2.1 Introduction

Wetlands are areas where water is the primary factor controlling the environment and the associated plants and animals’ lives. They are found at places where the water table is at or near the surface or where the land is covered by water. In Uganda wetlands are called ‘swamps’ which consist of seasonally flooded grassland, swamp forests, permanently flooded papyrus and grass swamp and upland bog (Balirwa, 1995). In Nepal, wetlands have been defined as ‘landmass saturated with water due to high water table through ground water, atmospheric precipitation or inundation which may be natural or artificial, permanent or temporary, static or flowing, freshwater or brackish’ (Shrestha and Bhandari, 1992). As per the classification given by Cowardin et al. (1979) and Schot (1999), wetlands can be classified into five types as i) Marine - Open ocean, continental shelf, including beaches, rocky shores, lagoons, and shallow coral reefs like the high-energy, rocky, marine shoreline; ii) Estuarine – Deep water tidal habitats with a range of fresh-brackish-marine water chemistry and daily tidal cycles like mangroves; iii) Riverine - Freshwater, perennial streams comprised of the deep water habitat contained within a channel; iv) Lacustrine - Inland water bodies that are situated in topographic depressions, lack emergent trees and shrubs, have less than 30% vegetation cover like the reed beds grow in fresh, shallow water on the margin of lake; and v) Palustrine - All non-tidal wetlands that are substantially covered with emergent vegetation -trees, shrubs, moss, etc. like the cat tails on the margin of a marsh.

Wetlands were treated as transitional habitats in succession from open water to land ecosystem, but now they are considered as a distinct ecosystem with definite ecological characteristics, functions and values (MoEF, 2009). They are very dynamic, changing according to season and stage of succession. They sustain high levels of productivity and biological diversity; therefore become an important ecosystem from a conservation standpoint (Mitsch and Gosselink, 2000).
2.2 History of Keibul Lamjao National Park (KLN)

Keibul Lamjao National Park (KLN) is the last and only natural home of endangered brow-antlered deer (Rucervus eldii eldii McClelland, 1842), locally known as Sangai which is a species of Eld’s deer that was once distributed across much of South East Asia. Now only isolated populations are present in western part of Irrawady basin in Manipur and in Hainan Island of Southern Asia (McShea et al., 2001). Further it is the only floating wildlife reserve in the world. It is an area of low laying swamps, located in the southeastern part of Loktak Lake, the largest natural freshwater lake in northeastern India, covering 61% of the total extent of wetlands in Manipur (Trisal and Manihar, 2004). The lake is located 38 km south of Imphal city, the capital of Manipur in north eastern India. It lies between 24˚25΄N and 24˚42΄N latitude and 93˚46΄E and 93˚55΄E longitude. The lake can be broadly divided into northern, central and southern zones. The zones are different from each other in terms of biodiversity and anthropogenic pressures. The lake is one of the Ramsar sites, identified under the Convention on Wetland of International Importance on 23 March 1990.

By 1950, the Sangai that was once found in Manipur valley was regarded extinct by the Government of Manipur until in 1953, the deer was rediscovered inhabiting in the floating meadows and adjoining hills of Keibul Lamjao by E.P. Gee, the then Honorary Secretary, Eastern Region, Indian Board for Wildlife. The Sangai and its habitat were declared a protected animal and protected sanctuary respectively in 1954. The area was reduced to 27 km² in 1959 and then increased to 40 km² in 1965. The area was officially declared protected in 1965, a reserved forest in 1974 and finally a national park in 1977 under the Wildlife (Protection) Act, 1972 (Singh, 1992b) in due appreciation of its unique fauna and flora and to preserve its flagship species, i.e. the brow-antlered deer, Sangai.

2.3 Physiography

2.3.1 Location and Geo-topography

The KLN is a low laying swamp lying between latitude 24˚26΄N to 24˚32΄N and longitude 93˚48΄E to 93˚52΄ E. It is situated in the southeastern part of Loktak Lake in Bishnupur district near the historical town of Moirang. The park has an area covering
40 km² (Figure 2.1) out of which 26 km² is covered with *phumdis* or floating meadows and the remaining 14 km² is open water.

Figure 2.1: Map showing location of KLN, Manipur.

The park comprises of grasslands in the floating meadows, submerged grassland, elevated ridges forming islets and woodlands on the hillocks. Altitude varies from 768 m at the ridges to 792.5 m at the top of the hills. On the basis of the biogeography of India it comes under North East zone and Province 9B (Singh, 1992b). Geologically,
the hills are quite young as they were formed during the Tertiary Orogeny (2.5 - 65 million years ago) of the Himalayas from the shallow bed of Tethys Sea (Singh and Singh, 1994).

2.3.2 Biodiversity

The forests of surrounding hills of KLN Park may be categorized as 3C/C to ‘East Himalayan Moist Mixed Deciduous Forests’ (Champion and Seth, 1968). The forest type is characterized by deciduous dominants and evergreen sub-dominants. The important species are Quercus griffithi, Quercus serrata, Castanopsis sp., Schima wallichii, Mallotus philippensis, Bauhinia purpurea, Amoora rohitika, Rhus sp. But most part of the hills in and around KLN Park have pine (Pinus kesiya) plantation taken up by the Forest Department. In the grasslands of the park more than 100 species of grasses and sedges have been recorded with Zizania latifolia, Phragmites karka, Saccharum munja, Narenga porphyrocoma, Leersia hexandra, Carex spp., Oryza perennis and Capillipedium spp. constituting the major food items of the Sangai (Singh, 1985).

The park is rich in fauna and accounts for 81 species of birds, 25 species of reptiles and 22 species of mammals (Singh, 1992a). Some important mammalian species that inhabit the Park along with the Sangai are the hog deer (Axis porcinus), wild pig (Sus scrofa), large Indian civet (Viverra zibetha), small Indian civet (Viverricula indica), jungle cat (Felis chaus) and otter (Lutra lutra). The park is also a unique wintering ground for various migratory waterfowl, the spot-bill duck (Anas poecilorhyncha), gadwall (Anas strepera), shoveller (Anas clypeata) and common teal (Anas crecca), and the permanent home for many resident birds (Singh, 1997).

The park is also the breeding ground of a number of fishes such as the common carp (Cyprinus carpio), grass carp (Ctenopharyngodon idella), swamp eel (Monopterus albus), channa (Channa punctatus), feather back (Notopterus notopterus), mola (Amblypharyngodon mola) and many others and continues to be an important fish resource. It also supports a significant population of reptiles such as the russell viper (Vipera russellii), common krait (Bungarus caeruleus), king cobra (Ophiophagus hannah) and Burmese python (Python molurus) (Singh, 1992b).
Figure 2.2: Map of the KLN P with the surrounding villages.

2.4 Boundaries
The boundary of KLN P is defined by villages, streams, rivers and hillocks as described in the notification of the constitution of the park and depicted in maps. The
park is surrounded by 40 villages on all directions comprising of different communities. The villages of Arong, Khordak, Komlokhong, Laphupat Tera and Phaobakchao are situated in the east, whereas Sagram, Keibul and Chingmei villages are situated in the west; Thanga villages are towards the north while Keirenphabi, Thanga Lawai, Kumbi, Wapokpi and Nongmaikhong are located to south of the park. The park is separated from Loktak Lake by the Thanga hills in the north, its eastern boundary is the Manipur River and the western and southern boundary are the paddy fields of the adjoining villages (Sinh, 1975).

The park has distinct ecological boundaries, which have been obliterated by the construction of a dam at Ithai, under the Loktak Hydro-Electric Project. Under the project the water level is maintained at 768 m which caused submergence of areas on both sides of Thangbirel-Yangbi which were the higher places in the park and the permanent floating meadows. The ecological boundaries have been changed drastically. There are broadly three ecological areas - firstly the areas under floating meadow which are the central, western and southern parts of the park which form the main habitat of Sangai and other bigger animals; second is the area consisting of three hillocks viz. Chingjao which is the northernmost, Pabotching a little south to Chingjao and Toyaching further more south and finally deep water in the northern sides without floating meadows which may be treated as an aquatic ecosystem. There is no existing specific zonation for setting internal boundaries.

2.5 Climate

The park has moderately cold sub-tropical monsoon climate characterized by low temperatures and heavy dew at night from November to February and rapid rise in temperature during April and May. Frost and fog are common phenomena during the winter mornings and nights during December and January. The temperature ranges from a maximum of 34.4°C to a minimum of 1.7°C (Singh, 1992b). The average annual rainfall in and around the park is approximately 150 cm varying between 100 cm and 350 cm. The rainfall occurs mostly during west monsoon period during May to September. However, the park gets some rainfall during retreating monsoon in winter. On average 49% and 81% are the lowest and highest relative humidity recorded in the month of March and August respectively (Sinh, 1975; Singh, 1992b). However, the increasing trend is checked with occasional thunderstorms and light
showers. Maximum temperature recorded was 35°C and minimum 1.66°C (Sinh, 1975). Wind blows in the south-west direction.

2.6 *Phumdis* (Floating Meadows)

*Phumdi* or floating meadow is the most important and unique part of the habitat. It is the floating mass of entangled vegetation, formed by the accumulation of organic debris and biomass with soil particles, which has been concentrated in solid form. It covers approximately 2/3 to 3/4 area of the park. Its thickness varies from few centimeters to about two meters. The humus of floating meadow is black in colour and very spongy with large number of pores. It floats with 1/5 and 4/5 part above and below water respectively.

Both non-biotic and biotic factors play critically important roles in the formation of floating meadows. Soils with plants of adjacent hills are brought down by rain water. The plant material in the lake sprouts and young shoots gradually spread to form thick mass of floating meadow with the accumulation of soil and vegetative debris and humus. Because of high proportion of vegetative materials, floating meadow floats. Sometimes its formation is initiated by aggregation of plants with *Azolla* sp. forming its nucleus. It gradually accumulates more and more aquatic plants, colonizing grasses, soil particles etc. in course of time it becomes thicker and gets converted into thick mass, which can support human beings and wild animals (Singh, 1992b). Area covered by floating meadow is the most important area of the park as it provides food, shelter, breeding place, playing field etc. to animals in general and Sangai in particular.

According to Devi (1993), structurally the floating meadow is composed of three distinct vertical zones. The uppermost root zone is generally 0-15 cm in thickness. The mat zone located just below the root zone varies in thickness in different localities from 15-65 cm. The mat zone is a layer of densely interwoven live, dead and decaying roots with some litter accumulation on the surface. The plant parts in this region still retain their identity. Below the root and mat zone is the peat zone. The thickness of this zone varies from 10-25 cm below this peat layer is a zone of free water; generally clear in nature and appearance that varies in depth with the lake water level. Next to the free water zone is a layer of organic sludge whose thickness
also varies with the water depth. The total distance between the marsh surface and the underlying hard clay surface of the lake bottom varies with the fluctuation of water levels. This floating meadow has been the natural habitat of the endemic and endangered deer, Sangai and thickness of approximately 75 cm can support a Sangai.

Earlier, the utilization of the plant resources found in the park had no significant impact on the ecology of floating meadows. But the present utilization trend coupled with the changed water regime presents a dismal scenario. The water from Imphal River and Khuga River entering in the park due to back flow washes the roots of floating meadows and in the process the soil particles, which provides nutrition and binding strength to floating meadows are washed away. Therefore, the floating meadows gets thinned and weakened over a period of time (Tuboi, 2013).

2.7 Impact of local communities on the park

Despite its protected status, KLNP is under enormous anthropogenic pressure. Of the 145 plant species found in the park, 54 are important to the local people (Singh, 2002a). People residing around the park have been exploiting the aquatic plants and fishes for their livelihood. There are no strict regulations from the park authorities owing to lack of permanent staffs and personnel and there is no clear cut demarcation of park boundary or fencing. Moreover, after the commissioning of the Loktak Hydro-Power Project in 1983, large agricultural areas at the lake periphery have been submerged which have changed the economic life of the people. This coupled with the increasing population has caused serious stress to the habitat of Sangai and other wild animals in the park. Some of the main activities adopted by the local people in the park are fishing, vegetable collection, collection of fuel wood from the park and the surrounding hills, collection of plants for thatch, fencing, making mats, medicinal plants and for cultural activities.

The other factors which constrain to the conservation of Sangai are the impacts of Loktak Hydro Electric project, which alone is the main cause for the reduction of floating meadows thickness and extent (Rocky, 2002) decline of vegetation, silting up of Loktak Lake, grazing, uncontrolled burning of grass to improve the grazing ground, encroachment and accelerated use of land along catchments and watershed areas (Singh, 1991) and finally in-breeding due to its fatally low population.
Plate 2.1: Different views of KLN, Manipur.