. According to Chatrath (1992), some of the main threats faced by wetlands are siltation, eutrophication, shrinkage of areas, reclamation of area, encroachments, pollution, changes of water quality excessive tourism load, over exploitation of the Fisheries Resource, reduced arrival of migratory birds etc. Marothia (2004) studied the environmental economics prospects of different wetlands of the globe in relation to pollution status.

Siltation is the common problem faced by most wetlands. Extensive deforestation in the catchments area for industrial and commercial purposes and by the local people for fuel, fodder and small timber over the years, removal of vegetation cover in the surrounding areas have, resulted in the rampant soil erosion. Jhum Cultivation on the hill slopes is another important factors for siltation. De-Roy (1992), mentioned that as much as 40.9 tons of soil can be eroded per year from one hectare of Jhum fields. Traditionally, local communities keep large herds of cattle near the wetlands for grazing, resulting in creation of barren areas, which add to increased siltation in the water body. The major source of siltation in Dal lake is the Telbal Nala and it has been estimated that the total amount of deposited silt in 1996 was 36200 m$^3$ (Trisal, 1992). Chatrath (1992), mentioned that 13 million tons of silt is brought annually into the Chilka lake primarily by the rivers and rivulets
that fall into it. Adhikari et al (2003) and Frace and Yudento (2004), proposed some modeling designs for the control of soil erosion in the Wetlands.

Eutrophication is the aging process which is one of the major problems facing by any aquatic system. Eutrophic refers to the water bodies which are highly productive in terms of organic matter formed and well supplied with nutrients. It is a process whereby a water body becomes rich in nutrients and therefore supports a dense plant population which suffocates and causing death to animal life. The source of the nutrients are the domestic sewage or waste and agricultural fields in which chemical fertilizers were used. Sharma (2002), mentioned that in the U.S.A., Lake Erie is the excellent example of eutrophication due to man-made problems.

Shrinkage of water area is another danger of the wetlands existence. It is mainly due to the deposition of silt in bed, resulting in reduced inflow of water into the lake. In recent years many wetlands are being encroached and reclaimed for other purposes like growing rice and vegetables. According to Dugan (1994), about 50 percent of the wetlands throughout the globe has been lost due to the conversion of the wetlands into agricultural lands. He further states that 54 percent of the wetlands in the USA, 40 percent in Britain, 80 percent in West France, 70 percent in Partugal and 90 percent of Wetlands in New-Zealand have
been lost due to the use of wetlands for agricultural and industrial developments. Narayanan (1992), stated that construction of dams and bands affects the water flow and modifies the character of the wetlands.

A large number of wetlands are currently facing the problem of water pollution. Some general causes for the pollution are anthropogenic activities like agricultural, industrial and human settlement nearby wetland areas. Agricultural causes initiate the problem of eutrophication and shrinkage of area. The inflow of chemical fertilizers and pesticides into the wetlands can result eutrophication and degradation. Among the industrial activities, disposal of pollutants into the water body is the main cause of pollution. In recent times, Human settlement and disposal of the solid wastes, as well as the discharge of domestic sewage into the water body have resulted in the degradation of wetlands. Pollution generally changes the water quality of the wetlands. The Status Report of Ministry of Environment and Forests, Government of India states that wetlands have been destroyed by drainage and land filling and over exploitation of resources, pollution and other damaging human activities. As per report finished by the WWF, Northern India has lost half of its wetland in the last century. 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). In general water pollution is an
inevitable fall out of development in industry, urban centers and most importantly increase in world's population (Trivedy et al., 1987). The wetlands have only a limited capacity to assimilate the wastewaters of various kinds, the ecosystems have thus simply collapsed in the face of unprecedented amount of waste discharged in them. The entry of the some of the synthesized chemicals has further deteriorated their health and finally the whole ecosystem. The pollutant is either a chemical viz. a nutrient, radio-active substance, an organic compound or geological i.e. soil particles, a physical factor like heat or of biological origin like micro and macro- organism which is put into the wetland with actual or potential, adverse or harmful, unpleasant and inconvenient effects. Trivedy et al. (1987). again mentioned some of the important effects of water pollutants like loss of aesthetic and recreational value of water, spread of diseases, deterioration of taste, undesirable effects on aquatic plants and animals. loss of aquatic production, deterioration in agricultural soil (irrigation by polluted water) accumulation of toxic substances in aquatic ecosystems and ultimately in man, adverse effect on availability of safe, clean water, long term psychological and social impacts etc.

However, the nutrients can reach the water body through a number of sources like- domestic sewage, urban run-off, agricultural run-off, run-off from cattle areas, soil erosion, artificial fertilization of
water bodies for fisheries, rainfall etc. As mentioned by Seshavatharam (1992), the Kolleru lake in Andhra Pradesh receives considerable amounts of effluents from different industries like the Milk Products Factory, Vijayawada (7,00000 lt./day); SHVP Chemicals, Koderupadu (2,00000 lt./day), Krishna Paper Mills; Veeravalli (35,000 lt/day); the Pedapadu drain from Kolleru Paper Mills Ltd., Bommuluru (7,00000 lt/day) the Thammileru drain from Mohiddin Tambi Tanneries, Eluru (1,000 lt./day) and Balusuvagu drain from the Cooperative Sugar Factory, Bhimadolu (4.00000 lt/day). Chatrath in 1992, predicted the coming danger of the Chilka lake in Orissa from the newly growing small industrial units near the periphery of the lake especially those to the Calcutta- Madras (Now Kolkata- Chenni) rail link and National Highways. Trisal (1992), mentioned that about 100 million litters of sewage flow into the Dal- Lake in Kashmir through a number of Channels. The sources of pollutants in the Loktak lake, Manipur are the sewage, chemicals, domestic effluents from other outlaying settlements particularly the big township of Moirang (De-Roy, 1992). She also stated that due to the use of pesticides such as Dimecron, Malathion and Sumithion during 1975 and 1977, a huge destruction of aquatic annelids, insects, fishes, amphibians, reptiles, waterfowls and mammals, fish fry, fingerlings and adult fishes were taking place for a long period in the Loktak lake, Manipur. Kumar (1998) studied the impact of coal mining
effluents on the limnology of wetlands in South Bihar and opined that coal mining wastes doesn't only constitute an immediate and a very serious danger but also causes long term disaster to the ecosystems.

Another threat to the wetlands is the pollution from the crude oil and slugs which is generally released into them during exploration including drilling, production and transportation. Crude oil contains different types of organic chemical compounds like iso-propenoids, alicyclic and aromatic components and other petroleum products which are in many forms, acids, alkalies, phenols, tarry or resinous nutrients. Once, entered into the water body, these substances can easily retain there for a long period and can be detected even years after an oil spill. Chhapgar (1993), estimated 70 mg of hydrocarbons per kg (of mud) at the bottom mud of the Arabian sea even one and half years after 600 tons of oil spilt into the sea. Crude oil being lighter than water, floats on the surface of water and thus prevents gaseous exchange. Fishes get adversely affected by loosing their prey, algae, zooplanktons and molluscs. The ecosystem is also affected by loosing its bio-diversity. According to Varkey (1999), effects of crude oil and its remnants in the sea as well as aquatic body are of many types.

Several workers studied on problems related to wetland managements are Finlayson et al (1991), Lowe (2000), Jie and Nianfeng(2003), Jasortia and Singh (2005) etc. Chow- Faser et al in
1998 studied the phytosociological works on a degraded coastal wetland of Lake Ontario.


Inspite of such elaborate nature of works done by several authors in different parts of the globe, very little information is available till date on the ecology of aquatic macrophytes in North East India in particular.
reference to oil field pollution. A few of the relevant works available in this region are Devi (1993), Singh (1996), Devi and Sharma (1998).


Rudrasagar area in Sivasagar District is one of the four major oil fields of the Oil and Natural Gas Corporation Limited (ONGCL) which is a flat and flood prone. As a result of exploration and production activities by the ONGCL in Rudrasagar area have caused the loudest outrties on the ground that they have caused the greatest damage to the environment. Rudrasagar area comprises a number of wetland ecosystems and most of the drilling sites are located in the paddy fields, law laying areas, forest areas and in some cases these are on the bank or near the water courses and therefore wetland areas are extensively polluted by the crude oil, and oil slugs and waste materials. Agricultural fields and wetlands near the drilling and gas gathering stations are thus directly affected. As per report of the Pollution Control Board, Assam (1993) - "......... the constant upward movement of the gas flare and also poor construction of flare pit, seepage through the crude oil lakes have resulted in the problem of pollution in the nearby areas. Constant heat
and light from the flare pits are also causing pollution in the adjacent agricultural fields especially in the production of rice." It was also reported in News Letter, (1996) that ".............. crude oil pollution is an extreme example of our quest for energy that has threatened the environment and the economy of the poor villagers.............."

Undoubtedly, the area is a polluted one and these directly affects not only the aquatic environment but also on the socio-economic of the people of the nearby villages.

Considering these as a whole, an attempt has been made in the present investigation to assess the ecological status of wetlands of Rudrasagar area in Sivasagar District, Assam, as affected by oil exploration activities.

**OBJECTIVES:**

The present investigation is to assess the Phytosociology, Biomass dynamics and Productivity of different macrophytes of the wetlands of Rudrasagar and socio-economic consideration of the inhabitants in the vicinity of the experimental sites as affected by oil exploration and operations. The investigation is proposed to be undertaken in the following lines.

1. Survey, sampling and analysis of the seasonal periodicity of the macrophytes.
2. Phytosociological studies like Frequency, Density, Abundance and Comparative Importance Value Index (IVI) of the component plant species.

3. Life form analysis of the macrophytes as well as phytoclimatic nature of the area under study.

4. Productivity of the macrophytes and estimation of biomass value of the macrophytes.

5. Physico-chemical attributes of the water samples like water temperature, turbidity index, total solutes, $p^H$, conductivity, free CO$_2$, Dissolved Oxygen (DO), total alkalinity, total hardness, chloride of water and pH, organic carbon, total nitrate, C/N ratio of sediments.

6. Socio-economic problems of the fringe area people in relation to changed water quality status of the wetlands as a result of pollution from oil field operation.

7. Statistical analysis of different results obtained.

The contents of the Thesis have been presented under the following chapters.

CHAPTER - I:- Introduction

CHAPTER - II :- Description of the Study Sites.

CHAPTER - III:- Materials and Methods
CHAPTER - IV:- Phytosociology of the macrophytes.

CHAPTER - V:- Biomass dynamics and productivity of macrophytes.

CHAPTER - VI:- Physico chemical characteristics of water samples of wetlands.

CHAPTER - VII:- Socio- economic aspects of wetlands concerning fringe area people of the wetland as affected by oil exploration activities.

CHAPTER - VIII:- General discussion.

CHAPTER – IX :- Summary.

BIBLIOGRAPHY.