CHAPTER I

INTRODUCTION

1. Introduction

The natural wetlands of Nepal include rivers, lakes and ponds, riverine floodplains, swamps, marshes, the man made water storage areas and deep water agricultural lands. There are approximately 6000 rivers and rivulets including permanent and seasonal rivers, streams and creeks (WECS, 2002).

The Ramsar Bureau has designated and listed the Beeshazar Tal (Lake) of Chitwan district, Ghodaghodi Tal of Kailali district and the Jagadishpur reservoir of Kapilvastu district of Nepal as Ramsar Sites in August 13, 2003. Moreover six new wetland sites, namely Rara Lake, Phoksundo Lake, Gokyo and associated Lakes, Gosainkunda and associated Lakes, Koshi Tappu wetlands and Maipokhari of Ilam have also been added in the Ramsar list (Kafle and Savillo, 2009).

The physico-chemical parameters of water bodies influence the aquatic organisms in various ways directly or indirectly. Mainly air and water temperature, transparency, pH, dissolved oxygen,free carbon dioxide, alkalinity, hardness, chloride and BOD determine the hydrological condition of water body and any alteration of it influences the outbreak of diseases and production level of fishes. In fish farming, fish disease is one of the major constraints for the adequate production. Fish disease is a global problem affecting fresh water and marine fish, wild, cultured, sport fish and even ornamental fish with large scale mortalities (Trust, 1986).

Fishes are the major food source for the protein and are available throughout the world. In Nepal also, traditionally majority of people consume fish as food. Nepal has to depend on the fresh water resources for the production of fish. Total production of fish was 56,000 mt /year in the year 2012-2013 (Shrestha and Mishra, 2014). The present production level is still much below the potentiality of existing water resources. Nepal government has given priority to aquaculture development for high production to fulfill the protein demand of the country. The use of artificial feed, fertilizer in the semi-intensive and intensive culture to increase production may adversely alter the physico-chemical properties of water and other environmental conditions that create the diseases outbreak.

However, few works have been done in Nepal regarding the physico-chemical properties of water bodies. Loffler (1969) reported the dominance of calcium among cations, low chloride and less than 1µg/L phosphorus from the high altitude lakes of Mount Everest region. Lohman *et al.* (1988) studied pre and post monsoon limnological characteristics of lakes of Pokhara and Kathmandu valleys. They obtained low alkalinity and conductivity in the lakes of Pokhara valley. McEachern (1994) reported 8.4 pH, 0.03 mg/L phosphate and 8.5 mg/L dissolved oxygen in Narayani, a lowland (< 1000 m) river of Nepal. Aryal and Lacoul (1996) studied water quality and diversity of diatoms in Punyamati river. They reported high pH, total hardness and BOD at polluted site where transparency and dissolved oxygen were low. Ormerod *et al.* (1996) reported the pH range between 7.3-8, chloride (0.4-1.4) mg/L, nitrate (0.06-0.28) mg/L and phosphate (0.02-0.04) mg/L from the highland (> 2000 m) rivers of Nepal. Sharma (1996) reported quite suitable physico-chemical characteristics of the Koshi river with a high degree of ecological efficiency and enormous potential for biotic development. Shrestha *et al.* (2009) reported that the water quality parameters of Tamor River e.g. air temperature, water temperature, DO, pH, alkalinity, total hardness; CO_2 and conductivity were within the suitable range for cold water fishes.

Niroula *et al.* (2010) revealed pH, conductivity, turbidity, total phosphorus and total alkalinity were higher in summer whereas total dissolved solids, nitrate, total hardness ($CaCO_3$), dissolved oxygen, BOD and chloride content were higher in winter and water temperature, ammonia and carbon dioxide were higher in rainy season. More seasonal fluctuations in turbidity, carbon dioxide and chloride content were observed in Betana pond, Eastern Nepal.

Thapa Chhetry and Pal (2011) studied the physico-chemical parameters of Koshi river at Kushaha area, Nepal and revealed that the water temperature was maximum in summer but the transparency, pH, dissolved oxygen, total alkalinity and total hardness were maximum in winter season. Free carbon dioxide was maximum in rainy season; chloride and BOD were maximum in summer season. The air temperature and water temperature had positive and significant correlation with free carbon dioxide and BOD. Dissolved oxygen had positive and significant correlation with pH, total alkalinity and total hardness. Total alkalinity had positive and significant correlation with transparency, total hardness and chloride. Bhatt and Khanal (2011) reported that the increase in pH of water appeared to be associated with increasing use of alkaline detergents in residential areas.

Thapa and Pal (2012) found maximum and minimum variation and correlation between different physico-chemical parameters in Baidya Fish Farm and Itahari fish ponds. The water qualities of fish ponds were normal except chloride and ammonia during manuaring period. Outbreaks of epizootic ulcerative syndrome (EUS) were observed at the periphery of Baidya fish farm due to sudden fall in temperature during winter months.

Various diseases of fish have so far been reported worldwide. Bacterial diseases such as furunculosis (Ghittino, 1972; Morrison and Plumb, 1994), streptococciosis, bacterial gill disease (Lumsden *et al.*, 1994), viral haemorrhagic septicemia (Meyers *et al.*, 1992), fungal diseases (Noga *et al.,* 1991), metazoan and protozoan diseases (Paperna, 1980) are some of the fish diseases which have plagued both wild and cultured waters throughout the world. The commonly occurring fish diseases in Nepal, India and Bangaladesh are dropsy, ulcerative disease, haemorrhagic septicemia, microsporidiasis, dactylogyrosis, ligulosis, argulosis and saprolegniosis (Kumar *et al.*, 1991; Das and Das, 1995). Protozoan parasitic diseases trichodinasis and ichthyopthiriasis, trematodiasis (dactylogyrosis and gyrodactylosis), pediculosis (argulosis), lernaeasis, ligulosis, nematodiasis, fungal infection such as saprolegniasis, branchiomycosis (gill rot) and some fish pathogenic bacteria like *Streptococcus fecalis*, *Micrococcus* spp., *Pseudomonas* spp., *Aerococcus* spp. and *Flavibacterium* spp. were reported from Nepal (Rayamajhi and Bajracharya, 2005).

Among fish diseases, epizootic ulcerative syndrome (EUS) caused a loss of about 15-20 % of total fish production with estimated worth of Rs. 30 million during its initial outbreak in Eastern Terai of Nepal, in February 1989 and afterwards (Phillips, 1989; ADB/NACA, 1991). The most destructive fish disease is EUS (ADB/NACA, 1995). The intense rearing of fish through high stocking densities, use of artificial feed and fertilizer, application of chemotherapeutic agents have not only led to increase the large scale fish production throughout the world but also created conditions leading to the physiological stress and an increasing risk of disease outbreak (Pillay, 1996; McLean, 1996). Lilley *et al.* (2002) mentioned that among 37% of fish farms, 95% cases were of EUS affected and national loss due to EUS was about US$ 114,000 compare to total loss from diseases US$ 120,000 in Nepal (Phillips, 1989; ADB/NACA 1995). The socioeconomic status of the fish farmers and fish traders were badly affected by EUS (Rahman *et al.,* 1988) and created unemployment to the local people in Bangladesh. People are unwilling to start aquaculture activities due to the

perceived high risk of diseases mainly EUS outbreaks and lack of knowledge of how to deal with fish disease (Callinan *et al.*, 1999).

EUS is a disease affecting wild and farmed fish. It first appeared in summer months in farmed Ayu (*Plecoglossus altivelis*) in Japan in 1971 (Egusa and Masuda, 1971) and was named as mycotic granulomatosis (Miyazaki and Egusa, 1972). In 1972, a similar ulcerative disease in fish was reported from central Queensland, Australia with recurrence in subsequent years and the disease was known as red spot disease (RSD) (Rodgers and Burke, 1981). After the outbreak of mycotic granulomatous and red spot disease in fish, disease characterized by dermal ulcers with heavy mortalities was reported in freshwater and estuaries fish in Asia-Pacific regions. This infectious disease has spread across the entire south Asia extending from Papua New Guinea in the south east to Pakistan in the west. The disease is called epizootic ulcerative syndrome, EUS (FAO, 1986). Subsequently it spread to USA and Africa in 2006 and was confirmed as EUS in 2007 (Sosa *et al.*, 2007a; Mudenda, 2012). EUS is basically a disease of complex nature involving certain fungal and bacterial elements in its later stages, and probably one or more viruses (Chinabut, 1995).

Outbreaks of EUS occur in a cyclic manner when temperature falls especially after a heavy rainfall, low alkalinity and pH fluctuations in Asia Pacific regions (Roberts *et al.*, 1986). Macintosh and Phillips (1986) found that sediments at many outbreak sites of Asia Pacific regions were slightly acidic and had low calcium content. Ahmed and Rab (1995) noted an association between EUS outbreaks and ponds having reddish sandy soils and relatively high turbidities in these ponds in Bangladesh may have been stressful to fish. Roy and Pal (2003) studied some physicochemical properties of EUS affected pond water in West Bengal and showed that the outbreak of EUS occurred when dissolved oxygen content, hardness and total alkalinity of pond water remained low. Fluctuations in temperature, pH, salinity or dissolved oxygen beyond the optimum range for the host may lead to stress and disease outbreak. More epidemiological studies are required to get an insight into the role of various environmental risk factors responsible for EUS (Pradhan *et al.*, 2014).

So far no detailed works on the physico-chemical parameters of water bodies and on the fish diseases have been carried out in Eastern Nepal. Under this circumstance it was considered worthwhile to study the physicochemical parameters of some water bodies of eastern Nepal and fish diseases prevalent in this area.

Study Sites

Baidya fish farm (Site 1), Babiya Birta fish farm (Site 2), Tarahara fish farm (Site 3), Betana wetland (Site 4), Singhia River (Site 5) and Budhi River (Site 6) were selected in the disease prone areas of Eastern Nepal. Water analyses were conducted at monthly intervals for a period of two years (Nov. 2008 – Oct. 2010) and diseased fishes were collected from these sites.

Site1. Baidya Fish Farm, Tankisinwari, Morang (Figs.1.1a and b, 1.2).

It is located at latitude 26°31 '11.12" N and Longitude 87° 16' 25.64" E.

Site2. Babiya Birta Fish Farm, Morang (Figs.1.3, 1.4a and b).

It is located at latitude 26°30' 23.85" N and Longitude 87° 26' 09.01" E.

Site3. Tarahara Fish Farm, Sunsari (Figs. 1.5a and b, 1.6).

It is located at latitude 26°42' 05.77" N and Longitude 87° 16' 38.50" E.

Site4. Betana Wetland, Belbari, Morang (Figs.1.7a and b, 1.8).

It is located at latitude 26°39 '37.79" N and Longitude 87° 25' 55.50" E.

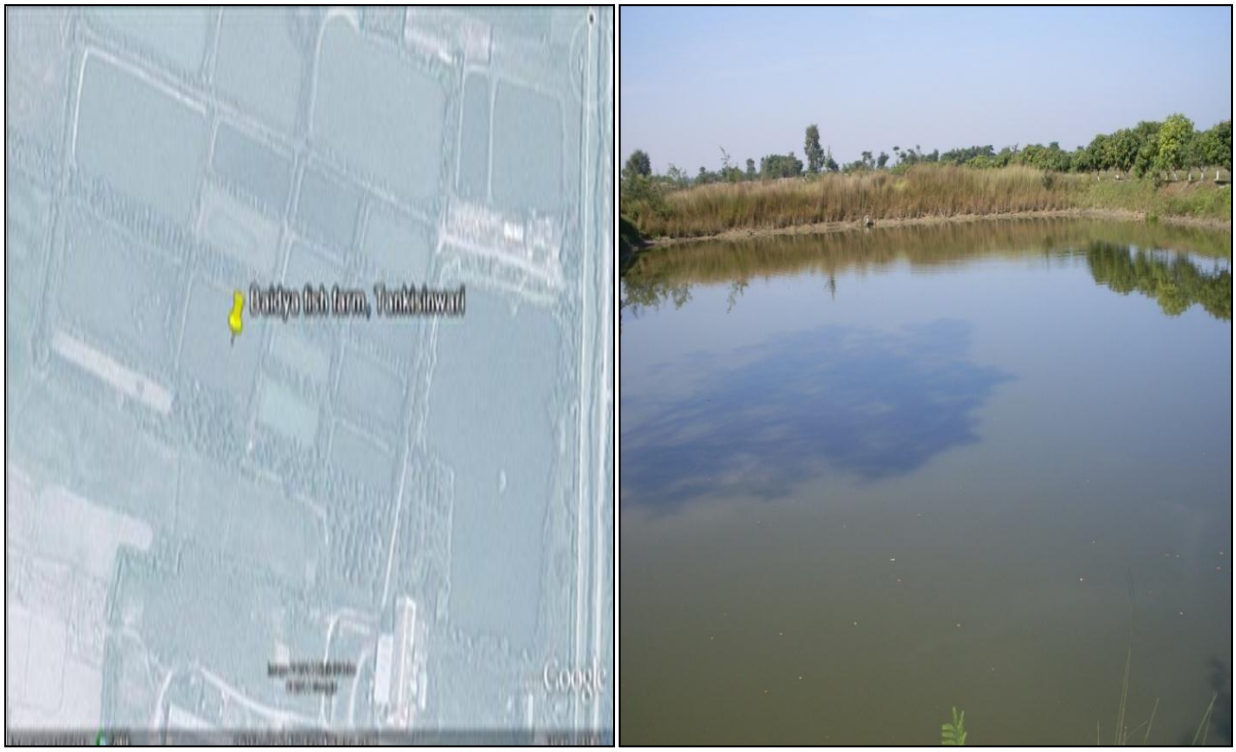
Site5. Singhia River (Near Hatkhola bridge) Morang (Figs. 1.9a and b)

It is located at latitude 26°27' 39.30" N and Longitude 87° 17' 51.62" E.

Site6. Budhi River (Near Duhabi bridge) (Figs. 1.10a and b)

It is located at latitude 26°33' 47.81" N and Longitude 87° 16' 22.01" E.

Map of the study areas is given below (Fig.1.11).



(a) (b)

Fig.1.1 a and b Baidya fish farm, Tankisinwari, Morang (Site1)

Fig.1.2 Baidya fish farm, Tankisinwari, Morang (Site1)

Fig.1.3. Babiya Birta fish farm, Morang (Site 2)

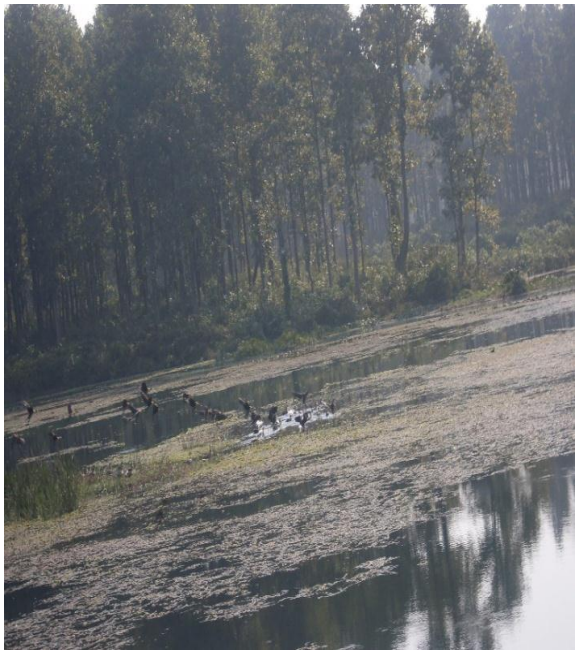
(a) (b)

Fig.1.4a and b Babiya Birta fish farm, Morang (Site 2)

(a) (b)

Fig.1.5 a and b Tarahara fish farm, Sunsari (Site 3)

Fig.1.6 Tarahara fish farm, Sunsari (Site 3)



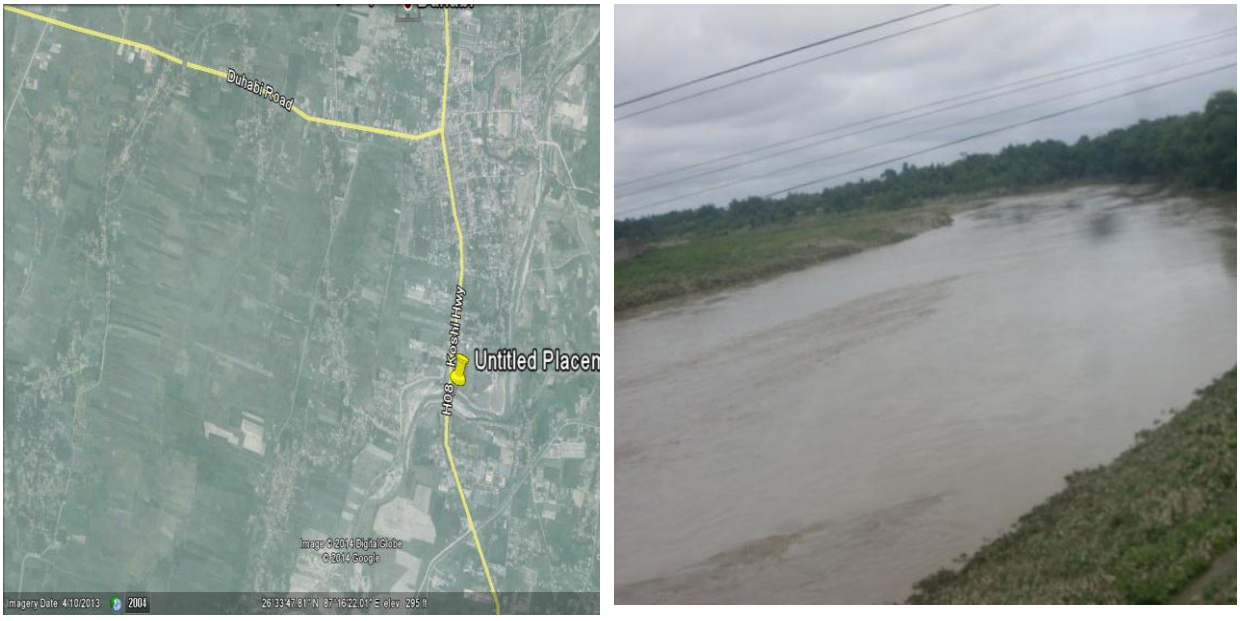
(a) (b)

Fig.1.7 a and b Betana wetland, Belbari, Morang (Site 4)

1.8. Betana wetland, Belbari, Morang

(a) (b)

Fig. 1.9 a and b Singhia River (Near Hatkhola Bridge), Morang (Site 5)



(a) (b)

Fig.1.10 a and b Budhi River (Near Duhabi Bridge), Sunsari (Site 6)

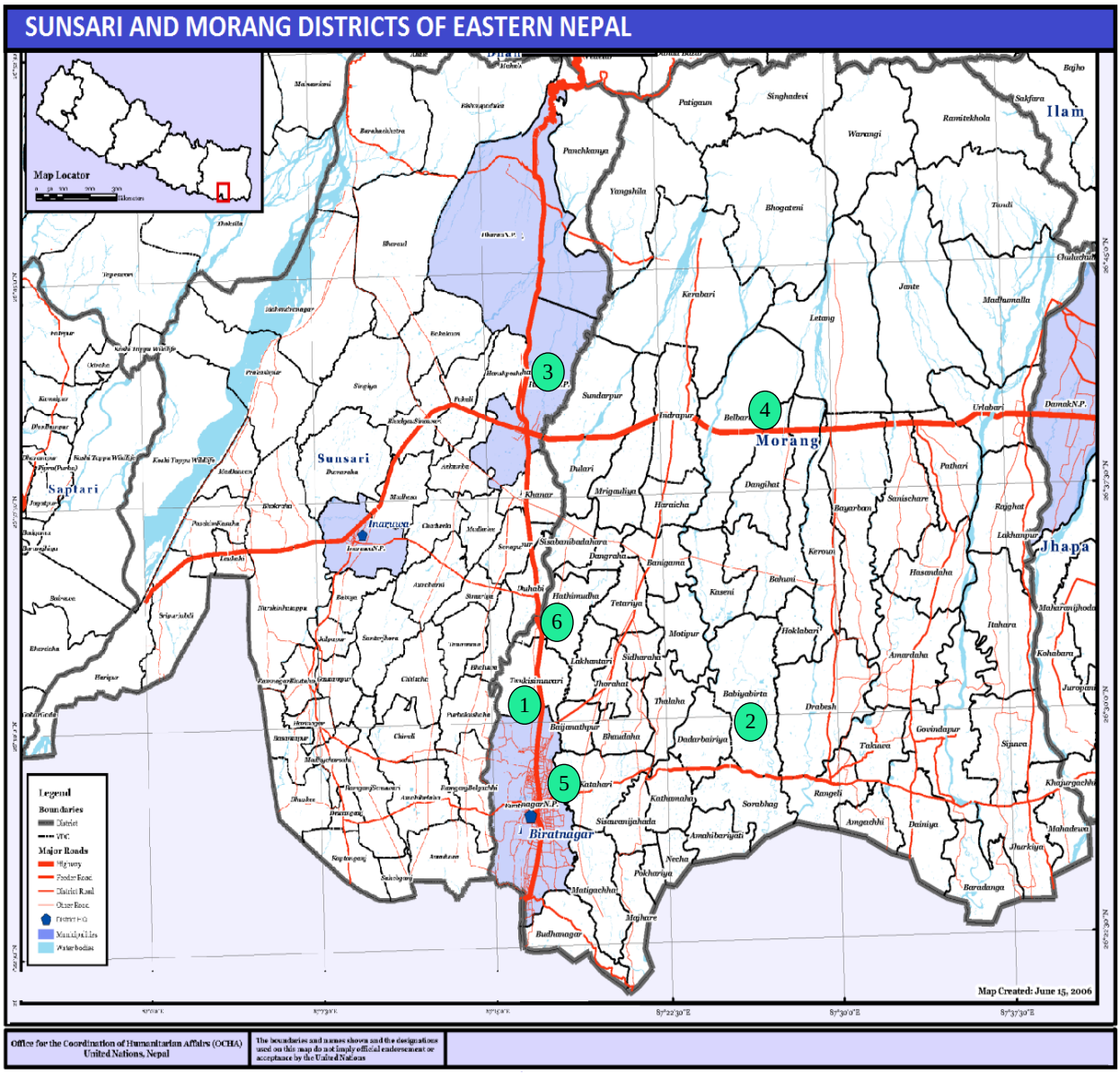


Fig.1.11. Map of Sunsari District showing sampling sites (1- 6) (Source: OCHA, UN, Nepal)