Management Plan
Nammal Lake Game Reserve

A part of

Salt Range Wetlands Complex

The Ministry of Environment's Pakistan Wetlands Programme

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List of Acronyms and Abbreviations

APHA ..... American Public Health Association
BOD ..... Biological Oxygen Demand
BOR ..... Board Of Revenue
^{o}C ..... Degree Celsius
% ..... Percentage
CBD ..... Convention on Biological Diversity
CBO ..... Community Based Organisations
CCB ..... Community Citizen Board
CHAP ..... Conservation and Hunting Association of Pakistan
CIWC ..... Central Indus Wetlands Complex
CITES ..... Convention on International Trade in Endangered Species of Flora and Fauna
COD ..... Chemical Oxygen Demand
DCO ..... District Coordination Officer
DO ..... Dissolved Oxygen
EC ..... Electrical Conductivity
EPA ..... Environment Protection Agency
FAO ..... Food and Agriculture Organisation
Fig. ..... Figure
GIS ..... Geographic Information System
GPS ..... Global Positioning System
Ha ..... Hectare
HH ..... Household
Km ..... Kilometre
Km^2 ..... Square Kilometre
M ..... Meter
MCWC ..... Makran Coastal Wetlands Complex
ml ..... Millilitre
MM ..... Millimetre
MoE ..... Ministry of Environment
MOU ..... Memorandum of Understanding
NAWC ..... North Alpine Wetlands Complex
NCCW ..... National Council for Conservation of Wildlife
NEQS ..... National Environment Quality Standards
NGOs ..... Non Government Organisations
NRSP ..... National Rural Support programme
NTFP ..... Non Timber Forest Products
PA ..... Protected Area
PCRET ..... Pakistan Council for Renewable Energy Technology
PDDC ..... Punjab Dairy Development Council
PMNH ..... Pakistan Museum of Natural History

PWP.....Pakistan Wetlands Programme
PW&PD..... Punjab Wildlife and Parks Department
RAPPAM.....Rapid Assessment of Priority Protected Areas Management
SRWC..... Salt Range Wetlands Complex
SO_4 .....Sulphate
STFP.....Sustainable Tourism Foundation of Pakistan
Sp.....Species
TDS.....Total Dissolved Solids
TSS..... Total Suspended Solids
UN.....United Nations
UNCCD.....United Nations Convention on Combating Desertification
UNFF .....United Nations Forum on Forest
USEPA.....United States Environment Protection Agency
VWCC.....Village Wetlands Conservation Committee
WHO ..... World Health Organisation
WWF-Pakistan.....World Wide Fund for Nature – Pakistan
ZSD.....Zoological Survey Department

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Masood Arshad, Ph.D.
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1.0. Introduction

1.1. Wetlands defined

Ramsar Convention defined wetlands as:

"…*areas of marsh, fen,*[1] *peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."*

In the case of Pakistan, this definition will include glaciers and the areas of wetlands that fluctuate in size to include the 10-year high water levels.

1.2. Why are wetlands important?

Wetlands are often significant for their ecological, hydrological, social and economical values. Functioning wetlands can be a critical part of the environment as they support a high level of biological productivity and diversity, provide habitat for *flora* and *fauna* including rare and threatened communities and species, maintain local and regional hydrological regimes, remove nutrients and pollutants, act as stores for rain and flood waters and support human activities and values.

1.3. Wetlands of Pakistan

Although predominantly arid and semi-arid, Pakistan possesses a great variety of wetlands, principally in the valleys of Indus River and its tributaries and near the coast (ranging from coastal habitats to snow deserts of Himalayas and Karakorum). Pakistan is hosting more than 225 significant wetlands of diverse nature and environment; these wetlands are seasonal and permanent, covering about 9.7% of land surface. The total area of inland waters in Pakistan was estimated at over 7,800,000 ha in 1986 and the area of coastal mangrove swamps at more than 250,000 ha in 1987. Nineteen of these have been internationally recognised as Ramsar Sites (Fig. 1) by the *Ramsar Convention* Bureau. These Sites are of great ecological significance, supporting unique habitats and associated biodiversity. These wetlands support large number of water birds, including the largest populations of the globally threatened White-headed Duck *Oxyura leucocephala* and Marbled Teal *Marmaronetta angustirostris* in the Asia region. The same resource, however, also sustains an estimated 144 million permanent human residents and 3-4 million displaced persons from adjacent countries, who are benefiting from these wetlands resources.

Pakistan's permanent and ephemeral wetlands are globally significant in two ways: first, in terms of the intrinsic value of their indigenous biodiversity and secondly, as an acute example of the *poverty/subsistence-use nexus* that constitutes one of the most fundamental threats to biodiversity worldwide. The high global significance of Pakistan's wetlands is attributable to the diversity of species that they support. In all, eighteen threatened species of wetlands dependent mammals are found in the country including the endemic Punjab Urial (*Ovis vignei punjabiensis*) and Indus River Dolphin (*Platanista minor*). Further, twenty threatened bird species are supported by Pakistan's wetlands in addition to twelve reptiles and two endemic species of amphibians. Pakistan's wetlands also support between 191-198 indigenous freshwater fish species (including fifteen endemics) and a total of 788 marine and estuarine fish species. The high altitude wetlands, characterised by sites such as Karumbar Lake, situated at an elevation of

[1] Fen = Alkaline marsh.

4,150 m, and Saucer Lake, at 4,250 m on the Deosai Plains, represent a relatively unique category of alpine wetlands that is confined to the Himalaya, Hindukush and Karakoram mountain cordilleras.

1.4. Wetland types of Pakistan

Knowing the location, distribution and character of wetlands, their values and uses, and the threats to them is an essential basis for developing and implementing management for their wise use. However, the global review of wetland inventories indicated lack of a standardised, systematic approach to wetland inventory across the Asian region. The review also suggests that national level wetland inventories should be developed by using an approach that is comparable with other wetland inventories and for which the Ramsar Convention should provide guidance. Based on the hydrologic, geomorphologic, chemical or biological factors, 22 distinct types of wetlands were classified and representative areas were delineated (Fig. 2).

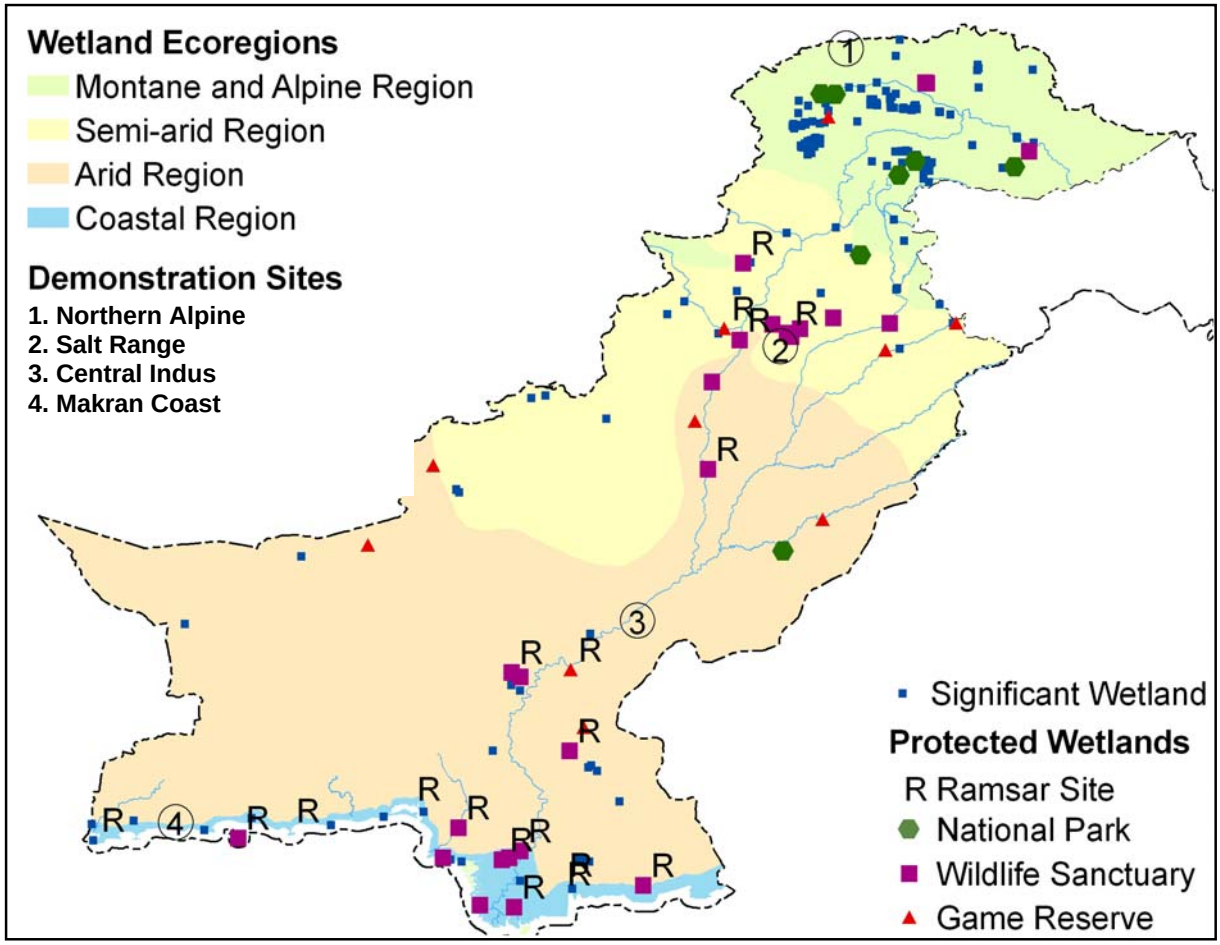


Figure 1: Distribution patterns of Significant Wetlands, Wetlands Eco-regions and Ramsar Sites of Pakistan. R denotes Ramsar Sites (19 in number).

1.5. National and global environmental context

Geographical location and boundary of Pakistan, regardless of its small size, represents a large variety of ecological conditions and is characterised by nine major ecological zones. Three major ecological realms such as *Indo-Malayan*, *Palaearctic* and *Ethiopian* (African) amalgamate in the country and support the biodiversity of all these ecological regions. Pakistan is an arid country, which was once water sufficient but now it has become a

water scarce country and if same situation prevail it may be included in the list of water deficit countries. The wetlands are one of the main sources of water for human such as agriculture, domestic use and for industrial purposes. These wetlands also provide habitat to a range of wetlands biodiversity which is of great economic value to human being and is directly related to the livelihoods of the dependent communities. The plenty of wetlands is crucial to dilute the flood intensity and infrastructure losses in addition to their importance to govern the agriculture-based economy of the country. These wetlands are of immense ecological importance for their unique ecosystems which are supporting the biodiversity of international concerns. About eighteen threatened wetlands dependent mammal species are found in the country including endemic Indus River Dolphin (*Platanista minor*) and the Punjab Urial (*Ovis vignei punjabiensis*). These habitats are host to 20 threatened bird species; 12 reptiles; 2 endemic amphibian species; and 198 freshwater including 15 endemic, and 788 marine and estuarine fish species.

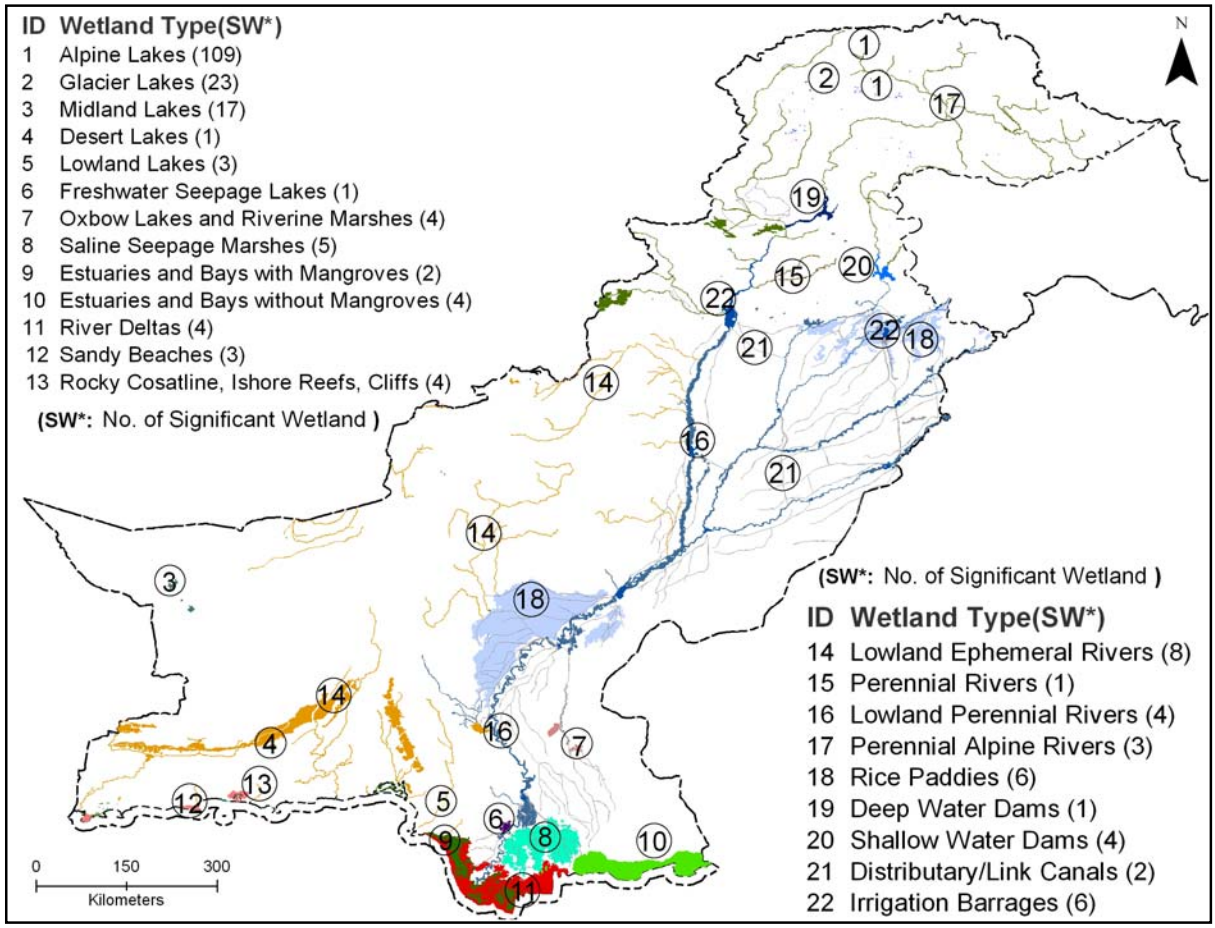


Figure 2: Major wetlands types of Pakistan

1.6. Issues and problems of the wetlands in Pakistan

Pakistan's wetlands and associated *flora* and *fauna* are facing a wide range of threats that can be categorised into three major groups; (1) ***Unsustainable anthropogenic use of wetlands***: these activities include the over-exploitation of wetlands resources such as destructive fishing practices, over-harvesting of wetlands vegetation, over-grazing and illegal hunting of birds, mammals and reptiles. (2) ***Physical changes to wetlands on an ecosystem level***: land reclamation, deforestation, expansion of agricultural fields in the close vicinity of wetlands and over-gazing are causing much severe structural threats to

wetlands. (3) ***Off-site activities that cause physical and chemical changes to wetlands***: these are practices that do not take place directly on or around wetlands and carried out in some other locations but they have significant impacts on wetlands. Threats of this category include the changes in water volume like water flow and water pollution.

1.7. Gaps and weaknesses in the Policy Environment / Legislation

Pakistan has a difficult policy environment. This is particularly true of policy level interactions and planning interventions associated with environmental protection, conservation, or recognition of poverty-environment linkages. However, the situation is changing. In recent years, the Government of Pakistan have initiated policy and planning measures to rectify the situation. However, appropriate institutional design remains missing particularly in terms of delineation of authority, adequate resource provision (human, physical, financial) and accountability mechanisms. The Government of Pakistan has through the Poverty Reduction Strategy Paper and the 10th 5-year Development Plan, also known as the 'People's Development Plan' (formerly the Medium Term Development Framework 2005- 2010) attempted to integrate environment in its long-term planning documents. However, this recognition of the importance of conservation and the value of environmental sustainability remains restricted to specific sectors such as agriculture, water, pollution, and forest (and associated natural resources). The activities and programmes proposed in these documents fail to make the link with appropriate poverty environment indicators and present a fractured image of state level natural resource management.

Policy documents such as the National Conservation Strategy (1992), the National Environmental Action Plan (2001), the National Environmental Policy (2005) and the proposed National Water Policy play an important role in describing the state's perspective on environment and natural resource management. They provide a roadmap for future policy and practical engagements. However, concrete impacts of these policy documents, the actions and planning trajectories they outline remain nebulous.

The Government of Pakistan is party to 5 natural resource related Conventions i.e. Convention on Biological Diversity (CBD), UN Convention to Combat Desertification (UNCCD), Convention on Migratory Species, Ramsar Convention on Wetlands, and Convention on International Trade of Engendered Species of Wild Fauna & Flora (CITES). In addition to these Conventions, Pakistan is also an active party to UN Forum on Forests (UNFF). While at the federal level, there is some awareness and understanding of the obligations, duties and opportunities emanating from these agreements but at the provincial and district levels, stakeholders, responsible for actively implementing targeted actions, collecting necessary data etc in line with these agreements remain largely uninformed.

In terms of legislation, the cornerstone of Pakistan's environmental legislation is the Pakistan Environmental Protection Act of 1997. The Act works under the presumption of environmental federalism wherein it creates the authority for the delegation of environmental management functions and powers to Environmental Protection Agencies at the provincial level. The provincial governments, in turn, have the authority to further delegate these powers. They also have the scope to adopt more stringent environmental regulations rather than adopt the bare minimum of standards and engage in a race to the bottom. The presumption of environmental federalism is further supplemented by the Local Government Ordinance of 2001. The Ordinance promotes responsibility and accountability at the local level and was designed to engage citizens in public political life from the smallest unit of government – the Union Council.

While the benefits of environmental federalism are plentiful, its application in Pakistan remains challenging on two fronts. First, the Pakistan Environmental Protection Agency remains charged with developing appropriate oversight and monitoring guidelines for the

functions and activities of all provincial environmental protection agencies. Second, the Pakistan Environmental Protection Agency is responsible for building capacity and allocating sufficient resources to provincial agencies necessary to meet their delegated responsibilities. In general terms, government institutions, ministries, departments and associated public bodies are responsible for enforcing policies and ensuring the appropriate implementation of sanctioned plans. However, in order to do this effectively, institutional mandates need to be clear and transparent and implementing bodies require sufficient human, physical, and financial resources buttressed by legislative authority. Finally, an effective and transparent accountability mechanism should exist to evaluate institutions on how effectively they meet their respective mandates and utilise their resources.

The preceding discussion holds true for the Province of Punjab. Linking environmental conservation and sustainable natural resource use, Punjab's wealth of natural resources and diversity of ecosystems is a significant part of its overall development, particularly since large rural populations is dependent on these natural resources for their livelihood. Deterioration of these natural assets such as reduction in freshwater flows, habitat destruction, deforestation, pollution, water logging and salinity may be indicative of poor natural resource management, weak enforcement of environmental protection legislation, and feeble policy actions. Both civil society and several government departments exhibit a grave lack of awareness of environmental laws and rights. While this may be attributed to the fact that environmental law is a comparatively new area in Pakistan; it should also be attributed to poor dissemination of information and outreach. One of the cross cutting issues that affect forest and wildlife management in Pakistan is the existing legal framework which does not provide incentives for the local communities and corporate sector on the one hand, and provides no scope for the adoption of emerging concepts and management innovations. Moreover, the laws are obsolete in terms of the fines levied and the penalties imposed for poaching, fishing during prohibited seasons, infrastructure development in protected areas, unsanctioned logging, encroachment on forested land and other protected areas etc.

1.8. Pakistan Wetlands Programme: concept and design

However, these precious habitats are facing severe threats of degradation due to human interference, over-exploitation and mismanagement, which demands special cure. In order to safeguard and protect these precious wetlands, the World Wide Fund for Nature Pakistan (WWF – P) in consultation with other partner organisations in the year 2000 undertook wetlands conservation initiatives, which resulted in the form of an inception of the Pakistan Wetlands Programme (PWP) in 2005.

The overall aim of the PWP is to promote wetlands conservation and their associated globally significant biodiversity through poverty alleviation of wetlands dependent human communities. In order to achieve the major aim of the project, two major set of objectives were defined:

- Create and maintain an enabling environment for effective and sustainable conservation of natural wetlands at federal, provincial / territorial and local levels through public awareness, capacity-building and identifying gaps in policy and legislation at national level;
- Implement sustainable wetlands conservation at four representative sites that will serve as replicable models for subsequent nationwide wetlands conservation initiatives through development and application of wetlands management plans.

1.8.1. The Management Plan Concept

The management plan is a product of the planning process, documenting the management approach, the decisions made, the basis for these, and the guidance for

future management for an entire PA over a given period of time. It should contain information on what is to be achieved by management and the rationale behind the management decisions made. The management plan can be defined as:

> *"a written, circulated and approved document which describes the site or area and the problems and opportunities for management of its nature conservation, land form or landscape features, enabling objectives based on this information to be met through relevant work over a stated period of time" (Eurosite, 1999)*

These should be succinct documents identifying key features of the site, clearly establishing management objectives based on the associated risks and threats, the number of competing interests, the level of stakeholder involvement and the associated social issues and indicating actions to be implemented. The task of preparing plans is challenging, keeping in view the multiple objectives i.e. biological and cultural, a wide array of social preferences and values, institutional structures and barriers, philosophical outlooks, forms of knowledge and conflicting opinions. In addition, plans also need to be flexible enough to cater for unforeseen events which might arise during the duration of the Plan.

The level of operational detail to include in a management plan is a decision for the respective Department to determine. How detailed the plan should be in terms of its operational content will most probably depend on whether there are other systems set up within the Department or whether the management plan is expected to provide the detailed day-to-day guidance to the Park authority.

The need for having a management plan is emphasised by the following statement:

> *"If there is no general management plan; preservation, development and use activities in a Park will occur in a haphazard basis, often in response to political pressures with little consideration as to the implications for the future. This result is likely to be lost opportunities and irreversible damage to park resources and values"*

1.8.2. Wetlands Complexes Management Plans

The four wetlands complexes (Fig. 3) were included as part of the PWP after a series of consultation with national, provincial and local stakeholders. The sites were specifically chosen to be broadly representative of prevailing conditions and typical wetlands conservation problems in each of four separate ecological regions. These wetlands complexes include:

- Northern Alpine Wetlands Complex (NAWC)
- Salt Range Wetlands Complex (SRWC)
- Central Indus Wetlands Complex (CIWC)
- Makran Coastal Wetlands Complex (MCWC)

The major aim of each of the wetlands complex is to sustainably conserve wetlands biodiversity by designing and implementing a comprehensive management plan.

1.9. Wetland Protected Areas of the Salt Range

The Government of Punjab has notified a list of Protected Areas in the Salt Range in order to conserve the unique biodiversity of the region especially the endemic Punjab Urial (*Ovis vignei punjabiensis*) and globally threatened White-headed Duck (*Oxyura leucocephala*) and other endangered waterfowls. In order to conserve the globally significant biodiversity of the Salt Range, one National Park, five Wildlife Sanctuaries and two Game Reserves have been established. In addition, wetlands protected areas are also notified keeping in view the importance of the globally significant migratory water birds.

The Salt Range Wetlands Complex includes 5 significant lakes comprising of Uchhali, Khabekki, Jahlar, Nammal and Kallar Kahar wetlands. The first three lakes are part of the Uchhali Wetlands Complex, which is also notified as a Ramsar Site. A series of other

small dams and adjacent small lakes exist in the premises of Salt Range region including Lava Lake, Dharab Dam, Dhok Talian Dam, Khokhar Zair Dam etc. but the major concentration of wetlands dependent biodiversity is found in the five significant lakes.

1.10. Management Plan for Salt Range Wetlands Complex

Salt Range Wetlands Complex is one of the four hotspots identified by the Pakistan Wetlands Programme. A series of site specific management plans are developed under the overall umbrella of Salt Range Wetlands Complex. The Nammal Lake is located in District Mianwali, Punjab province. It has been designated as Game Reserve and hold special significance as a part of the Salt Range Wetlands in terms of biodiversity it contains. There is a need to develop specific management plan for the wetland Protected Area in order to address specific issues related to stakeholder's involvement and its objectives of management.

1.11. Wetlands management plan for Nammal Lake Game Reserve

The management plan for the Nammal Lake Game Reserve will consist of a brief introduction to the area, details of Biophysical and Social Environment of the region, which also discusses the processes involved in data collection (useful for the development of a management plan), potential issues and threats faced by the wetlands, overall management vision for the Lake, strategic interventions and the implementation and monitoring mechanism that not only defines the priority of an intervention but also the stakeholders involved in its implementation.

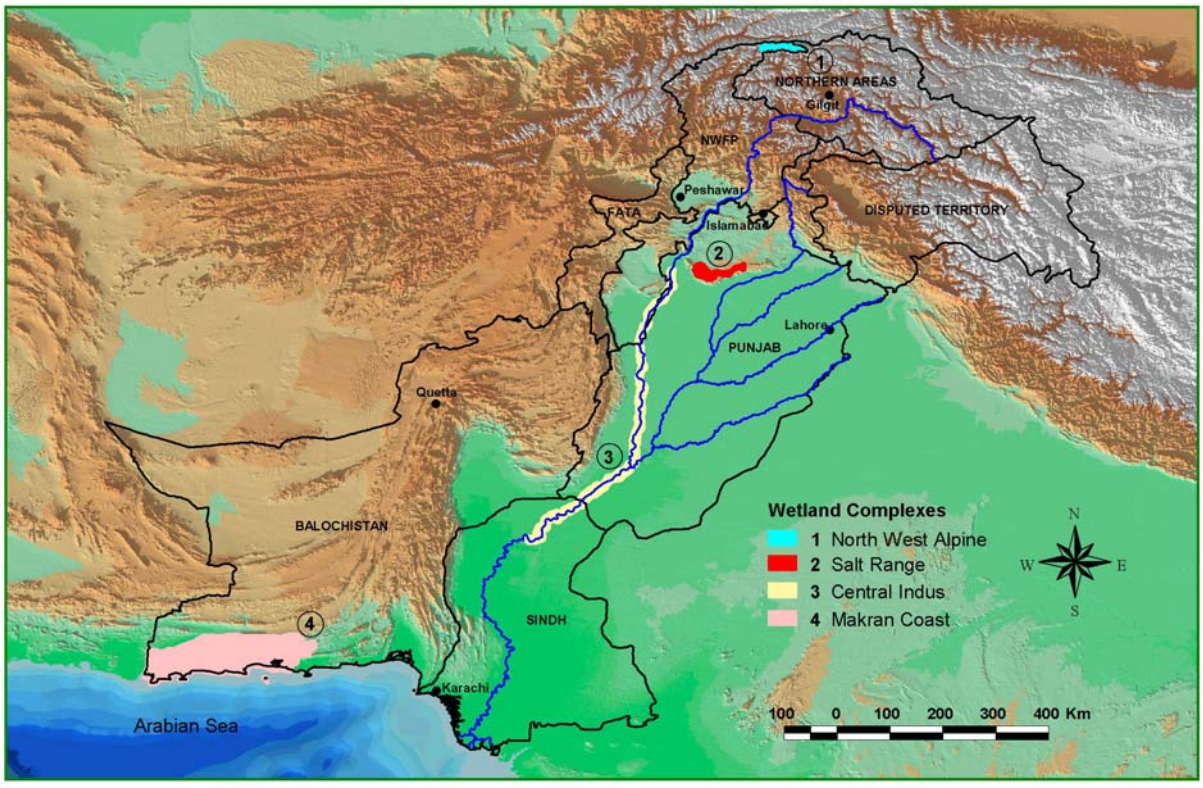


Figure 3: Four major wetlands complexes covered under Pakistan Wetlands Programme

2.0. Nammal Lake Game Reserve

2.1. Introduction

The name Salt Range, owing to the second largest mineral salt (Sodium chloride) deposits in the world, is given to the hill system situated in the Northern Punjab, in Jhelum, Chakwal, Khushab and Mianwali Districts. First time the name Salt Range was used in 1808 by Elphinston, a British Envoy, when he observed the extraction of salt in the area. The salt deposits of the area were deposited as a result of the evaporation of Tethys Sea and formation of Indus plains from collision of Indian plate with Asian plate resulting from continental drift (King and Vincent, 1993).

The Salt Range is an east-west trending thrust front about 175 km long. It forms an impressive scarp, from 250 - 1520 m in altitude. Sakesar top is the highest point (1524 m). It extends between 32^{o} 41 - 32^{o} 56 N. and 71^{o} 50 to 74^{o} E. This range first enters the Chakwal district at its extreme south west corner where the spurs of mount Sakesar descend into the village Lawa, close to Nammal Lake. In this part of its course the range keeps mostly to the district of Khushab, but near Khewra, it passes altogether into the Jhelum district where it bifurcates into two distinct ridges, one of them running towards south-east while the other into the east, about 8 km apart from each other. Each of them is made of a number of small roughly parallel ridges. This parallelism is modified by a marked tendency for linked and looped formations. On the south, the range presents a monotonous line of parched and barren slopes, rarely more than 250 m high from the mean sea level, descending abruptly into the valley of the Jhelum River. On the northern side they gradually sink down into the Chakwal plateau (Lindsay, 1923).

Sedimentary rocks and the fossils preserved therein give a complete record of the geological and biological history of the earth. The rock layers in the area have been tilted vertically, even inverted in some places, so that the older, fossil strewn layers now lie on the surface (Shaw, 1989). The over use of vegetation has accelerated rates of erosion resulting in bare sheet rocks devoid of any soil layers. The rocks are composed of limestone and sandstone or both. At some places infertile red marl is exposed due to similar reasons and the steep geological tilt resulting in frequent slips. The plant cover is poor on sandstone and red marl. The density of vegetation on southern aspects is poor while the northern slopes are comparatively better covered with vegetation.

The general habitat type prevailing in the Salt Range is dry sub-tropical semi-evergreen scrub forest (Roberts, 1991). The dominant plant species are Acacia *modesta, Olea ferrugenia, Salvadora alights, Zizyphus nummularia, Dodonea viscosa, Prosopis glandulosa, Justicia adhatoda, Calotropis procera.* Shrubs are sparse with scattered *Zizyphus nummularia* and, *May tenus Rawlins* except in some ravines and on the high ridges where *Daytona viscosa* is prominent and grasses like *Cymbopogon jawarancusa, Eleusine compressa, Heteropogon contortus, Aristida adscensionis, Cynodon dactylon and Saccharum* species are found.

Salt Range had a varied and abundant wildlife species in the historic times. Punjab Urial, Chinkara, important carnivores, Chukar, See-see, grey and black partridges were in plenty due to nature of vegetation and topography, which has been over hunted in the past and led to marked reduction in the numbers and restriction of the range of most species. Chinkara is nearly extinct from the Salt Range. Punjab Urial population is also declining day by day. In order to conserve the globally significant biodiversity of the Salt Range, one National Park, five Wildlife Sanctuaries and two Game Reserves have been established (Fig. 4) by the Punjab Wildlife and Parks Department.

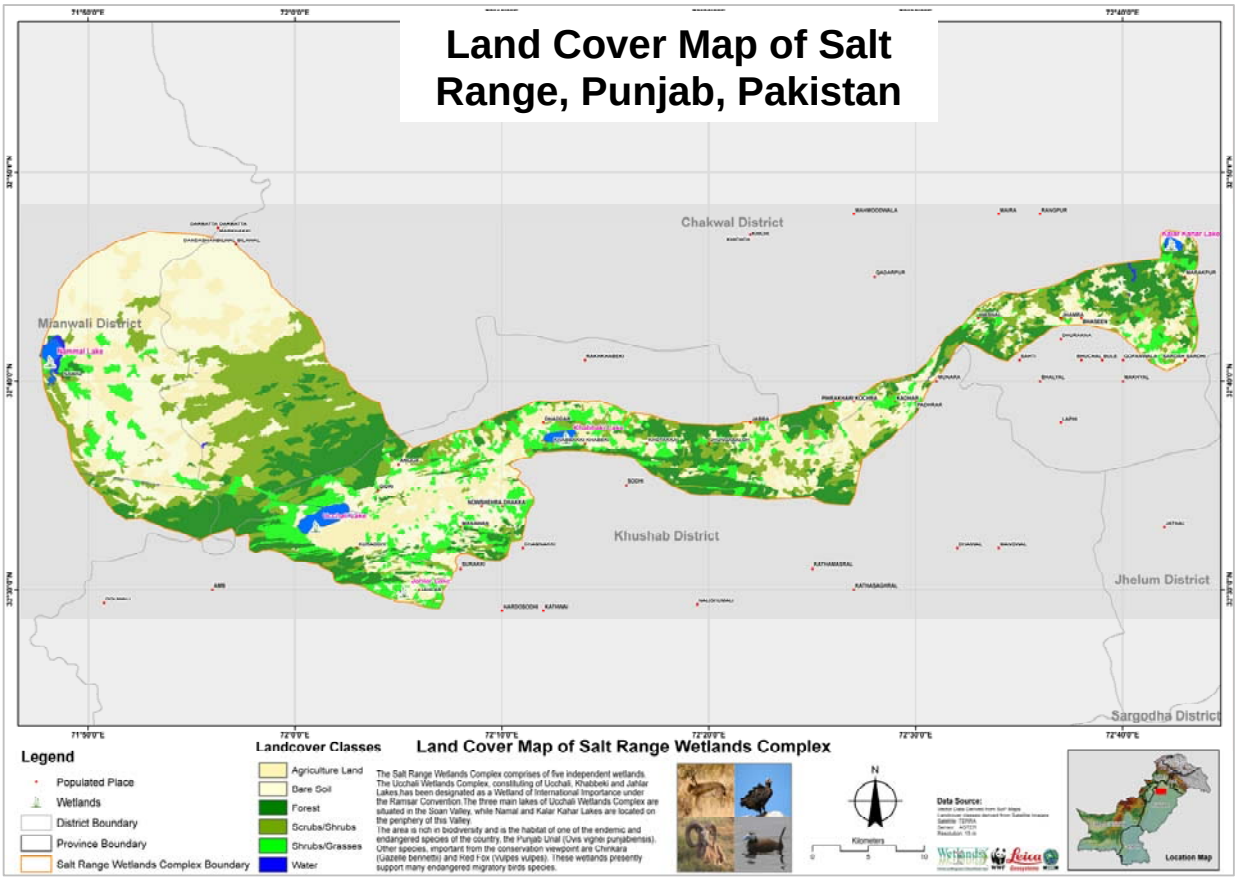


Figure 4: Locations of all five lakes of Salt Range Wetlands Complex with land cover information

2.2. Salt Range Wetlands Complex

The Salt Range Wetlands Complex comprises of five independent wetlands: Kallar Kahar, Khabekki, Uchhali, Jahlar and Nammal Lakes (Fig. 5). The entire SRWC has a total length of 175 km parallel to the Salt Range Escarpment that runs from Jhelum, in the east, to Kalabagh in the west. The Uchhali Wetlands Complex, constituting of Uchhali, Khabekki and Jahlar lakes, has been designated as a Wetland of International Importance under the Ramsar Convention, a distinction it shares with only eighteen other wetlands in Pakistan. The three main lakes of Uchhali Wetlands Complex (Fig. 6) are situated inside a cup-shaped catchment area called the Soan Valley, while Nammal and Kallar Kahar Lakes are located on the periphery of this Valley.

This wetland complex provides habitat to a wide variety of wintering waterfowl including the endangered species of White-headed Duck *Oxyura leucocephala,* Ferruginous Duck *Aythya nyroca*, Greylag Goose *Anser anser* and Greater Flamingos *Phoenicopterus rube*. The Complex provides core habitat for the endemic Punjab Urial (*Ovis vignei punjabiensis*) in the catchment areas. These lakes are situated on communal lands even the beds of lake are private property and experience the agriculture practices when the water level is low in these lakes. These lakes are facing a continuous problem of siltation which is reducing their depth in addition to water pollution from the domestic water discharge. The rain showers, soil moisture and poor soil nitrogen contents determine the vegetation composition.

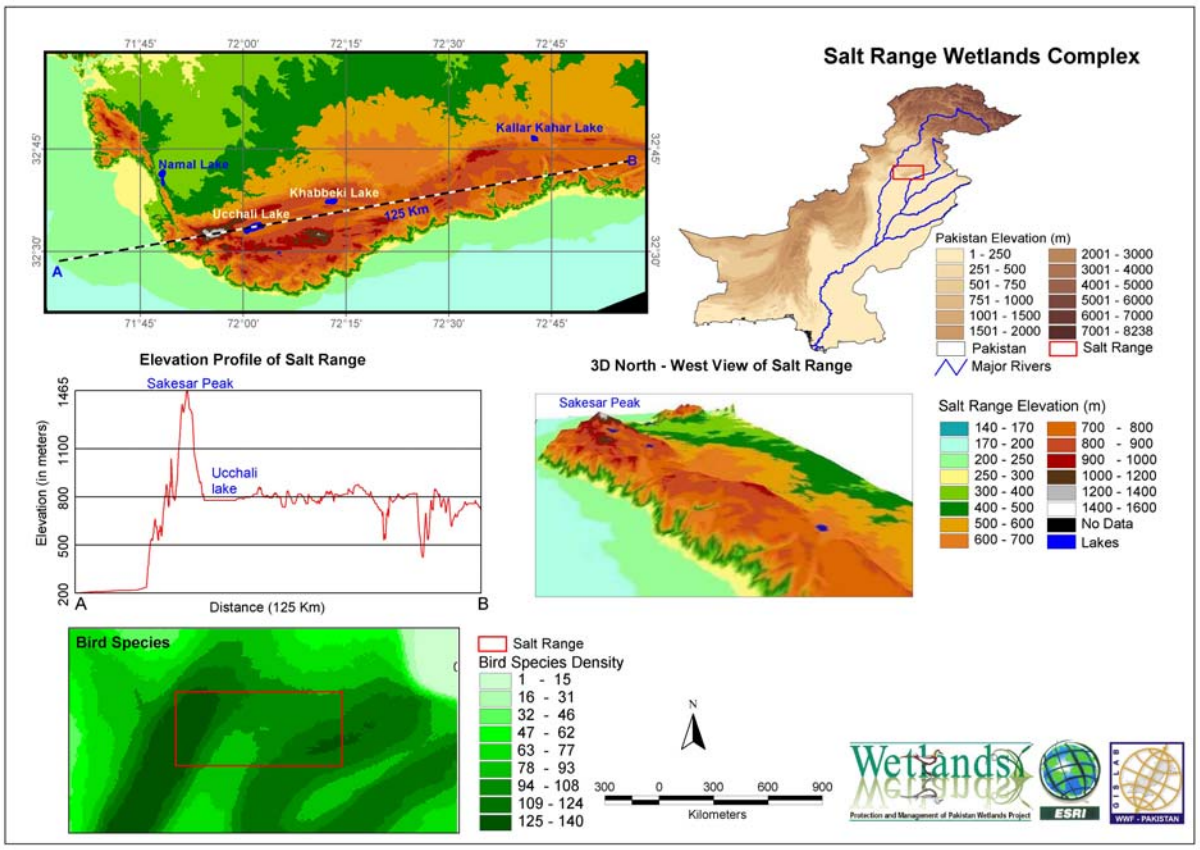


Figure 5: A 3-Dimensional profile of Salt Range Wetlands Complex, Punjab, Pakistan

2.3. Nammal Lake Game Reserve

Nammal Lake is located in the Mianwali District, some 30 km from Mianwali along Mianwali Talagang Road at an altitude of 532 m. The Mianwali District is a slightly neglected area of the Punjab province. Hidden in the Salt Range Mountains, the Lake is quite rich in natural resources.

Nammal Lake Game Reserve is a shallow water brackish lake. A number of migratory birds visit this lake during winters. The hill torrents and rains fill Nammal Lake round the year. Due to a drought like situation in the country in the past few years, this lake also dried up, but again was fed, observed during the present survey period (August 2007) and the recent wet seasons of 2010 and 2011.

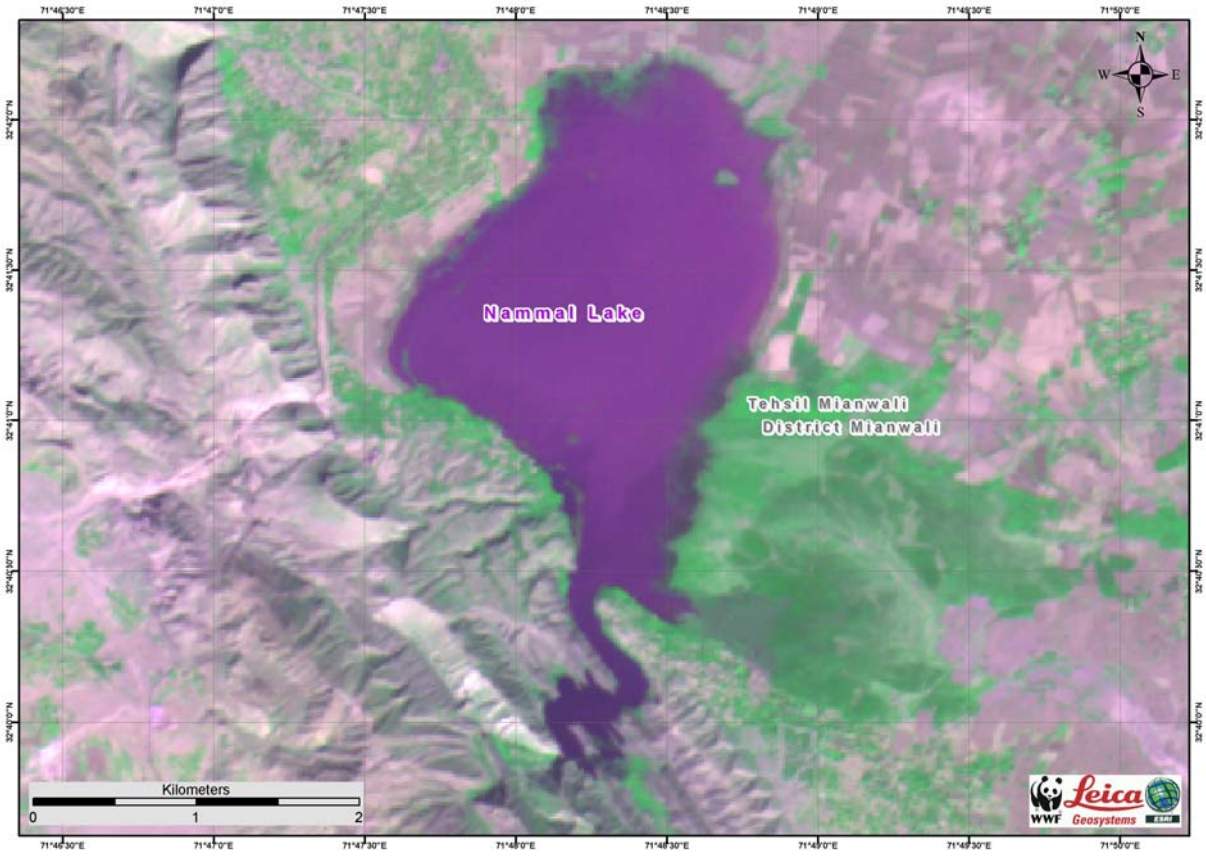


Figure 6: Nammal Lake Game Reserve located in Tehsil and District Mianwali, Punjab

2.4. Conservation status of the Nammal Lake Game Reserve

Nammal Lake was declared a Wildlife Sanctuary in November 1964; however in January 1991 its status was changed to Game Reserve in 1991. This change in its status was mainly due to the decrease in waterfowl population with the passage of time. The total area of Nammal Lake Game Reserve is 486 ha (4.86 km^2), which remained unchanged even after its change of status.

Box I: Definition of a Game Reserve

The Game Reserve, defined under Section 18 of the Punjab Wildlife Act, 1974, states

I. The Government may declare any area to be a "Game Reserve".

II. No hunting and shooting of a wild animal shall be allowed in the Game Reserve, except under a special permit, which may specify the maximum number of game animal that may be killed or captured, the area and duration for which such permit shall be valid:

   a. Provided that the number of occasions on which hunting and shooting may be allowed shall not exceed two in a year.

2.5. Land tenure of Nammal Lake Game Reserve

The surface area of the wetland is state owned while the adjacent agricultural fields around the lake are privately owned but the forests and rangelands present on the mountains and plains are state-owned.

2.6. Principal Management Objectives of Nammal Lake Game Reserve

The principal management objectives for Nammal Lake Game Reserve are to:

- Ensure the long-term conservation of the Nammal Lake Game Reserve, associated wildlife and the significant habitat;
- Establish a baseline environment data set and overall develop, maintain and improve an inventory of Nammal Lake Game Reserve;
- Enhance the quality of decision making and undertake effective liaison between the local government, concerned institutions and community regarding the appropriate environmental management for the area;
- Buildup capacity and strengthen wetlands dependent communities in sustainable use of natural resources through enterprise development, improving their livelihoods and exploring alternative options of subsistence; and,
- Develop Nammal Lake Game Reserve Management Plan and recommend prescriptions for effective implementation in collaboration with partners and stakeholders.

3.0. Biophysical Environment

3.1. Introduction

The "Nammal Lake Game Reserve" (32^{o} 41' N, 71^{o} 49' E) is a special type of wetland, found in the Salt Range, north-central part of the Punjab, Pakistan. It lies at an approximate distance of 30 km east-north-east of Mianwali. It covers a total area of 486 ha and lies at an altitude of 352 m.

Nammal is a shallow brackish lake, partly impounded by a dam in one corner, and fed by a small spring and several intermittent streams rising in the low hills of the Salt Range to the south-east. Maximum depth of the lake is 5.8 m and the mean 4.6 m. The water level fluctuates widely, and is partially controlled by the removal of water for irrigation and for other uses. Human presence in recent times has resulted in substantial areas being reclaimed for agriculture. Large areas previously under water have been drained due to drought conditions and there has been a continuous trend in the last few years towards reduction of water levels in the lake.

These lakes and the ecosystem they support are not only shrinking in their surface area but are also experiencing deterioration of water quality. This poses a serious health hazard to wildlife in general and birds in particular. As a consequence, a number of ecological changes mainly by natural and human pressure, the health and very life of the lakes are threatened.

3.2. Climate of the Region

The climate of the area is dry sub-tropical with an annual rainfall of between 300 mm and 600 mm. Minimum temperatures in January range from 1^{o}C to 5^{o}C, and the maximum temperatures in June are from 40^{o}C to 45^{o}C. January being the coldest and June the hottest month of the year. During winters the temperature often drops to below zero, usually in December and January.

3.3. Geomorphology and soils of the region

Sedimentary rocks and preserved fossil records portray a complete picture of geological and biological history of the region. The severe tilting of these rocks during geological ages resulted in the exposure of these layers near the surface at many places. Aridity prevailing in the area for major part of the year is the main climatic characteristic that affects its soils. This has resulted in limiting the soil moisture and scantiness of vegetative cover. The over use of vegetation has accelerated rates of erosion, resulting in bare sheet rocks devoid of any soil layers. The rocks are composed of limestone and sandstone or both and clay scattered over the whole of the area. The sandstone is laminated by white cream colour, dark red or purple brown. Limestone occurs in pure, laminated and compact form generally in the higher reaches. At some places infertile red marl is exposed due to similar reasons and the steep geological tilt resulting in frequent slips. Soils in the catchment area of Nammal Lake Game Reserve are rich in basic (rock salt) but poor in Nitrogenous matter. Salt layer normally lies at the lowest level but subsequent upheavals have so tiered the layers that at many places the salt layers are exposed, due to washing away of the topside.

The exposed salt rocks get dissolved in water on rainy occasion and this dissolved salt later on deposits on faraway soil during runoff and affects the water bodies. The catchment area of the Nammal Lake Game Reserve is rich in minerals e.g. salt, coal, lime, different kinds of clay and gypsum. The geological interest of the site is very high and is also responsible for the nature of present landscape.

3.4. Water Quality Monitoring

Surface and groundwater resources of the Nammal Lake were analysed in order to establish the baseline conditions and to provide benchmark for the monitoring of the physical and biological aspects of the environment. This baseline will also provide the necessary information required for the effective management of the wetland site.

In order to collect necessary data and water samples for the laboratory analysis, necessary field surveys were conducted in the first week of August 2007. Water samples for surface water as well as groundwater were collected, tested and analysed for physical, chemical and microbiological parameters. Further, the results obtained from laboratory analysis were compared with the United States Environmental Protection Agency (USEPA) and World Health Organisation (WHO) standards. The services of a World's leading verification, testing and certification company "Societe Generate de Surveillance (SGS)" were acquired for field surveys and water sampling.

The major objective was to develop a sampling and spot testing plan for water quality including both surface water and groundwater; Identification of suitable sampling points, and, implementation of quality control and assurance protocols during sampling, spot testing, sample handling, transportation and laboratory test.

3.4.1. Surface Water Quality Analysis

The surface water quality analysis was undertaken from the point of view of determining the suitability of water for aquatic flora and fauna, and to determine the pollution load in the surface water, which could affect the ecology of the water body. Thirty seven (37) important physical and chemical parameters were measured for the samples collected from two (2) different sampling points / locations (Fig. 7). In addition to the physical and chemical parameters, microbiological analysis was also done to determine the quality of water for various purposes. Parameters selected for physical and chemical analysis of the surface water quality are listed in Table 1 below.

Table 1: Surface Water Quality Parameters studied at Nammal Lake Game Reserve

#	Parameter	#	Parameter
1	Arsenic	20	Mercury
2	Ammonia	21	Nitrate
3	An-ionic Detergents	22	Nitrite
4	Barium	23	Nickel
5	Biological Oxygen Demand (BOD)	24	Oil & Grease
6	Boron	25	pH
7	Cadmium	26	Phenolic compound
8	Chloride	27	Salinity
9	Chlorine	28	Selenium
10	Chromium hexavalent	29	Silver
11	Chemical Oxygen Demand (COD)	30	Sulphate
12	Conductivity	31	Sulphide
13	Copper	32	Temperature
14	Cyanide	33	Total Dissolved Solids (TDS)
15	Dissolved Oxygen (DO)	34	Total Suspended Solids (TSS)
16	Fluoride	35	Total Toxic Metals
17	Iron	36	Turbidity
18	Lead	37	Zinc
19	Manganese		

The water quality standards vary according to the ultimate usage of water. Drinking water quality standards are more stringent than the water quality standards for irrigation water or standards for discharges to the surface bodies.

The results of surface water quality were compared with National Environmental Quality Standards (NEQS) as well as other international standards such as US EPA, Food and Agriculture Organisation (FAO) and World Health Organisation (WHO) where applicable and/or available.

In order to establish the water quality baseline conditions, the surface water quality of Nammal Lake was assessed at two different locations: Surface Water Location 1 (SW1) indicating the quality of water at south-eastern end of the lake, Surface Water Location 2 (SW2) represents the quality of water at the northern end of the lake. In addition to the detailed water quality assessment, multi-probe water sampler Hydro Lab MS-5 was also used to assess the general water conditions at one specific location, which is represented as Hydro Lab 1 (HL1). Figure 7 below shows the water sampling locations at Nammal Lake.

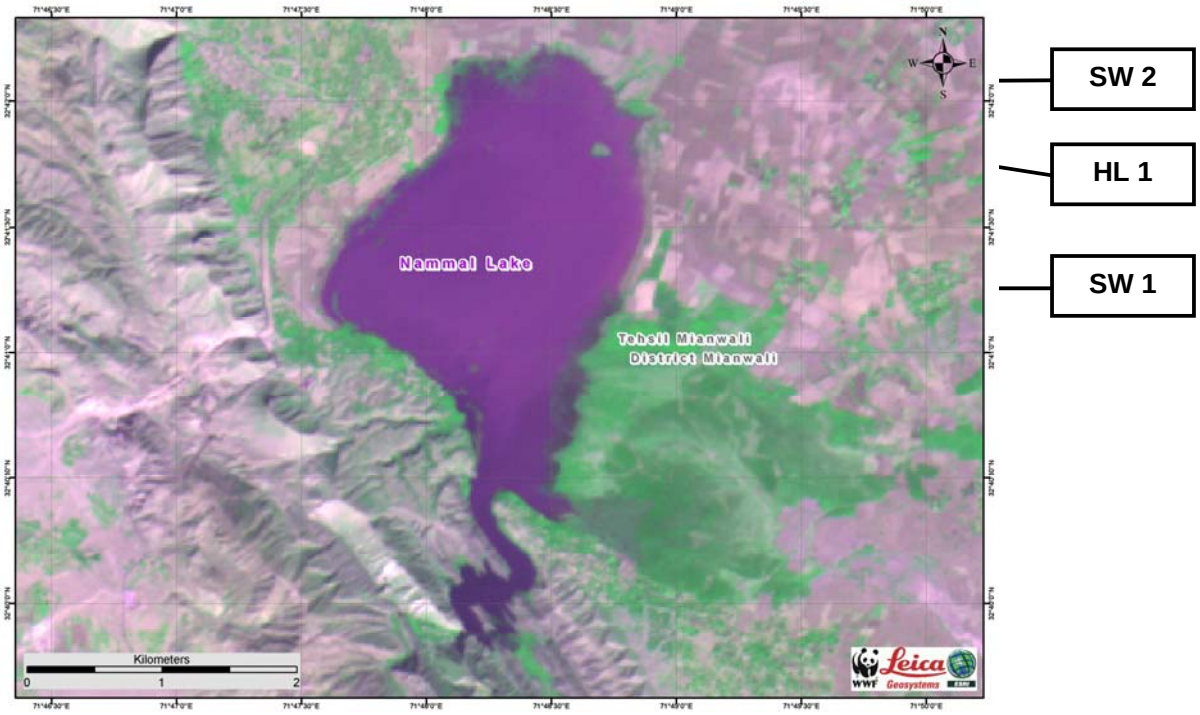


Fig. 7: Surface water sampling points at Nammal Lake Game Reserve

SW 1 Nammal Lake at the South Eastern End
N 32^{o} 40' 990 E 071^{o} 47' 912 Time: 1300 hrs (02-08-07)

SW 2 Nammal Lake at the Northern End
N 32^{o} 42' 230 E 071^{o} 47' 997 Time: 1345 hrs (02-08-07)

HL 1 Hydro Lab Analysis Point at Nammal Lake
N 32^{o} 42' 230 E 071^{o} 47' 997 Time: 1400 hrs (02-08-07)

Few parameters of surface water quality such as pH, Temperature, Dissolved Oxygen (DO), Conductivity etc. were analysed on-site with the help of appropriate and calibrated instruments. All other parameters were analysed in the laboratory. Samples of surface water from different sampling points were collected in sterilized bottles and transported in a potable cooler to the laboratory in Lahore. It was ensured by the Laboratory analysts that all water samples were collected and preserved in appropriate containers as per APHA guidelines. The results were compared with NEQS as well as other international standards such as US EPA - National Water Quality Criteria (NWQC). The summary of the results are presented in Table 2.

Table 2: Surface Water Quality Results of Nammal Lake

#	Parameter	Units	Sampling Locations			NEQS	USEPA NWQC
			SW1	SW2	HL1		
1	Arsenic	mg/L	BDL	BDL		1.0	0.34 AL
2	Ammonia	mg/L	BDL	BDL		40	-
3	An-ionic Detergents	mg/L	BDL	BDL		20	-
4	Barium	mg/L	BDL	BDL		1.5	-
5	Biological Oxygen Demand (BOD)	mg/L	15	17		80	-
6	Boron	mg/L	BDL	BDL		6.0	-
7	Cadmium	mg/L	0.02	BDL		0.1	0.002
8	Chloride	mg/L	29.14	29.14		1000	860
9	Chlorine	mg/L	BDL	BDL		1.0	0.019
10	Chromium Hexavalent	mg/L	BDL	BDL		1.0	0.016
11	Chemical Oxygen Demand (COD)	mg/L	36	39		150	-
12	Conductivity	μS	683	661	671	-	-
13	Copper	mg/L	BDL	BDL		1.0	0.013
14	Cyanide	mg/L	BDL	BDL		1.0	0.022
15	Dissolved Oxygen (DO)	mg/L	5.8	5.5	6.4	-	-
16	Fluoride	mg/L	0.1	0.26		10	-
17	Iron	mg/L	0.06	3.6		8.0	1.0
18	Lead	mg/L	BDL	BDL		0.5	0.065
19	Manganese	mg/L	0.06	0.16		1.5	-
20	Mercury	mg/L	BDL	BDL		0.01	0.0014
21	Nitrate	mg/L	1.4	1.5		-	-
22	Nitrite	mg/L	3.0	8		-	-
23	Nickel	mg/L	BDL	BDL		1.0	0.47
24	Oil & Grease	mg/L	BDL	BDL		10	-
25	pH	-	8.46	8.3	8.7	6-9	6.5-9
26	Phenolic compound	mg/L	BDL	BDL		0.1	-
27	Salinity	mg/kg	300	310	330	-	-
28	Selenium	mg/L	BDL	BDL		0.5	0.005
29	Silver	mg/L	BDL	BDL		1.0	0.0032
30	Sulphate	mg/L	145.7	136.8		600	-
31	Sulphide	mg/L	BDL	BDL		1.0	-
32	Temperature	℃	35	35	38	-	-
33	Total Dissolved Solids (TDS)	mg/L	456	494	400	3500	-
34	Total Suspended Solids (TSS)	mg/L	44	172		200	-
35	Total Toxic Metals	mg/L	0.02	BDL		2.0	-
36	Turbidity	NTU	34	150		-	-
37	Zinc	mg/L	0.02	0.04		5.0	0.12

BDL = Below Detection Limit AI = Acute Level

3.4.1.1. Microbiological analysis of surface water

Table 3 below shows the results of microbiological analysis of surface water.

Table 3: Microbiological Analysis of Surface Water of Nammal Lake Game Reserve

#	Parameter	Units	Sampling Locations		WHO Standard
			SW 1	SW 2	
1	Total Colony Count	Cfu / ml	762	TNTC	<500
2	Total Coli Forms	Cfu / 100ml	TNTC	55	0
3	Fecal E. Coli	Cfu / 100ml	18	07	0
4	Fecal Enterococci / Streptococci	Cfu / 100ml	Absent	Absent	0

TNTC: Too Numerous To Count, **Cfu**: Colony forming unit

The microbiological analysis of surface water shows the high colony forming at both sampling points. In addition to the total colony count, number of total coli forms particularly fecal E. coli was also present in the water samples. Presence of microbial content in water body can be linked to the agricultural run off and sewage discharges leading to the contamination of lake. It is, therefore, concluded that the lake water is heavily contaminated with microbiological elements.

3.4.2. Ground Water Quality Analysis

Ground water quality in the close vicinity of Nammal Lake was also analysed in order to determine its suitability for drinking purposes. Twenty six (26) parameters of concern for drinking water quality were analysed (Fig. 8). These parameters include physical and chemical elements. Microbiological analysis was also conducted to determine the quality of groundwater for drinking purposes. Table 4 below shows the drinking water parameters and the results selected for analysis.

Table 4: Groundwater Quality Parameters

#	Parameter	#	Parameter
1	Arsenic	14	Nitrite
2	Bicarbonate alkalinity	15	Odour
3	Carbonate alkalinity	16	pH
4	Chloride	17	Potassium
5	Chlorine	18	Sodium
6	Colour	19	Sulphide
7	Conductivity	20	Sulphate
8	Cyanide	21	Temperature
9	Fluoride	22	Total Alkalinity
10	Hardness Ca	23	Total Hardness
11	Hardness Mg	24	Total Dissolved Solids (TDS)
12	Iron	25	Total Suspended Solids (TSS)
13	Nitrate	26	Turbidity

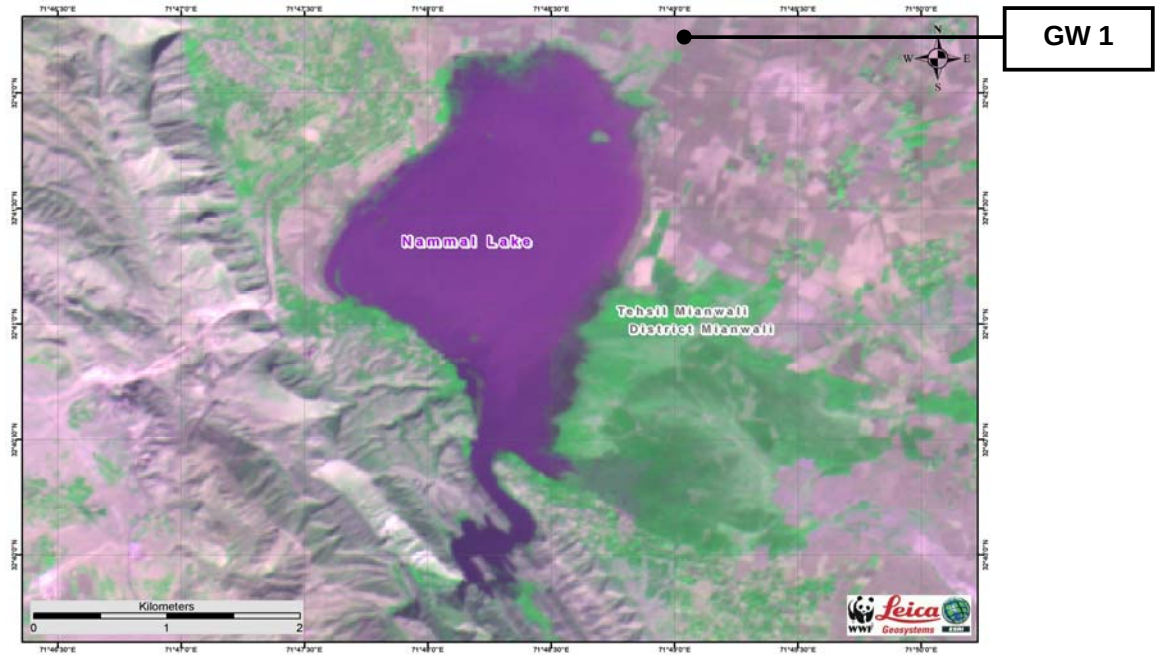


Fig. 8: Groundwater sampling point at Nammal Lake Game Reserve (Water pump at a petrol pump near Nammal Lake (Depth 45 m). N 32^{o} 43'.004, E 071^{o} 49'.013
Time: 1420 hrs (02-08-07)

Sample for groundwater was taken in sterilized bottles and then transported in a portable cooler to the SGS environmental laboratory in Lahore for analysis. The results are compiled and presented below in Table 5. The test results for drinking water were compared with World Health Organization (WHO) drinking water guidelines.

Table 5: Results of groundwater quality test of Nammal Lake

#	Parameters	Units	Nammal Lake	WHO Standards
			GW1	
1	Arsenic	mg/L	BDL	0.01
2	Bicarbonate Alkalinity	mg/L	506.3	-
3	Carbonate Alkalinity	mg/L	BDL	-
4	Chloride	mg/L	1462	250
5	Chlorine	mg/L	BDL	5
6	Colour	*cu*	<1.0	15
7	Conductivity	μS	5640	-
8	Cyanide	mg/L	0.01	0.07
9	Fluoride	mg/L	2.6	1.5
10	Ca-Hardness	mg/L	495	200
11	Mg-Hardness	mg/L	1000	-
12	Iron	mg/L	0.04	0.3
13	Nitrate	mg/L	7.0	50
14	Nitrite	mg/L	2.4	3
15	Odour	TON	Odourless	-
16	pH	mg/L	7.56	6.5 to 8.5
17	Potassium	mg/L	16	-
18	Sodium	mg/L	390	200
19	Sulphate	mg/L	219.3	250
20	Sulphide	mg/L	BDL	-
21	Temperature	°C	28	-
22	Total Alkalinity	mg/L	415	-
23	Total Hardness	mg/L	1495	500
24	Total Dissolved Solids (TDS)	mg/L	2769	1000
25	Total Suspended Solids (TSS)	mg/L	BDL	-
26	Turbidity	NTU	BDL	5

Detailed physical and chemical analysis of groundwater indicates high concentration of fluoride in the groundwater (2.6 mg/l), which was recorded above the WHO recommended values (1.5 mg/l). Fluoride is an essential element and its deficiency results in dental decay while its excess causes pain and tenderness in bones and mottled teeth in children. Fluoride concentration of approximately 1.0mg/l in drinking water effectively reduces dental caries without harmful effects on teeth and body. Sources of fluoride to water are erosion of natural deposits and discharge from fertiliser and aluminium factories. Therefore, fluoride may occur naturally in water or it may be added in control amounts. The concentration of fluoride in the groundwater near Nammal Lake was recorded as 2.6 mg/l as compared to WHO limits of 1.5 mg/l. Likewise high concentration of Sodium and Potassium was observed. Their high concentration in water can be attributed to the sewage and agricultural discharge into the water body. High concentration of sodium in water can be due to the erosion of salt deposits and minerals.

Chloride concentration was also recorded high (1462 mg/l) as compared to the WHO recommended values of 250 mg/l. Chloride is common in areas with limestone deposits, but not found in most other soils, rocks or minerals. The presence of chlorine where it does not occur naturally indicates possible water pollution. Sources of chloride are septic tank effluent, animal waste, and kitchen waste and potash fertilizer. According to WHO,

Chloride in drinking-water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt and saline intrusions. It can contaminate groundwater and can make it unsuitable for human consumption.

The hardness of groundwater was also very high. The total hardness was recorded as 1495 mg/l as compared to the WHO limits of 500 mg/l. The contribution of calcium in hardness was also observed as quite high. The calcium hardness as per WHO should not exceed 200 mg/l in drinking water, whereas, it was recorded as 495 mg/l in the groundwater near Nammal Lake. These all high concentrations contribute to the values of TDS, which was recorded as 2769 mg/l. The maximum recommended values of TDS as per WHO is 1000 mg/l. Moreover, high concentration of theses above mentioned parameters also indicates the human impacts on the water quality.

All other chemical and physical parameters, such as, cyanide, iron, nitrate, nitrite, pH and sulphate were found in reasonable ranges. Arsenic, turbidity, sulphides and odour were found below the detection limits.

3.4.2.1. Microbiological analysis of ground water

As per WHO guideline values for microbial quality of drinking water, *E.coli* or thermo-tolerant coliform bacteria must not be detectable in any 100 ml water sample. Table 6 below shows the results of microbiological analysis of groundwater.

Table 6: Microbiological Analysis of groundwater of Nammal Lake Game Reserve

#	Parameter	Unit	Nammal Lake	WHO Standards
			GW 1	
1	Total Colony Count	cfu/100ml	382	500
2	Total Coli forms	cfu/100ml	01	0
3	Fecal Coli forms / E. Coli	cfu/100ml	Absent	0
4	Fecal Enterococci / Streptococci	cfu/ml	Absent	0

TNTC: Too Numerous To Count, **Cfu**: Colony forming unit

The results show that there is no biological contamination due to fecal E. coli or fecal Enterococci/streptococci in the drinking water sample. The concentration of microbial content in the groundwater was also found within the WHO standard limit. The groundwater is therefore not found contaminated due to microbiological contamination.

3.5. *Flora* of Nammal Lake Game Reserve

The vegetation of the area is sub tropical scrub type with scattered broad-leaved trees, shrubs and a basal grass cover. However the vegetation around the lake was modified due to abundant soil moisture and water salinity. Vegetation of the area is divided into two main categories: Terrestrial and Aquatic.

3.5.1. Terrestrial vegetation

Terrestrial vegetation of the Nammal Lake of the Salt Range was studied during August, 2007. The line transect method was used to study the phyto-sociology of the Lake.

Seven transects were laid around 7 sites of the lake. The transects were laid on the lake bed, the plain area surrounding the lake and the hilly areas adjacent to the lake.

On the bank of the Lake, the grass *Cynodon dactylon* dominated along *Zizyphus mauritiana* and *Aerva javanica*. In the plain sites around the lake, the grass *Cynodon dactylon* was the dominant species along with the co-dominant grasses like *Dichanthium annulatum* and *Brachiaria ramosa*. Herbs like *Conyza bonariensis* and *Peganum harmala* were also abundant in these sites. The hilly sites were dominated by grasses along with shrubs. *Digitaria ciliaris*, *Dichanthium annulatum* and *Eragrostris papposa* were the dominant grass species in these sites. Shrubs *Buxus papillosa* and *Justicia adhatoda* were also dominant in these sites.

A total of 51 plant species belonging to 23 families were recorded from the area. Poaceae was the largest family contributing 7 species of grasses. Papilionaceae contributed 5 species, while Amaranthaceae and Asteraceae were represented by 4 species each. Rhamnaceae contributed 3 species. Acanthaceae, Boraginaceae, Convolvulaceae, Mimosaceae, Solanaceae and Zygophyllaceae had 2 species each. The rest of the families were represented by one species each. Study of the life forms of the species revealed that there were 8 (16%) species of trees, 7 (18%) shrub species, 14 (27%) perennial and 17 (39%) annual herbs.

The mesquite *Prosopis julifora* (Jand) was the most common tree of the area. This small, viciously spiny tree, introduced in the area for its hardy and fast-growing nature has become extremely common. Other common trees were *Acacia modesta* (Phulai), *Acacia nilotica* (Kiker), *Tamarix aphylla* (Farash), *Melia azedarach* (Dhrek), *Zizyphus mauritiana* (Ber), etc. *Salvadora oleoides*, a halophytic shrub-like tree was common in the area and indicated the saline nature of the soil. Among the shrubs *Withania coagulans*, *Dodonea viscosa* (Sanattha), *Justicia adhatoda* (Bhaiker), *Zizyphus nummularia* (Beri), etc. were common in the study area. The herbaceous layer was dominated by grasses, of which *Cynodon dactylon, Digitaria ciliaris, Dactyloctenium aegyptium, Dactyloctenium scindicum, Cenchrus biflorus, Cenchrus ciliaris, Echinochloa colonum, Dichanthium annulatum,* etc. were very common. *Cyperus rotundus,* a sedge was also very frequent. The grasses not only play an important role in the ecosystem of the area, but also provide fodder to the cattle and goats of the people of the area.

Fruit of *Phoenix sylvestris* (Wild Date), *Zizyphus mauritiana* and *Zizyphus nummularia* are edible. The wood of *Prosopis juliflora* (mesquite) is extensively used as a fuelwood and is thus valuable to the local people. *Justicia adhatoda, Withania coagulans, Datura innoxia, Solanum erianthum, Tribulus terrstris*, etc. are used medicinally by the locals.

It was noted that the lake was valuable for the people as well as wildlife of the area. If properly managed, the area can be more productive in terms of agriculture and livestock farming. Efforts should be made to prevent pollution of the lake as a result of human activities.

3.5.2. Algae / Phytoplankton and Aquatic Vegetation

Qualitative and quantitative determinations of Algae is essential for determining the aquatic productivity as algae is the chief source of food for aquatic animals including fishes algae is an important group of Cryptogamic flora, while some species are excellent and others are good producers of food in the food cycle of aquatic ecosystems. Algae is widely distributed and is an important component of various ecosystems like marine, rivers, ponds, streams, dams, lakes etc. Algal flora is also good indicator of pollution.

Algal/phytoplankton species were collected during August, 2007 with the help of boat using phytoplankton net of 5-10 µm mesh. Water samples were collected each time using water sampler (Nansen bottle) for studying physico-chemical features using standard methods (APHA, 1985) and for identification of phytoplankton. Samples were preserved in 4 % formalin solution (Mason, 1967). The species composition was determined by

utremohal method (Lund, 1958). The micro algae (*Ultra nannoplankton*) were not counted as Gorham *et al*., (1974) considering these algae are comparatively not important in high productive lakes. Identification and counts were done using inverted light microscope (BH-2 Olympus using objectives 10^X, 20^X, 40^X, 100^X but usually 20^X and 10^X eye piece was used) and identified with the help of available literature (Tilden, 1910; Husted, 1930; Majeed, 1935; Smith, 1950; Silva, 1954; Desikachary, 1959; Prescott, 1962; Siddiqi & Farooqi, 1964; Patrick, 1966; Philpose, 1967; Islam & Tahmida, 1970; Tiffany & Briton, 1970; Vinyard, 1979; Akiyama & Yamagishi, 1981; Shameel, 2001).

The lake provide characteristic marshy lands to support aquatic vegetation such as *Carex fedia, Hydrilla verticillata, Juncus* sp, *Phragmites karka, Potamogeton crispus, Saccharum spontaneum, Typha angustata, Vallisneria spiralis* and *Zannichellia palustris*.

A total of 30 algal/phytoplankton samples were collected from the study area. A total of 99 algal/phytoplankton species belonging to 45 genera of the 6 phyla (Cyanophyta, Volvocophyta, Bacillariophyta, Chrysophyta, Dinophyta and Chlorophyta) were recorded. Water is rich in primary productivity of algal/phytoplankton species. The abundance of algal species revealed that the ratio of gasses was high, which is considered beneficial for aquatic organisms, fish and other fauna. Temporarily algal species/phytoplankton and aquatic life is disturbed due to tides, turbid water (with suspended salt), material, silt, sand particles etc. Different species have different importance as some of the species are used as medicines, nitrogen fixing, vitamins, toxics, oil, pollution, water quality, hardness, salinity, and alkalinity as well as for food purposes. Table 7 describes the distribution of algae / phytoplankton in Nammal Lake.

Table 7: Distribution of Phytoplankton/Algal species in Nammal Lake, Salt Range, Punjab

Kingdom	Phylum	Class	Order	Family	Genera	Species	Percentage%
Monera	Cyanophyta	2	2	2	13	32	32.3
Protista	Volvocophyta	2	2	5	11	33	33.3
	Bacillariophyta	1	2	8	14	24	24.2
	Chrysophyta	1	1	1	1	1	1.1
	Dinophyta	1	1	1	1	3	3.1
Protoctista	Chlorophyta	3	4	4	5	6	6
Total: 3	6	10	12	21	45	99	100

3.6. Fauna of Nammal Lake Game Reserve

3.6.1. Large mammals of Nammal Lake Game Reserve

Wetlands are highly productive communities and provide habitat and food resources to a wide range of species. They have a high level of nutrients and coupled with the availability of water as a result they provide ideal habitat for fish, amphibians, shellfish, and insects. Additionally, many birds and mammals rely on wetlands for food, water, breeding grounds, and shelter.

Large mammals were surveyed in Nammal Lake during August 2007 in order to establish baseline regarding their diversity and abundance in the study area. Direct sighting as well as indirect methods i.e. signs of their presence in the study area, are used for large mammals survey.

Line transect: Large mammal studies were carried out on direct observations of the animal itself and on indirect observations of the animal's activities, such as scats, footprints and feeding signs. Transect lines were not more than one Kilometre in length, subdivided into less than 500 m. Each transect line was recorded by Geographical Positioning System (GPS) receiver.

Spotlight: Transect counts of animals by using spotlight is a best method for nocturnal mammals but spotlight counts have its own limitations. Most importantly, where animal density is low, it is very hard to detect a species presence. Survey was conducted on 4x4 vehicles from 09:00 pm to 01:00 am; and also walk through the habitat with portable search light. Vehicle speed was maintained at 10-15 km/hr to maximise the chance of sighting. Number of species observed during the survey and their geographical positions were recorded on every sighting.

The habitat at Nammal has the potential for large mammals. During the survey (Table 8), several of the inhabitants of the area as well as Wildlife Watchers were interviewed about the presence of different mammalian species. During survey of large mammals at Nammal Lake, only Asiatic Jackal (*Canis aureus*) and Indian Fox (*Vulpes bengalensis*) were recorded. A single Indian Fox was observed.

Table 8: Mammalian fauna of Nammal Lake observed during the study period

#	Scientific Name	Common Name	Order	Status
1	*Canis aureus*	Asiatic Jackal	Carnivora	Common
2	*Lepus capensis*	Cape Hare	Lagomorpha	Common
3	*Herpestes edwardsi*	Mongoose	Carnivora	Rare

3.6.2. Small mammals of Nammal Lake Game Reserve

There is a long association between human and rodents. The rodents are the severe pests of the crops. They cause damage in a number of ways including damage of crops in the fields, grain damage in storage and structural damage in houses, shops and commercial areas. The extent of damage ranges from 5 % up to 43 % in wheat in central Punjab. Rats are also carrier of different type of diseases through ecto- and endo-parasites e.g. fleas, ticks and mites etc. which cause plague, oriental sore and rat bite fever.

Small mammals include the non game wildlife and hence unfortunately are given less attention. They however, form an indispensable component of the fauna of any ecosystem. They hold an important position in the interlocking web of eating and being eaten and therefore play an important role in determining the holding capacity and supporting the number of animals at different trophic levels of the food chain. The rodents, the insectivores, the bats, the mongooses, and the hedgehogs not only ensure the ecological balance required for any self sustained ecosystem but also play their specific role in the biological control of that area.

These small animals fill almost every niche and depend upon variety of food of submerged roots, fallen seeds, rhizomes and bulbs, insects, snakes, scorpions, spiders and beetles. The diversity in the feeding habits of these animals has multiple implications. They feed on insects and as a result control the insect population and agriculture pests of the area at one hand and on the other hand they consume grains, rhizomes, underground or submerged roots and are serious agriculture pests that inflict substantial damage to the farmers. However, in the living system of nature, no component operates in isolation. There are enough predators like foxes, Jackals, cats, owls wolves, lizards and above all snakes, which feed on small mammals and bring the population of these animals to a sustainable level as they are being eaten up by other animals living in that particular ecosystem.

Small mammal survey was carried out during August, 2007 at Nammal Lake Game Reserve in order to establish baseline regarding their diversity and abundance in the study area. Different methods were used to study small mammals in the study area.

Bait used: A mixture of different food grains mixed with fragrant seeds was used as bait for the attraction of the small mammals. Wheat and rice were used as food grains while peanut butter, coriander, oats and onion were used for fragrance. This bait was found highly successful in the study area probably due to overall food shortage and also because of ingredients used for fragrance. Freshly prepared bait was used on every trapping day. Only small amount of bait was put on the rear side of the traps. The care was taken while putting the bait in the rear side of the trap to make sure that bait was placed on the platform fitted on the rear side of the trap for this purpose.

Traps and trapping procedure: Sherman and snap traps and mist nets were used for the present studies to collect the specimens. Fifty traps were set at a specific area on a line approximately 500 m long and traps were set approximately 10 m apart. Each trap was marked by a colourful ribbon to locate the traps easily. The traps were set in the afternoon and checked early in the morning. The specimens were transferred in a polythene bag and were identified in the field and released. The specimens with some doubt were preserved in 10 % formalin and brought to laboratory and identified using identification keys. At least one specimen of each species was preserved as voucher specimen.

Snap traps: Snap traps were also used in selected areas. Fifty traps were set along a line transect of 250 m with each trap 5 m apart. The specimens trapped in snap traps were used as voucher specimens and were placed in mammal's repository of Pakistan Museum of Natural History, Islamabad.

A total of 10 species of small mammals were recorded during the study period from Nammal Lake Game Reserve (Table 9). Table 9 describes the taxonomic and ecological characteristics of the small mammals of the Nammal Lake, whereas Table 10 describes the comparative existence of small mammals with other lakes of the Salt Range.

Table 9: Taxonomic and ecological characteristics of the small mammals of Nammal Lake

#	Scientific Name	Order/Family	English Names	Local name	Feeding Habit	Activity Pattern
1	*Mus musculus*	Rodentia/ Muridae	Common House mouse	Choohi	GRN	NC
2	*Rattus rattus*	Rodentia/ Muridae	Common Rat	Chooha	GRN	NS
3	*Gerbilus nanus*	Rodentia/ Muridae	Baluchistn gerbil	Chooha	GRN	NS
4	*Funambulus pennantii*	Rodentia/ Petromidae	Palm Squirrel	Gulehri	GRN	DR
5	*Hystrix cristatus*	Rodentia/ Hystricidae	Indian Crested porcupine	Seh	HER	NC
6	*Herpestes edwardsi*	Carnivora/ Herpestidae	Common Indian Mongoose	Neola	CAR	DR
7	*Herpestes javanicus*	Carnivora/ Herpestidae	Small Indian Mongoose	Neola	CAR	DR
8	*Hemiechinus collaris*	Insectivora/ Erinaceidae	Long-eared hedgehog	Kundyara Chooha	CAR	NC
9	*Lepus nigricolis*	Lagomorpha/ Leporidae	Indian Hare	Khargoash	HER	NC
10	*Scotophilus heathii*	Chiroptera/ Vespertilionidae	Common Yellow-bellied Bat	Chumgadar	INS	NC

GRN=Granivore, CAR=Carnivore, HER=Herbivore, INS=Insectivore, FRU=Fruitivore, NC=Nocturnal, DR=Diurnal, NS=Non-specific,

Table 10: Comparative existence of small mammals of Nammal Lake with other lakes of the Salt Range Wetlands Complex

#	Scientific Name	Kallar Kahar Lake	Khabekki Lake	Uchhali lake	Jahlar Lake	Nammal Lake
1	*Bandicota bengalensis*	+	+	-	-	-
2	*Millardia meltada*	+	-	+	-	-
3	*Mus musculus*	+	+	+	+	+
4	*Rattus rattus*	+	+	+	+	+
5	*Tatera indica*	-	+	+	-	-
6	*Gerbilus nanus*	-	-	-	+	+
7	*Funambulus pennantii*	+	+	+	+	+
8	*Hystrix cristatus*	+	+	+	+	+
9	*Herpestes edwardsi*	+	+	+	+	+
10	*Herpestes javanicus*	+	+	+	+	+
11	*Vivera indica*	+	+	+	+	-
12	*Hemiechinus collaris*	+	+	+	+	+
13	*Lepus nigricolis*	+	+	+	+	+
14	*Suncus murinus*	+	-	+	-	-
15	*Pteropus giganteus*	+	-	-	-	-
16	*Scotophilus heathii*	+	+	+	+	+
17	*Hipposideros cineraceus*	+	-	-	-	-

3.6.3. Avifauna of the Nammal lake Game Reserve

The Salt Range is only the 2nd region in Pakistan where six Galliformes species coexist with each other. They are the Grey and Black Francolins, Chukar, See see Partridge, Common Quail and Rain Quail (Birdwatcher Club, 2006). Other species which are encountered in Salt Range are Blue tailed Bee-eater; Blossom headed Parakeet, Indian Courser, Spotted Dove, Brahminy Starlings, Asian Pied Starling, Little Crake, and the Ruddy Crake. Buntings, Redstarts, and the White throated fantail also visit the area.

In order to determine the diversity of the bird species dependent on the Nammal Lake Game Reserve, a comprehensive survey was carried out during August 2007.

The Nammal Lake was visited early mornings and late evenings to record the bird species. Point count method (Bibby and Burgess, 1992; William and Sutherland, 1996) was used and 20 points were selected randomly at each lake/catchment area. Aided with binocular (12x50) and spotting scope (15x60), the birds were identified following Ali and Ripley (1987), Woodcock (1980), and Roberts (1991 and 1992). The care was taken that sun should always be on the back, so that the plumage patterns of the birds could be distinguished. Data were recorded on pre-designed data sheets.

A total of 45 bird species belonging to 13 orders and 31 families/subfamilies were recorded from Nammal Lake (Table 11). Approximately 80% of the species recorded were resident/breeding in the area. The species with highest densities were Red-wattled lapwing (11.39), Common Myna (10.6), House Crow (7.82), Common Swallow (6.36), Pond Heron (5.96) and Little Green Bee-eater (5.92). The least common species were Sparrow Hawk, Large Egret, Night Heron, Common Kestrel, Pheasant Crow and Tailor Bird.

The Salt Range has rich and varied bird faun that belongs to Oriental, Palaearctic and Ethiopian regions. Majority of the recorded resident species were Oriental in origin. Roberts (1991) reported that this proportion increased in summer and monsoon due to summer migrants; perhaps being attracted post monsoon insect abundance and green vegetative shelters.

Among the resident species, House Crow, House Sparrow, Common Myna, Indian Kite, Purple Sunbird, Red-vented Bulbul, White-cheeked Bulbul, Red-wattled Lapwing, Black-

winged Stilt, Cattle Egret, Pond Heron, Black Drongo, were very common. Black-shouldered Kite, Grey Partridge, Common Kestrel, Pheasant Crow, White-breasted Kingfisher, Bush Chat, Sparrow Hawk, Indian Nightjar, Pied Kingfisher, and Tailor Bird were recorded as rare in the area. Spotted Munia was recorded as rare in Salt Range but Roberts (1992) recorded it as locally frequent.

Black-winged Stilt was recorded in small groups from the boundaries of the lakes. Ali and Ripley (1987) recorded it as winter visitor to northwest Pakistan while Roberts (1991) recorded it as resident but it shows local migration under the stress of water conditions. Common Swallow is widely distributed and recorded abundantly during the survey. According to Roberts (1992), it is winter visitor and resident species.

Night Heron and Large Egret are local migrants (Roberts, 1991). They migrate according to the water conditions. Among the summer visitors, Little Green Bee-Eater, Common Koel, Great Grey Shrike, and Blue-cheeked Bee-eater, were recorded; only Little Green Bee-Eater was found in good numbers, while all other recorded as rare/occasional birds. Blue-cheeked Bee-eater is a common summer visitor to Salt Range but it was recorded only at Nammal Lake. It has oriental origin found widely in Southeast Asia, migrates from southeast China, India, wintering in the Celebes, Philippines, and is summer migrant to Punjab and Northwest Pakistan (Ali and Ripley, 1987; Roberts, 1991).

Among the passage migrant, only Asian Paradise Flycatcher was recorded. According to Lillah (1991), Paradise Flycatcher is a rare summer migrant to Salt range but Roberts (1992) recorded it as passage migrant. According to Ali and Ripley (1987), it is common summer visitor to Punjab.

Among the winter visitors, Coot, Common Sandpiper, and Ruffous-backed Shrike were recorded. They perhaps migrated earlier and observed in study area in first week of August 2007 or it is also possible that may be they stay here throughout the year.

Table 11: List of birds observed during survey (August 2007) at Nammal Lake

Order	Family	Scientific Name	English Name	Habits	Breeding	Status
Accipitriformes	Accipitridae	*Elanus caeruleus*	Black shoulder Kite	R	+	C
		Milvus migrans	Indian Kite	R	+	C
		Accipiter badius cenchroides	Shikra or Sparrow Hawk	R	+	C
Caprimulgiformes	Caprimulgidae	*Caprimulgus asiaticus*	Indian Nightjar	R	+	C
Charadriiformes	Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt	R	-	A
	Charadriidae	*Hoplopterus indicus*	Red-wattled Lapwing	R	+	A
	Tringinae	*Actitis hypoleucos*	Common Sand Piper	W	-	C
Ciconiformes	Ardeidae	*Egretta garzetta*	Little Egret	R	+	C
		Bubulcus ibis	Cattle Egret	R	+	C
		Egretta intermedia	Intermediate Egret	R	+	F
		Egretta alba	Large Egret	LM	_	C
		Ardeola grayii	Pond Heron	R	+	C
		Nycticorax nyctiocorax	Night Heron	LM/R	+	C
Columbiformes	Columbidae	*Streptopelia decaocto*	Ringed or Collard Dove	R	+	A
		Streptopelia senegalensis	Little brown Dove	R	+	A
Coraciiformes	Alcedinidae	*Halcyon smyrnensis*	White breasted Kingfisher	R	+	C
		Ceryle rudis	Pied Kingfisher	R	+	C
	Meropidae	*Merops orientalis*	Little green Bee-eater	SM	+	A
		Merops superciliosus	Blue-cheeked Bee-eater	SM	-	C
	Coraciidae	*Coracias benghalensis*	Indian Roller or Blue Jay	R	+	C
Cuculiformes	Cuculidae	*Eudynamys scolopacea*	Common Koel	SM	-	C
		Centropus sinensis	Pheasant Crow	R	+	C
Falconiformes	Falconidae	*Falco tinnunculus*	Common Kestrel	R	-	C
Galliformes	Phasianaidae	*Francolinus pondicerianus*	Grey partridge	R	+	C
Gruiformes	Rallidae	*Gillinula chloropus*	Water hen or Moorhen	R	+	A
	Turnicidae	*Fulica atra*	Coot	W	-	A
Podicipediformes	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe	R	+	C
Strigiformes	Strigidae	*Bubo bubo*	Eagle Owl	R	+	F
Passeriformes	Corvidae	*Corvus splendens*	House Crow	R	+	A^+
		Dendrocitta vagabunnda	Indian Tree-pie	R	+	C
	Dicruridae	*Dicrurus macrocerus*	Black Drongo	R	+	A
	Estrildidae	*Lonchura punctulata*	Spotted Munia	R	?	F
	Hirundinidae	*Hirundo rustica*	Common Swallow	W/R	_	A
	Laniidae	*Lanius excubitor*	Great grey Shrike	SM	+	C
		Lanius schach	Ruffous-backed Shrike	W	-	F
	Monarchidae	*Terpsiphone paradisi*	Asian Paradise Flycatcher	PM	-	C
	Nectariniidae	*Nectarinia asiatica*	Purple sunbird	R	+	C
	Passeridae	*Passer domesticus*	Common Sparrow	R	+	A^+
	Ploceidae	*Ploceus philippinus*	Indian Baya	R	?	A
	Sturnidae	*Acridotheres tristis*	Common Myna	R	+	A^+
	Sylviidae	*Orthotomus sutorrus*	Tailor bird	R	?	C
	Timaliidae	*Turdoides caudatus*	Common Babbler	R	+	A
	Turdinae	*Saxicola caprata*	Pied stone-chat or bush-chat	R	+	C-A
	Pycnonotidae	*Pycnonotus leucogenys*	White cheeked Bulbul	R	+	A
		Pycnonotus cafer	Red vented Bulbul	R	+	A

Note: For all the birds status is given in Roberts (1991 & 1992). **Habit:** R = resident, W = wintering, I = irregular year round visitor, OM = ordinary migrant, V = vagrant, SM = summer migrant, PM = passage migrant, **Breeding:** + = breed in the area, - = does not breed in the area, **Status:** A = abundant, A^+ = very abundant, F = frequent, C = common, U = uncertain, S = scarce, SR = scare becoming rare, R = rare F-C = frequent to common, C-A = common to abundant

3.6.4. Fish fauna of Nammal Lake Game Reserve

A survey of fish fauna of Nammal Lake Game Reserve was carried out during August 2007. The cast netting technique supplemented by gill netting technique was used while studying the fish biodiversity in Nammal Lake Game Reserve.

Cast and Gillnet Technique: Sampling was made in the selected area covering all the representative habitats of the study area. Fishes were collected using cast nets of two different mesh sizes (small one having mesh size of 1 cm x 1 cm and having a circumference of 9 m and the large one with mesh size of 2.5 cm x 2.5 cm and with a circumference of 14 m.) so that the fish fauna of all the age classes could be collected and represented. Ten nets of each mesh size were casted on four sides of the lakes along a line transect of about 200 m.

The collected fish specimens were preserved in 10 % formaldehyde solution in the field. Large specimens were given an incision in the belly to ensure proper preservation. The specimens were identified in the laboratory and taxonomical checklists along with local names were compiled (Table 12, Table 13).

Barilius vagra, Barilius pakistanicus, Garra gotyla, Cyprinion watsoni, Tor putitora, Crossocheilus lratius, Labeo dero, Puntius vittatus, Schistura punjabiensis, Gambusia affinis, Mastacembelus armatus are the common fish species found in the Salt Range Wetlands.

The fish fauna of the Salt Range as a whole has never been fully described. Day (1872) made only a cursory remark about the fishes from Choa Saiden Shah and some adjoining streams. Hora (1923) listed all the species then known from the Salt Range and described the following species collected by him from Pind Dadan Khan Tehsil of Jhelum District:

1. *Garra montissalsi* Hora
2. *Scaphiodon readingi* Hora
3. *Labeo sindensis* (Day)
4. *Crossocheilus latius* (Hamilton)
5. *Barbus terio* (Hamilton)
6. *Barbus punjabensis* Day
7. *Barbus for* (Hamilton)
8. *Barilius vagra* (Hamilton)
9. *Noemacheilus punjabensis* Hora
10. *Ophiocephalus gachua* Hamilton

Out of the three new species described by Hora only one, *viz., Noemacheilus* (=Schistura) *punjabensis,* seems to be a valid species, while *Scaphiodon readingi* and *Garra montissalsi,* have been merged with *Cyprinion watsoni* (Day) and *Garra gotyla* (Gray) respectively by subsequent authors (Berg, 1949; Menon, 1964; Mirza, 1969).

Purthi (1933) listed the following species from Khewra Gorge

1. *Barillus vagra* (Hamilton)
2. *Barbus punjabensis* Day
3. *Chela punjabensis Day*
4. *Crossocheilus latius* (Hamilton)
5. *Garra montissalsi* Hora
6. *Scaphiodon readingi Hora*

Among the fishes listed above, the following species are not represented in the present collection from salt range lakes.

1. *Barbus (= Puntius) punjabensis Day*
2. *Barbus (= Puntius) terio* (Hamilton)
3. *Chela (= Salmostoma) punjabensis* Day
4. *Noemacheilus punjabensis* Hora
5. *Ophiocephalus (= Channa) gachua* Hamilton

Indigenous fish fauna of Nammal Lake

Barilius vagra, Barilius pakistanicus, Cyprinion watsoni, Crossocheilus latius, Labeo dero, Mastacembelus armatus are the indigenous fish fauna of the Nammal Lake.

Introduced fish fauna of Nammal Lake

1. *Cirrhinus mrigala* (indigenous)
2. *Labeo rohita* (indigenous)
3. *Channa morulius* (indigenous)
4. *Cyprinus carpio* (exotic)
5. *Hypophthalmichthys molitrix* (exotic)
6. *Hypophthalmichthys nobilis* (exotic)
7. *Ctenopharyngodon idella* (exotic)
8. *Oreochromis mossambicus.* (exotic)

Table 12: Comparison of fish fauna found in or nearby streams of different lakes of Salt Range Wetlands Complex.

#	Scientific Name	Common Name	Fish Fauna found in or around:				
			Nammal Lake	Uchhali Lake	Khabekki Lake	Jahlar Lake	Kallar Kahar Lake
1	*Barilius vagra*	Chilwa	+	-	+	-	-
2	*Barilius pakistanicus*	Pakistani Chilwa	+	+	+	+	-
3	*Garra gotyla*	Pathar Chat	-	-	+	-	-
4	*Cyprinion watsoni*	Sabzug	+	+	+	+	+
5	*Tor putitora*	Mahaseer	-	-	+	-	-
6	*Crossocheilus lratius*	Dogra	+	+	+	-	+
7	*Labeo dero*	Chhali	+	-	-	-	-
8	*Puntius vittatus*	Popra	-	-	-	-	+
9	*Schistura punjabiensis*	Sundali	-	-	+	-	-
10	*Gambusia affinis*	Gambusia	-	+	-	-	-
11	*Mastacembelus armatus*	Bam	+	-	-	-	-

Table 13: Comparison of fish fauna being reared in different lakes of Salt Range Wetlands

#	Scientific name	Common name	Fish Fauna introduced in:				
			Nammal Lake	Uchhali Lake	Khabekki Lake	Jahlar Lake	Kallar Kahar lake
1	*Cirrhinus mrigala*	Mori	+	-	+	-	-
2	*Labeo rohita*	Rohu	+	-	+	-	-
3	*Cyprinus carpio*	Common carp	+	-	+	-	+
4	*Hypophthalmichthys molitrix*	Silver carp	+	-	+	-	-
5	*Hypophthalmichthys nobilis*	Bighead carp	+	-	-	-	-
6	*Ctenopharyngodon idella*	Grass carp	+	-	+	-	-
7	*Oreochromis mossambicus*	Tilapia	+	-	-	-	+
8	*Channa morulis*	Soul	+	-	-	-	-

3.6.5. Amphibian and reptiles of Nammal Lake Game Reserve

Amphibians and reptiles are very important animals among the vertebrates. Amphibians show the transition of aquatic and terrestrial life. The animals that invaded land, reptiles were the first fully terrestrial forms of life. Apart from their impressive evolutionary history, they beautifully demonstrate different concepts of physiological and behavioural adaptation to different climates, from tropical forests to hot desert and marine to freshwater. They have not the ability to travel long distances like birds and mammals. In response to any local environmental changes they respond quickly and therefore may act as excellent biological indicators.

There are standard methods for the studies of Amphibians and Reptiles. These include: active searching and pit-fall trapping. For the "Active Searching" and "Pit-fall Trapping" requisite activities that include Observations, Identification, Collection and Preservation, were made as per study plan. The specimens were identified with the help of most recent keys available in literature (Khan, 2003, 2006).

Several of the localities of the lake including its buffer zone and the core area with different ecological features, were surveyed in summer during August 2007 for the presence of amphibians and reptiles. Both diurnal and nocturnal surveys were arranged and every possible method was employed for the observation and collection of amphibians and reptiles.

Out of 36 possibly occurring amphibian and reptilian species of the area, 10 species were observed or collected. The remaining species have been recorded through secondary data obtained through discussions with the local inhabitants and consulting the previous citations (Table 14). The amphibians are represented by six species belonging to six genera and three families. Among the reptiles, chelonians are represented by a single species belonging to family Trionychidae. Lizards outnumber all the groups of reptiles in the study area and are represented by 16 species belonging to 13 genera and seven families. Snakes are the second dominant group of herpetiles represented by 13 species belonging to 12 genera and six families.

Table 14: Amphibian and reptilian diversity recorded from Nammal Lake Game Reserve

#	Species Name	Taxonomic Position	English / Vernacular Name	Activity Pattern	Status	Feeding Habits
01	*Bufo stomaticus* * (Lütken, 1862)	Class: Amphibia Order: Anura Family: Bufonidae	Marbled Toad/ Daddo	Non-specific (Mostly nocturnal)	A	Insectivore
02	*Hoplobatrachus tigerinus* * (Daudin, 1803)	Class: Amphibia Order: Anura Family: Ranidae	Bull-frog/ Daddo	Nocturnal	C	Insectivore
03	*Euphlyctis c. cyanophlyctis* * (Schneider, 1799)		Skittering frog/ Daddo	Non specific (Mostly nocturnal)	C	Insectivore
04	*Fejervarya limnocharis* ** (Boie, 1834)		Alpine cricket frog/ Daddo	Nocturnal		Insectivore
05	*Sphaeroteca breviceps* ** (Schneider, 1799)		Burrowing frog/ Daddo	Nocturnal		Insectivore
06	*Microhyla ornata* ** (Dumèril & Bibron, 1841)	Class: Amphibia Order: Anura Family: Microhylidae	Ant frog/ Daddo	Nocturnal		Insectivore
07	*Lissemys punctata andersoni* ** (Webb, 1980)	Class: Reptilia Order: Chelonia Family: Trionychidae	Indian flap-shell/ Karkooma	Diurnal		Omnivore (mostly carnivore)

#	Species Name	Taxonomic Position	English / Vernacular Name	Activity Pattern	Status	Feeding Habits
08	*Uromastyx hardwickii* ** (Gray, 1827)	Class: Reptilia Order: Sauria Family: Uromastycidae	Spiny-tailed ground lizard/ Shaana	Diurnal		Herbivore
09	*Eublepharis macularius* ** (Blyth, 1854)	Class: Reptilia Order: Sauria Family: Eublepharidae	Fat-tail gecko/ Bindowa	Nocturnal		Insectivore
10	*Calotes v. versicolor* * (Daudin, 1802)	Class: Reptilia Order: Sauria Family: Agamidae	Indian garden lizard/ Sedar	Diurnal	C	Insectivore
11	*Laudakia m. melanura* ** (Stoliczka, 1872)		Black rock agama/ Pahari Bindowa	Diurnal		Insectivore
12	*Trapelus agilis agilis* ** (Oliver, 1804)		Brilliant agama/ Korr Kirili	Diurnal		Insectivore
13	*Hemidactylus flaviviridis* * (Rüpell, 1835)	Class: Reptilia Order: Sauria Family: Gekkonidae	Yellow-bellied house gecko/ Korr Kirili	Nocturnal	A	Insectivore
14	*Hemidactylus brookii* ** (Gray, 1845)		Spotted Indian house gecko/ Korr Kirili	Nocturnal		Insectivore
15	*Cyrtopodion scaber* * (Heyden in: Rüpell, 1827)		Keeled rock gecko/ Korr Kirili	Nocturnal	R	Insectivore
16	*Cyrtopodion montiumsalsorum* ** (Annandale, 1913)		Salt-range ground gecko/ Korr Kirili	Nocturnal		Insectivore
17	*Acanthodactylus cantoris* ** (Günther, 1864)	Class: Reptilia Order: Sauria Family: Lacertidae	Indian fringe-toed sandy lizard/ Kirili	Diurnal		Insectivore
18	*Mesalina watsonana* ** (Stoliczka, 1872)		Long-tailed desert Lacerta/ Kirili	Diurnal		Insectivore
19	*Ophisops jerdonii* ** (Blyth, 1853)		Punjab snake-eyed Lacerta/ Kirili	Diurnal		Insectivore
20	*Eutropis dissimilis* * (Hallowell, 1860)	Class: Reptilia Order: Sauria Family: Scincidae	Striped grass skink/ Salpeeti	Diurnal	C	Insectivore
21	*Ablepharus pannonicus* ** (Fitzinger, 1823)		Red-tailed snake-eyed skink/ Kirili	Diurnal		Insectivore
22	*Varanus bengalensis* * (Daudin, 1802)	Class: Reptilia Order: Sauria Family: Varanidae	Bengal monitor/ Gho	Non specific (Mostly diurnal)	A	Carnivore
23	*Varanus griseus koniecznyi* ** (Mertens, 1954)		Indo-pak desert monitor/ Gho	Non specific (Mostly diurnal)		Carnivore
24	*Leptotyphlops macrorhynchus* ** (Jan, 1862)	Class: Reptilia Order: Serpentes Family: Leptotyphlopidae	Beaked thread snake/ saanp	Non specific		Decompose org. matter
25	*Ramphotyphlops braminus* ** (Daudin, 1803)	Class: Reptilia Order: Serpentes Family: Typhlopidae	Brahminy blind snake/ saanp	Non specific		Decompose org. matter
26	*Eryx johnii* ** (Russell, 1801)	Class: Reptilia Order: Serpentes Family: Boidae	Indian sand boa/ Doomoi	Nocturnal		Carnivore
27	*Amphiesma stolatum* ** (Linnaeus, 1758)	Class: Reptilia Order: Serpentes Family: Colubridae	Striped keel-back/ saanp	Diurnal		Carnivore
28	*Platyceps v. ventromaculatus* ** (Gray and Hardwicke, 1834)		Glossy-bellied racer/ saanp	Nocturnal		Carnivore
29	*Platyceps r. rhodorachis* ** (Jan, 1865)		Cliff racer/ saanp	Diurnal		Carnivore
30	*Ptyas m. mucosus* * (Linnaeus, 1758)		Rope snake or Dhaman/ Chuhimaar	Diurnal	A	Carnivore

#	Species Name	Taxonomic Position	English / Vernacular Name	Activity Pattern	Status	Feeding Habits
31	*Spalerosophis atriceps* ** (Fischer, 1885)		Red-spotted diadem snake/ Chiriamaar	Nocturnal		Carnivore
32	*Xenochrophis p. piscator* ** (Schneider, 1799)		Checkered keel-back	Non specific		Carnivore
33	*Bungarus c. caeruleus* ** (Schneider, 1801)	Class: Reptilia Order: Serpentes Family: Elapidae	Indian or common Krait/ Sangchoor	Nocturnal		Carnivore
34	*Naja n. naja* ** (Linnaeus, 1758)		Black Cobra/ Chajliwala saanp	Non specific (mostly diurnal)		Carnivore
35	*Echis carinatus sochureki* * (Stemmler, 1969)	Class: Reptilia Order: Serpentes Family: Viperidae	Sochurek's saw-scaled viper/ Pissi	Nocturnal	A	Carnivore
36	*Daboia r. russelii* ** (Shaw and Nodder, 1797)		Russell's chain viper/ Dhai Garrhi	Nocturnal		Carnivore

Abundant (A) = Collected/ observed at more than 5 sites
Common (C) = Collected/ observed at 2-5 sites
Rare (R) = Collected/ observed at single site
(*) = Species observed/collected by the author
(**) = Species reported in literature/ secondary data

Out of all the Salt Range Lakes, Nammal Lake is represented by 10 species (richness), due to greatest evenness value of 0.937, the Lake have the most productive herpetofauna associated habitat with the highest Shannon Diversity Index of 2.473. Uchhali Lake represents the second highest evenness (0.2366) and diversity index of 2.366, Jahlar Lake being at third place with richness (14), evenness (0.8194) and Shannon Diversity Index of 2.199. The Kallar Kahar and Khabekki Lakes are least diverse of all the five lakes with Shannon Diversity Indices of 2.145 and 1.915 respectively.

4.0. Social Environment

4.1. Introduction

The socio-economic study of Nammal Lake Game Reserve was conducted to determine the socio-economic conditions of the local people and their dependence on natural resources of the area. Both secondary and primary data was collected for the study. Primary data was collected through household survey and RAPPAM questionnaires, whereas secondary data was collected through maps and literature revivew. This data further helped in identifying major interventions for the development of Management Plan of the Nammal Lake Game Reserve.

4.2. Pressures on the lake and objectives of the study

Some of the pressures identified during the secondary data review include:

1. Livestock grazing in Kacha land and on mountains surrounding the lake.
2. Non Timber Forest Product (NTFP) collection from the forests on the mountains.
3. Fishing in Nammal Lake.

This study provides information regarding socio-economic conditions of the villages next to Nammal Lake. The main objective behind the study was to map the socio-economic information including demography, settlement, livelihoods and natural resource use of Nammal Lake.

4.3. Methodology

The study utilised both secondary and primary data in order to establish a snapshot overview of the socio-economic situation of Nammal Lake. Initially, secondary data was collected through different sources such as maps and District Census Reports (DCRs) to determine the number of villages in close proximity to the Lake. Nammal and Rekhi villages were selected for survey as they met the village selection criteria developed by the team. Primary data was collected with an overall sample size of 9.5%. Primary data was collected through an open ended questionnaire from the government departments of district Mianwali to corroborate the secondary data about the selected villages. Household data from the selected villages around the lake was collected through a household questionnaire through an overall sample size of 3 %[2]. Data regarding the criteria for wealth classification and percentage of these classes was collected through Focus Group Discussions (FGDs). Information was also gathered from various government departments and NGOs using a semi-structured questionnaire. A modified Rapid Assessment and Prioritisation of Protected Areas Management (RAPPAM)[3] questionnaire was also used to determine human pressures and threats to the Nammal Lake.

4.3.1. Secondary Data

Reference material consulted during the survey included:

1. District Census Report Mianwali 1998 (Government of Pakistan)
2. 1998 Census Report of Pakistan (Government of Punjab)

[2] The sample size is not a scientific representation but has been taken arbitrarily keeping in view the time and resource constraints of the survey.

[3] Rapid Assessment and Prioritisation of Protected Areas Management is a methodology developed by WWF – International to determine the effectiveness of management system of Protected Areas.

3. The Punjab Wildlife Act 1974 – 1991
4. Socio-economic baseline of Taunsa Barrage Wildlife Sanctuary 2006 (by Salma Omar and Aamir Saeed)
5. WWF Rapid Assessment and Prioritisation of Protected Areas Management, (by J. Ervin, 2003.)
6. IUCN Directory of South Asian Protected Areas (compiled by Derek A. Scott)

4.3.2. Primary Data

Primary data was collected by using different tools including:

1. Developing selection criteria for identifying core villages around the lake and household questionnaires.
2. Visit to different Government and non government organisation for data collection through semi-structured interviews/questionnaires.
3. Data collection through RAPPAM questionnaire from Government and Non Governmental organisations
4. Focus Group Discussions

Selection criteria and selection of Villages: Following selection criterion was developed to select villages (Table 15) for socio-economic assessment of the Nammal Lake Game Reserve:

1. Distance from the Game Reserve
2. Number of Households
3. Distance from the Lake.

On the basis of the above mentioned criteria following villages were selected:

Table 15: Villages in the vicinity of the lake

Village	Number of HHs	Distance from the Lake (km)
Dhok Ali Khan	150	3
Dhok Ayub	150	5
Dhok Khalim Zail	150	7
Dhonaka	250	5
Nammal	150	1.5
Rekhi	300	1

(Source: NRSP Site Office)

Villages Nammal and Rekhi were selected for data collection:

The data provided by the DCR regarding the demography of the Nammal village surveyed is given in Table 16. No information on village Rekhi was found in the DCR.

Table 16: Demographic information of village Nammal

Village	Patwar Circle	Total Number of HHs	Average HH Size	Total Population	Literacy Ratio
Nammal[4]	Nammal	1180	5.8	6868	31.3

(Source: DCR Mianwali, 1998)

[4] This information is about Nammal town

Data collection and sample size: Household data from the two selected villages of Nammal Lake was collected by the survey team. A questionnaire was developed for data collection for 40 HHs. A total of 40 questionnaires were filled in from two villages of Nammal Lake, 16 questionnaires were filled from Nammal while 24 questionnaires were filled from Rekhi village (Table 17).

Table 17: Information on the number of households surveyed

Village	Total Number of HHs	Number of HHs Surveyed			
		Poor	Middle	Rich	Total
Nammal	150	4	9	3	16
Rekhi	300	5	17	2	24

(Source: Socio-economic Survey, August 2007)

During the survey the locals were classified according to their wealth to determine which class is most dependent on the natural resources of the lake. To this end, the local notables were contacted. Information gathered through the mentioned sources revealed that while all the three categories (Rich, Poor and Middle Class) were putting pressure on the natural resources of the lake, comparatively speaking the middle and rich were exerting more pressure as they own vast agriculture lands used for the cultivation of cash crops on a commercial basis.

4.4. Rapid Assessment of Priority Protected Area Management (RAPPAM)

RAPPAM is a methodology developed by WWF International in order to determine the effectiveness of the management system of a PA. Data was collected from six government as well as Non Governmental officials by using a modified RAPPAM questionnaire. Data about human pressures and threats to the Protected Areas, socio-economic use and management status of Protected Areas was determined accordingly.

Data collection through meetings: Meetings were conducted with various local government agencies, departments and non-governmental organisations of District Khushab to collect village wise information and data. Following offices were visited during the survey:

1. Revenue Department Mianwali
2. Forest Department Mianwali
3. Fisheries Department Mianwali.
4. Agriculture Department Mianwali
5. National Rural Support Programme, Regional Office
6. Sanjh Development Foundation

The RAPPAM questionnaire was divided into 10 sections dealing with different aspects of the Lake; pressures and threats, objectives, socio-economic importance, vulnerability, legal security, management planning, management decision making, finances, staffing, research, evaluation and monitoring. Data was collected from only three key informants as few people have extensive knowledge of Nammal Lake.

4.4.1. Management Objectives and Aims

The first section of the RAPPAM questionnaire includes general information to determine specific management objectives and critical management activities being carried out in the PA.

Overall goal of declaring a site as a protected area is protection of important species of flora and fauna. The strategies adopted for management describe the management objectives.

According to respondents, management objectives of the Nammal Lake Game Reserve are conservation of wetland and habitat of migratory birds. As flamingos and spoonbills used to visit the Nammal Lake regularly in 1970s, it was declared a protected area.

The activities conducted in a protected area to prevent any irreplaceable damage or unacceptable loss to its resources and habitat are included in critical management. The critical management activities conducted at the Nammal Lake Game Reserve include habitat management and control on hunting.

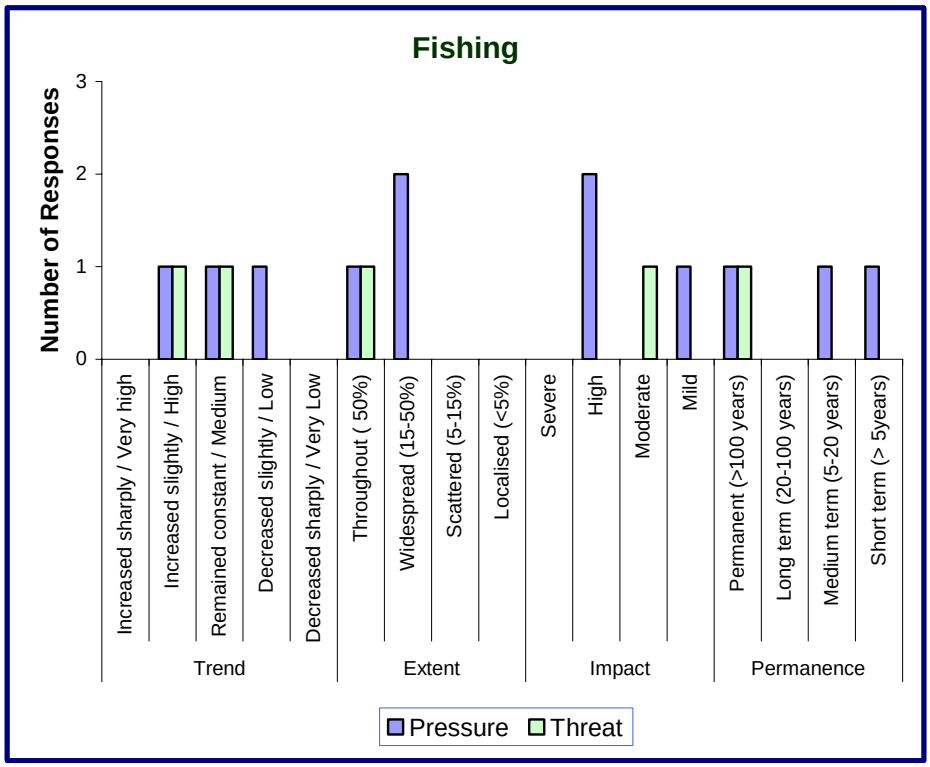
4.4.2. Pressures and Threats

Pressures and threats to the PA, including the trend, extent, impact and permanence, were identified by the respondents. For identification of the greatest pressure and threat each has been ranked according to information provided by the respondents. For example, the extent category has been ranked as:

Localised = 1
Scattered = 2
Widespread = 3
Throughout = 4

The highest score which a single pressure or a threat can attain is 17 if it is ranked at the highest end. As RAPPAM questionnaires were answered by three respondents, the highest score for a single pressure or threat, if it is ranked at the highest end by all of them, is 51 (17 x 3 = 51).

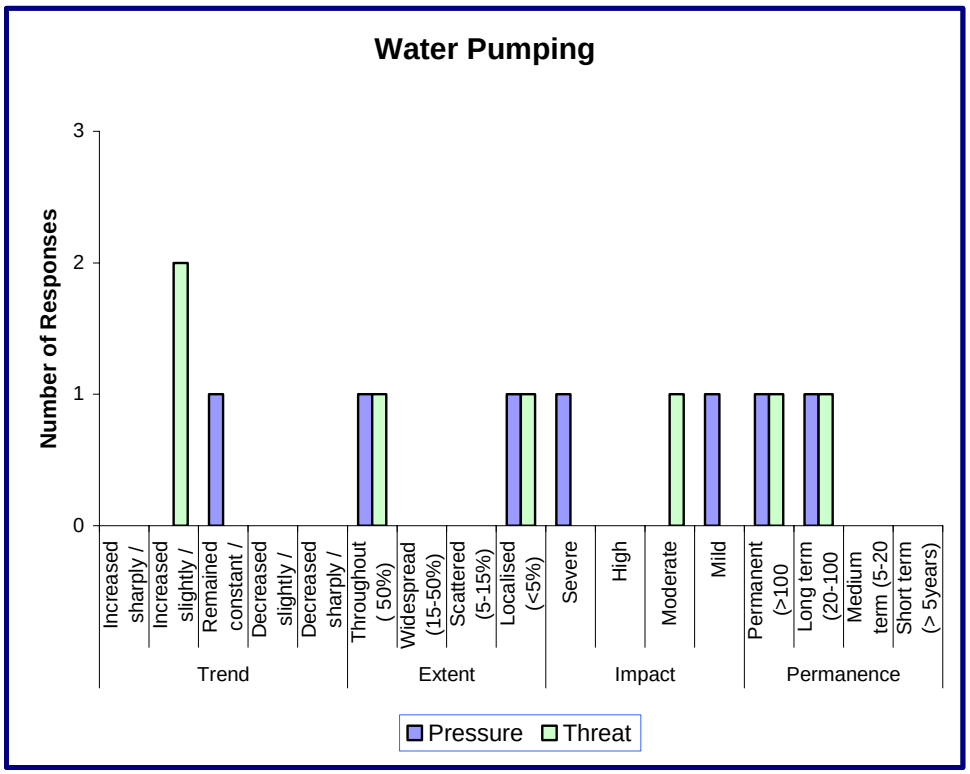
Fishing activity has been identified as the biggest pressure (score = 33) on the Nammal Lake by the respondents. It is being carried out over a wide area, which has its impact on the lake. Fishing activity might continue to occur throughout the lake for years to come and laying a moderate impact on it (Fig. 9).



(Source: Socio-economic Survey, August 2007)

Fig. 9: RAPPAM Assessment of fishing activity

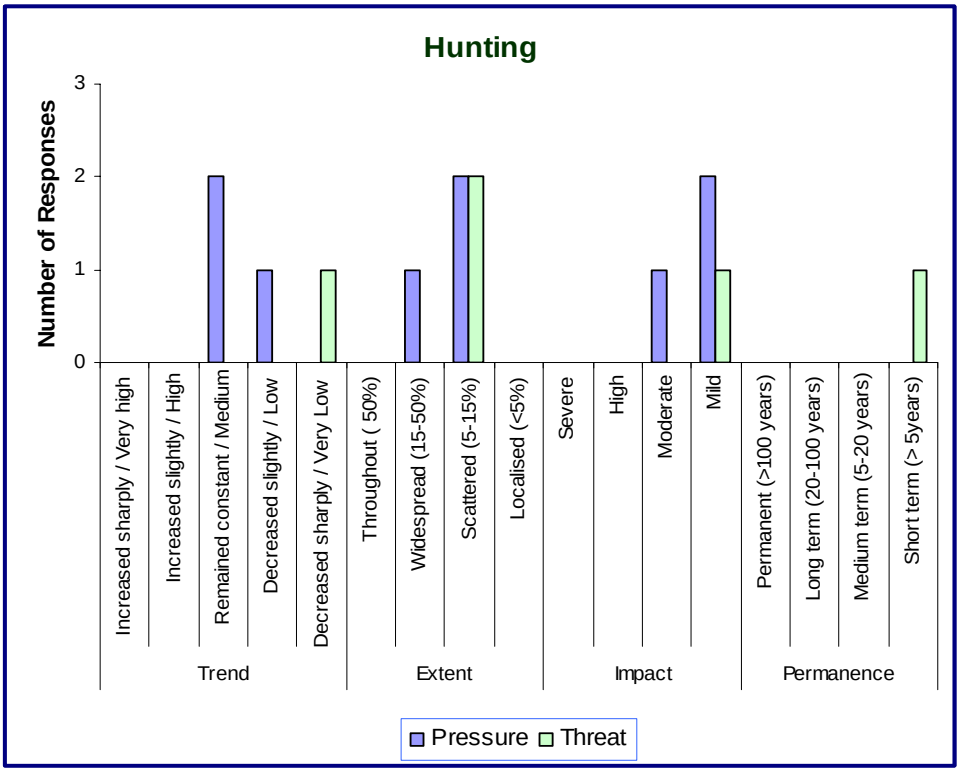
The Villages around Nammal Lake use ground water for irrigation. Due to over-exploitation of ground water, the ground water table of the Nammal Lake is decreasing, thereby, exerting pressure on it. This pressure (score = 20) has remained constant over the last 5 years but it has had a severe impact. Over the next 5 years, Nammal Lake is going to be under high threat from this activity, which will have a long term or permanent impact on it (Fig. 10).



(Source: Socio-economic Survey, August 2007)

Fig. 10: RAPPAM Assessment of excessive water pumping

Hunting of waterfowls is exerting a pressure (score= 19) on Nammal Lake Game Reserve. This activity has remained constant over the last 5 years but it has not had a severe or high negative impact on the PA (Fig. 11). Over the next five years, there is a low probability that this activity would continue over a scattered area. It would have a mild impact on the natural resources of Nammal Lake Game Reserve.

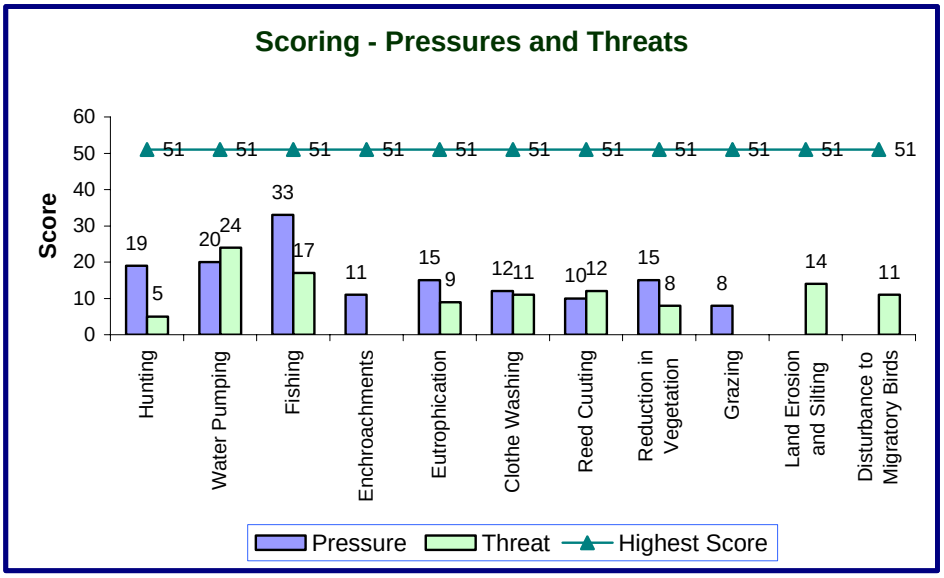


(Source: Socio-economic Survey, August 2007)

Fig. 11: RAPPAM Assessment of hunting

Fig. 12 gives a comparison of different pressures and threats on the basses of scores given by respondents.

Removal of vegetation such as collection of *Saccharum spp*. for fuelwood and cutting of reeds such as *Typha spp*. and *Phragmites spp.* is having a detrimental impact on the habitat of Nammal Lake. Land Erosion and silting of the lake is reducing water depth and if it continues, it would pose a threat to the PA.



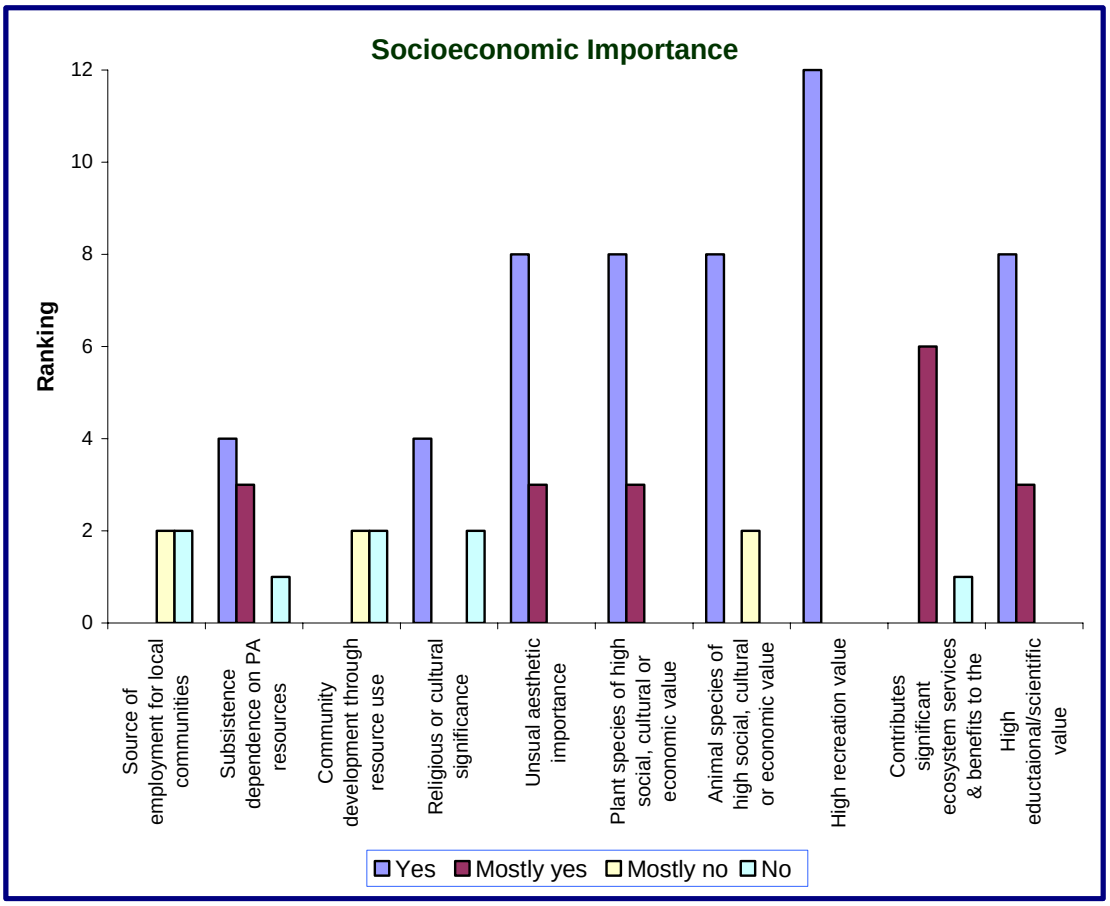
(Source: Socio-economic Survey, August 2007)

Fig. 12: Scores given to different pressures and threats

In the next sections of RAPPAM, every question is answered as 'yes', 'mostly yes', 'mostly no' and 'no'. The highest score for a question is 4. As the questions were answered by three respondents, the maximum score for any question will be 12 (4x3 = 12).

4.4.3. Socio-economic Importance

The Nammal Lake Game Reserve does not provide employment opportunities for the local people and their subsistence on it is low (8 points). Plant species have economic significance as fuelwood is collected and sold in the market. A Darbar situated near the lake has a high cultural and religious significance. Respondents rated the protected area high in terms of recreational, educational and scientific value. Fig. 13 gives details on the socio-economic importance of the lake as answered by the respondents.

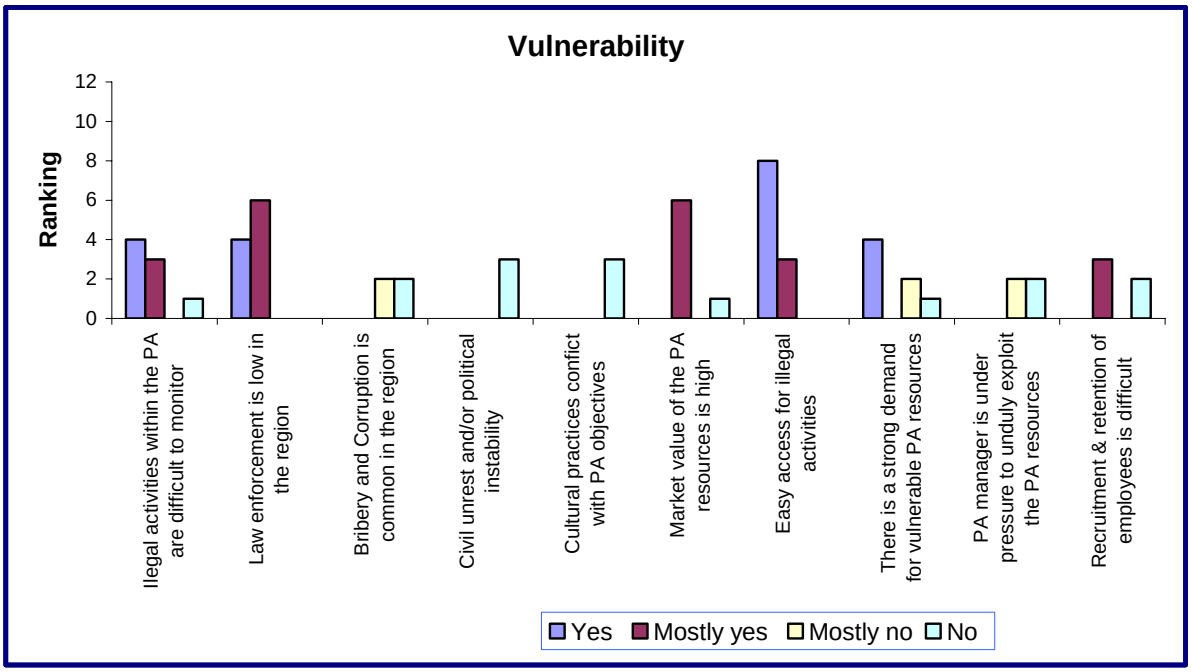


(Source: Socio-economic Survey, August 2007)

Fig. 13: RAPPAM assessment of socio-economic importance of the lake

4.4.4. Vulnerability

NLGR is quite vulnerable as law enforcement is low and it is difficult to detect any illegal activities occurring in the area. The area is easily accessible for illegal activities (11 points). Market value of the protected area resources is high (Fig. 14).



(Source: Socio-economic Survey, August 2007)

Fig. 14: RAPPAM assessment of vulnerability of Nammal Lake Game Reserve to illegal activities

4.4.5. Objectives

Assessment of objectives of the Nammal Lake Game Reserve yielded more or less consistent results. There is no specific management plan for NLGR and the general management plan for the PAs of Punjab is followed. The objectives of the plan are followed for the protection and maintenance of biodiversity (11 points). The administration staff at higher level understands the objectives and policies of this PA.

4.4.6. Legal Security, Staffing and Finances

According to the RAPPAM analysis, the Nammal Lake Game Reserve has a long-term legal binding and protection (11 points). The boundary demarcation is not adequate to meet the objectives of a PA.

The number of people employed for managing the PA is low and there is lack of skilled staff for performing critical management activities. Training and development opportunities for the staff were rated low by the respondents (5 points). Staff performance and progress on the targets is periodically reviewed but the employment conditions are not satisfactory for retaining a high quality staff.

NLGR does not have long-term financial stability. Every year funds are assigned with 10% increment. Funding to conduct critical management activities in the last 5 years was rated moderate by the respondents (8 points). Financial management practices do not enable efficient and effective PA management. The allocation of funds in relation to priorities and objectives of PA was rated low (4 points).

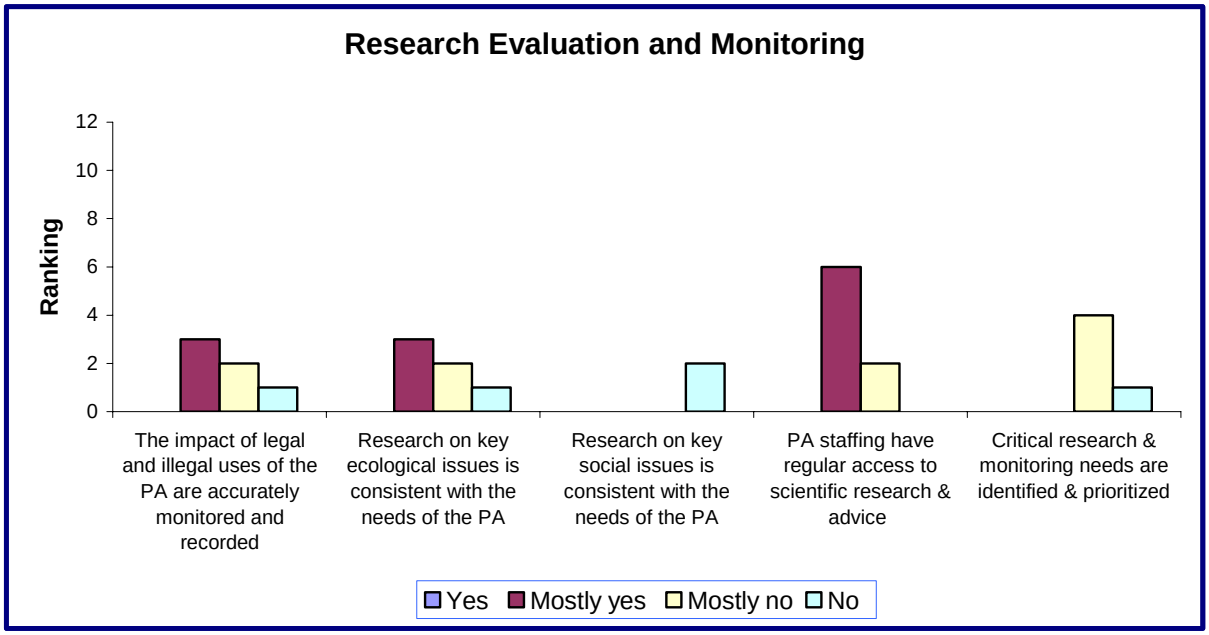
4.4.7. Management Planning and Management Decision Making

As mentioned earlier, there is no specific management plan for NLGR. An inventory of water birds is present. The respondents rated analysis of, and strategy for addressing, threats and pressures to the PA as moderate (7 points). There is a clear internal

organization involved in the management of the PA and its decisions are transparent. Local communities do not participate in the decisions related to NLGR, which affect them. There is effective communication between the PA staff and administration at all levels.

4.4.8. Research Evaluation and Monitoring

The respondents rated the success in accurate monitoring and recording of the impact of legal and illegal uses of the PA as moderate (6 points). The staff of NLGR have some access to scientific research and advice. Critical research and monitoring needs have not been identified or prioritised (Fig. 15).



(Source: Socio-economic Survey, August 2007)

Fig. 15: RAPPAM assessment of research, evaluation and monitoring

4.5. RAPPAM Analysis

Fishing is putting great pressure on the Nammal Lake Game Reserve and it has been rated highest (33 points) by the respondents. The highest threat to the Nammal Lake is from excessive water pumping (score = 24). Due to over-extraction of ground water by the surrounding villages, the ground water table of the Nammal Lake is decreasing and exerting pressure on it. The threat to the lake is likely to increase with the growing size of the village and the construction of a University near it.

Removal of vegetation such as collection of *Saccharum spp*. for fuelwood and cutting of reeds such as *Typha spp*. and *Phragmites spp.* is also mentioned as having a detrimental impact on the habitat of the Nammal Lake whereas land erosion and siltation of lake water is also mentioned as a factor contributing to the reduction in the depth of the Nammal Lake.

There is no specific management plan for NLGR and the general management plan for the PAs of Punjab is followed. The objectives of the plan are followed for the protection and maintenance of biodiversity. The Nammal Lake Game Reserve has a long-term legal binding and protection. The lake has a high recreation value. It is vulnerable to illegal activities because of weak law enforcement and insufficient number of staff.

5.0. Process adopted for the Management Plan

5.1. Literature Review

An extensive literature review was carried out in order to collect relevant information for the site. All sources of information such as: WWF – Pakistan's library, Internet, previous records of Punjab Wildlife and Parks Department and reports from other projects being operational in the area, were used to collect and analyse relevant information for the development of management plan for the site.

5.2. Ramsar Guidelines

The Nammal Lake is not designated as Ramsar Site but Ramsar Guidelines were followed for the development of this management plan in order to keep the uniformity of the documents and plans. The Ramsar guidelines consisted of three different sections: (i) Description of the area, (ii) Evaluation and objectives; and, (iii) Action Plan, which were used for the development of management plan of Nammal Lake Game Reserve.

5.3. Previous Management Plans

There has been no management plan available for the site. There is also lack of baseline scientific studies of Nammal Lake.

5.4. Environmental Assessment and Monitoring

During 2007 – 2008, extensive environmental assessment and monitoring were carried out by WWF – Pakistan as a part of the baseline assessment of all the wetlands of Pakistan. This was the first ever comprehensive baseline assessment of the Game Reserve, which revealed significant hydrological, physical, ecological and socio-economic information. This sets the basis for most of the information being reflected in this document. In addition, socio-economic assessment, community discussions and partner meetings helped in further redefining the priorities set in the current management plan.

5.5. Field Observations and Meetings

WWF – Pakistan has been involved in the conservation and management of significant wetlands of the country through enhancing awareness, capacity-building programmes and improving management. The Pakistan Wetlands Programme has been working in this region and has its presence in the region for the last two decades while working with communities and other government and non-government partners. During this time, several issues have emerged as a result of unsustainable use of the natural resources. These issues have been clearly highlighted in the present document.

5.6. Community Consultations and Partner Meetings

During the implementation process of the Pakistan Wetlands Programme, extensive consultations are being made, which has helped in redefining issues and the suggested solutions. Several detailed consultations with the staff of the Punjab Wildlife and Parks Department have already been organised but some issues still need more discussion as our knowledge and information improves.

6.0. Potential Issues and Threats

6.1. Management Issues

6.1.1. Lack of coordination between line agencies - Resource ownership conflicts

The land under the lake is government-owned (Revenue Department), and is the property of the adjoining communities, whereas the adjacent areas of the lakes are either *Shamilat* or communally owned and are part of the Reserve Forests, which are under the control of Punjab Forest Department. The fisheries is under the administrative control of Punjab Fisheries Department, whereas, *fauna* belongs to Punjab Wildlife and Parks Departments. Lack of coordination between these line agencies has resulted in resource ownership conflicts which has thus affected the ecology of the lake and its surrounding environment.

6.1.2. Weak law enforcement

Illegal hunting of waterfowls and large mammals in the catchment area of the lake, introduction of exotic fish species, pollution entering into the lakes originating from a broad range of human activities from the adjoining areas and illegal cutting of terrestrial and aquatic vegetation by adjacent communities and other interest groups are all examples of weak law enforcement in the area.

6.1.3. Lack of field equipment and technical skills of the field staff

During the time of preparation of this management plan, there are insufficient number of dedicated Wildlife Watchers for the overall protection of the resources of the Nammal Lake Game Reserve. The staff posted at the Lake lack resources, field equipment and the technical skills to effectively perform their tasks. The field staff is inadequately equipped with technical equipment e.g. binoculars, spotting scope, camera and GPS, which is a pre-requisite for effective monitoring and management of natural resources during recent times. In addition, the field staff does not have the capacity to record and subsequently report wildlife crime data on a regular basis, where population trends of important wildlife species of the region can be monitored for improved management decisions. . In addition, the mobility of the protection staff in the field is hampered due to the lack of transport facilities and the lack of security weapons has also encouraged the poachers to some extent.

6.1.4. Lack of finances for effective management of the lake

The Punjab Wildlife and Parks Department lacks financial resources to manage these lakes effectively. The developmental activities in the annual budget have reduced to minimum, which is not enough for the mobility of the staff, initiate any development intervention or implement legislations effectively.

6.2. Ecological Issues and Threats

6.2.1. Inadequate baseline information of Nammal Lake biodiversity

One of the most important aspects of sustainable conservation and future management of key wildlife species in an area is to establish biological benchmarks at the initial stages of the project in order to assess the effectiveness of the conservation and protection efforts applied to the study area after a certain period. The baseline data always reveal essential information regarding the biodiversity of the area and thus help set new standards for biodiversity measuring and monitoring according to the preset parameters. In general, the baselines involve a scientific assessment of what biodiversity is present in the area in terms of diversity and abundance by using standard protocols of data collection, compilation and analysis; what threats (internally and externally) are being faced by the

resources both for subsistence and commercial purposes; and the potential for the recovery of wildlife populations suggesting mitigation measures that becomes a part of recommendations for future management.

Nammal Lake is blessed with rich biological resources both in abundance and diversity and the presence of such a significant resource is attributed to its unique ecosystem, availability of suitable habitats in natural landscapes and many others. However, on the other hand, fishing, hunting for subsistence and commercial purposes, overgrazing and competition etc. are also some of the potential threats faced by the lake side by side.

6.2.2. Lack of regular monitoring of major wildlife species

Regular monitoring of wildlife species on standard methods (standard survey parameters, time and season, etc.) presents valuable information determining population trends and the threats associated to them. During the recent years (2010 and 2011), only mid-winter waterfowl census has been conducted in the Nammal Lake, which presents a quick snapshot of information during a specific period of time. In addition, very patchy information exists for other species of concern in the Lake and its surrounding areas.

6.2.3. Lack of management plan for Nammal Lake Game Reserve

There has been no scientific baseline assessment available in order to effectively manage the biological resources. The Lake also lacks comprehensive management plan which is a barrier to effective management of the resources.

6.2.4. Illegal hunting and poaching of wildlife in the Nammal Lake Game Reserve

Organised hunting is probably one of the most cross-cutting issues that wildlife managers face in this country during recent times. Unless the hunting is for subsistence, most forms of the sport are carried out by the elite class who see themselves above the laws of the relevant Departments (and often this proves true). Nammal Lake Game Reserve hosts a large diversity of game species, which is an attraction for the hunters. Unchecked and over-exploitation of certain species coupled with habitat degradation has resulted in the loss of major proportion of their populations from the wild. A few related issues are described below:

6.2.4.1. Illegal hunting / poaching of large mammals in the catchment area: Illegal hunting of large mammals in the catchment areas seems to be a frequent occurrence. Endemic and threatened Punjab Urial (*Ovis vignei punjabiensis*), a species of special concern, has lost major proportion of its natural habitat due to habitat destruction and fragmentation due to number of anthropogenic reasons. The population numbers have also declined significantly and it is hard to record animals in that region. This decline is strongly attributed to illegal hunting, lamb capture and competition with domestic livestock.

6.2.4.2. Illegal hunting of resident and migratory waterfowls: Nammal Lake Game Reserve presents a diverse habitat to a range of visiting migratory waterfowls in the region, as a staging ground. In addition, a number of important resident birds are also found in the area, which are equally important for maintaining the ecology of the Lake. Excessive hunting of resident and migratory waterfowls in Nammal Lake from locals as well as hunters from adjoining areas and from the visiting tourists from far flung areas, especially during the migratory season has not only disturbed their staging grounds but has also affected other species of *flora* and *fauna*.

6.2.4.3. Trapping: It has been observed during field studies that the game birds e.g. partridges, are also being trapped in nets in the catchment areas of Nammal Lake Game Reserve. The restrictions imposed by the Punjab Wildlife and Parks Department are not

observed by the poachers, which is a clear example of not only the weak law enforcement but resultantly their numbers have reduced in the wild.

6.2.4.4. Extraction of NTFPs: A few houselholds from the adjoining villages are involved in collecting Non-Timber Forest Products (NTFPs). Honey is collected by 3 households, which is mostly used by local communities for domestic as well as for comercial purposes. In addition, medicinal plants, mushrooms and vegetables are also collected from the wild, adjacent to the lake boundaries and from its catchment areas.

6.2.5. Fishing in the Nammal Lake

Extensive fishing in Nammal Lake Game Reserve is a major threat to the visiting birds during winter. The Punjab Fisheries Department issues fishing contract to the contractor (mostly from Kundian or Mianwali) for a period of three years. The contractor is not aware of the significance of the visiting waterfowls, which creates disturbance. As a result, the numbers are decling fast, as observed during the recent field studies. A few tourists also fish in the Lake without any license. Further human disturbance due to fishing activities also disturbs the breeding grounds of the waders e.g. red-wattled lapwing and other migratory birds.

6.2.6. Removal of wetlands / aquatic vegetation

It has been observed that *Saccharum* sp. is a preferred fuelwood species for the local communities in addition to cutting of natural reeds i.e. *Typha* and *Phragmites* spp. The leaves of the *Typha* are used for making mats by the local people. It was informed during the surveys that approx. 300 kanals of land around the lake is leased every year by the Revenue Department to earn maximum income from wetlands resources. In addition, *Typha* is also being used in the Brick Kiln as a fuel.

6.2.7. Forest cutting in the catchment areas of Nammal Lake Game Reserve

A general trend has been observed from the last decade in the Salt Range and especially in the catchment areas of the Nammal Lake Game Reserve that private forests are being cleared to a great extent in order to meet their domestic requirements as well as commercial objectives. In addition, the wood is also being exported out of the region to support and meet the wood and fuelwood requirements of other parts of the country, which is another big threat to the existing ecosystem. Government Reserve Forests in the catchment areas are easily accessible for the adjoining local communities for fuelwood collection in order to meet their domestic needs, as this is the only cheaper source of fuel and free firewood available to them. As a result, Nammal Lake is being severely affected due to this extensive deforestation mainly by increased siltation, ground water recharge, water quality and quantity in addition to reduction in water depth.

The clearing off the natural vegetation is also altering the natural ecosystem which has degraded wildlife habitat in the region and also clearing the remaining wildlife corridors. These open spaces are either being used by agriculture purposes and for open grazing or being planted with non-indigenous floral species, which are causing many more adverse environmental impacts (e.g. construction) to the very existence of the Lake.

6.2.8. Livestock grazing in and around the Lake

Most of the local communities graze their domestic livestock in the adjacent areas of the lake especially Kacha lands. Resultantly, there is a heavy grazing and fuelwood cutting pressure from the adjacent villages. Such an unrestricted grazing and cutting has been badly affecting the range ecology and its productivity, which is otherwise a vital habitat for several mammals, reptiles and avian species of the area. This excessive grazing has altered the natural vegetation characteristics of the lake.

6.2.9. Hazards of introduced fish species at Nammal Lake

There are at least five different exotic fish species which have been introduced in Nammal Lake by the Punjab Fisheries Department, in order to maximise earning from the wetland Protected Area, without regarding the status of the Lake. In addition, three indidenous species are also introduced in the Lake. These introduced and exotic species creates a competition with the natural occurring fish of the lake and disturbs the entire ecology of the system.

6.2.10. Presence of invasive and non-native species in and around Protected Area.

A number of invasive and non-native floral species (*Dodonea viscosa, Prosopis* sp., *Eucalyptus camaldulensis*) have been recorded from the catchment areas of the Protected Areas during the recent studies. *Dodonea viscosa* and *Prosopis juliflora* have widely spread due to overgrazing and land degradation, which has not only altered the range ecology of the region but has also affected the lake's biodiversity in the longer term. These invasive species are replacing the indigenous flora and climax species of the region, which is considered one of the threats to the ecosystem of Nammal Lake. This leads to further deterioration of the existing habitats. The resident bird species cannot adopt the changing habitat conditions, which results in the dispersal of local species from the area.

6.2.11. Non-biodegradable pollution originating from a broad range of human activities

Excessive pesticide usage in the adjoining agricultural areas and disposal of sewage in the lakes is a potential hazard to the lake ecology. The microbiological analysis of surface water shows the presence of faecal coli forms, which is due to the direct contact of water with the humans, as the sewage from the nearby village flows directly into the Lake, which is a generic issue in all the lakes of Salt Range Wetlands Complex.

6.2.12. Excessive groundwater extraction for use in agricultural crops

The high intake of water from numerous channels and tube wells that are used by the local residents are putting extreme pressure on the lake and wet areas are continuously being reduced. Three villages (Kalri, Nammal and Rekhi) extract water from the lake for use in agricultural crops. The newly established Nammal University also extracts water from Nammal Lake to meet its requirements. In addition, extension of agricultural areas around the lake and increased diversion of water supplies for irrigation have resulted in fewer run-offs reaching the lake. Every year more and more land around the lake is being cleared to make room for agriculture, livestock grazing and infrastructure development. This has resulted in lowering of water level of the Lake.

6.3. Socio-economic Issues and Threats

6.3.1. Lack of community empowerment, ownership of resources

There is a limited role of the communities in the overall planning and management of the resources of the Lake. The respective line Departments have not included locals in decision making which has resulted in the loss of ecological integrity of the Protected Area. The lack of involvement of communities with subsequent lack of ownership of resources is a major hurdle in the fast declining of the resources.

6.3.2. Poverty and limited livelihood opportunities

The Lake and its catchment area is an important source of livelihood for local people who meet their daily subsistence needs through various uses. Having scarcity of the diversified livelihood options in the face of rising poverty, local people illegally extract

maximum resources e.g. timber, fuelwood, fish, NTFPs and forage to fulfil their domestic and other needs by earning money through sale of the extracted resources. In addition, lack of such opportunities in the region has led to a great increase in subsistence hunting amongst the local people. This phenomenon continues to be unattended for the last several years, which has degraded the ecological integrity of the Lake.

6.3.3. Lack of alternate sources of energy

The resident population of the Salt Range are entirely dependent on the natural forests for meeting their energy needs and livelihood. In the absence of any alternative energy, the local communities extensively use indigenous vegetation to meet their domestic needs. In addition, people from outside are involved in forest cutting while paying good financial incentives to the local communities. As a result, the scrub forests in the catchment areas are disappearing fast, which are also affecting the native wildlife of the area.

6.3.4. Lack of developmental initiatives in the region

The region is not developed to its maximum potential in terms of its resource development and management. The development in this region has been very low so far by the district and provincial governments, which has not only resulted in less infrastructre and institutional development but also loss of its natural resources. Nammal University is one of the recent initiative by one of the political party headed by Imran Khan, which has created low level job opportunities for the communities.

6.3.5. Lack of public education and awareness

The researchers, resident communities, stakeholders and the visitors from Lahore, Islamabad and other adjoining areas seriously lack up-to-date information and awareness about the unique wildlife species of the area and the role they play in the overall ecology of the Salt Range ecosystem. However, there are certain issues which are essential to discuss so that appropriate strategies may be defined beforehand:

6.3.5.1. Lack of Informatory sign boards and road signs: There is no information by the respective Departments installed in and around the Protected Area to enhance awareness of the people regarding the region's biodiversity, which can raise raise the awareness level of the general public and tourists / visitors and cater their needs. In addition road signs depicting the habitat of the significant wildlife species are also not available, in order to avoid road kills (Monitor lizards, spiny-tailed lizards etc.) and other accidents.

6.3.5.2. Lack of information material: There is no resource material published for the promotion of *flora* and *fauna* of the region for the general public and the tourists/ visitors. Keeping in view the great ecological significance of the area, there is no existing mechanism, from where the tourist can get information about the lake and its resources.

6.3.5.3. Lack of general awareness amongst local communities: General public including all major segments of the society are mostly unaware of the ecological role of the Wetlands of the region and its associated *flora* and *fauna* in the daily lives of the people. Communities, having abysmal situation of literacy are also ignorant about the basic environmental phenomena and its impacts on their lives, livelihoods and economy.

6.3.5.4. Lack of eco-tourism facilities: Eco-tourism is one of the most income generating opportunity for the local communities worldwide. Salt Range offers several of such opportunities if properly managed and organised. This region lacks proper

eco-tourism facilities e.g. camping sites, traditional food, community guest houses, information centres, bird hide, watch towers, nature trails, resource centres etc., where general public can appreciate the biodiversity of the region. There is absolutely no information available for identification of birds that are protected throughout the year and cannot be hunted even if the license is available. Similar is the case with fishing in the lake.

7.0. Vision for the Nammal Lake Game Reserve

7.1. Strategic Objectives

7.1.1. Management Planning

Management planning is a subset of the more general discipline of planning, applied to PAs across the globe but with varying degrees of success. It is a tool rather a process for guiding Park authorities on how an area should be managed, today and in the future. This process does not end with the production of the plan, but it requires that on-going monitoring takes place to test the effectiveness of the plan. Lessons learnt from monitoring should be used to review the appropriateness of management purposes and policies. This feedback loop may thus lead to amendments to the original plan, to keep it on the right track, or in additions to the next version of the plan that is produced.

Before embarking on the design of a Management Plan, a clear idea of the costs and available resources should be gathered, particularly where there are to be resource and user surveys, public consultation and engagement of consultants. A realistic appraisal needs to be made to ensure that all costs associated with the plan can be fully met, bearing in mind that the planning process may take some years to complete. In the case of Nammal Lake Game Reserve, the financial allocations for the implementation of the management plan have been included in Pakistan Wetlands Programme to some extent in order to implement the related interventions. This further provides opportunities of implementation of interventions through partnerships and raising additional funds from national and international donors primarily to sustain PA operations and community interventions.

The time needed to prepare a Management Plan, for even a small site, is rarely less than 24 months due to the need for extensive baseline studies, consultations and surveys for addressing complex issues and subsequent drafting of the document. A realistic estimate of the time required should be made at the beginning of the process and allowed for.

Management by objectives is proactive rather than reactive and also 'results oriented' emphasising accomplishments and outcomes. Four distinct steps have been identified within this type of management and decision making:

- Formulation of clear, concise statements or objectives;
- Development of realistic action plans and implementation guidelines;
- Systematic monitoring and measuring of performance and achievement through reviewing the action plans and the implementation status of the guidelines; and,
- Taking corrective actions necessary to achieve planned results.

7.1.2. Guidelines for a good Management Plan

A management plan should be:

- Clear and accessible: easy to read, jargon free and well presented;
- Concise and comprehensive: no longer than is absolutely necessary;
- Accurate and objective: without major errors or statements likely to date;
- Systematic and logical: with management policies derived from an assessment of the site;
- Acceptable and motivating to all those with interests in and emotional attachment to site;
- Precise and practical: with clear objectives, realistic methods for achieving them;
- Focused and effective: fulfilling its purpose as a tool for site management;
- Precise with flexibility;
- Comprehensive with simplicity; and,
- Management oriented with ease of understanding by the public.

7.2. Developing management vision for Nammal Lake Game Reserve

The management planning process should develop and articulate an ideal condition, state or appearance for the future of the PA. Vision statements describe the desired or envisaged result of the policies for the conservation of the PA and provide coherent direction for management objectives. Importantly a vision statement should be aspirational and should:

- Describe the kind of PA that the plan is seeking to achieve in the long–term. This will help people to understand what it is hoped the area will be like in the future, the reasons for this, and the action needed to achieve the vision;
- Be a long–term statement which is unlikely to change significantly over time. It should therefore provide continuity in the process of managing PA in a sustainable way; and,
- Include environmental, recreational, cultural, social and economic aspects of the area.

The vision statement for Nammal Lake Game Reserve is as follows:

> *Nammal Lake Game Reserve is envisaged as the flagship of a system of Wetland Protected Areas in the Punjab Province, where definitive measures are implemented to ensure the viability of the biological diversity and ecological processes according to the pre-set guidelines laid out in the management plan that also protects the heritage and enhances the livelihoods of local communities adjacent to the Protected Area.*

Objectives follow from the management vision. They are more specific statements of intentions, setting out the conditions that management aims to achieve. They are thus statements of outcomes rather than how to achieve them. To the extent possible, these objectives should be prioritised to guide subsequent decisions and there is a need to reconcile the different objectives through appropriate planning responses.

In developing initial management objectives, a three-staged approach can be used:

- Design overall management objectives;
- Develop issue-specific management responses; and,
- Prepare initial management options that define management interventions.

The following guidelines for writing generic and specific objectives helped to define objectives of the Nammal Lake Game Reserve for its long-term sustainability:

- Precise/specific;
- Measurable, achievable and realistic;
- Reflect PA purpose, significance and exceptional values;
- Spell out the ends desired, but not the means to those ends;
- Adequately address the issues;
- Accompanied by a rationale; and,
- Written in priority order.

7.3. Describing management objectives for Nammal Lake Game Reserve

Typically the specific management objectives for Nammal Lake Game Reserve would be formulated to cover the following major aspects of PA planning and management:

- Human resource management;
- Effective law enforcement;
- Protected Areas emergency services;
- Wildlife management programmes;

- Ecological surveys and monitoring programme;
- Public information programme and awareness raising;
- Community outreach programmes;
- Research studies; and,
- Development of partnerships and linkages

7.3.1. Generic objectives of the Management Plan

Keeping in view the objectives of the establishment of Nammal Lake Game Reserve, following management guidelines are presented for the effective improvement of PA and its resources:

- To have management policies that are oriented towards the conservation of natural resources of the region in general and Nammal Lake in particular, and are based on realities with sufficient flexibility to accommodate existing human uses until alternatives are available for local subsistence;
- To have clear, specific and problem–oriented management objectives for the Lake which, if achieved, could greatly help in meeting the overall objective of the PA; and,
- To have specific and feasible management action programmes for achieving individual objectives of the plan that could be easily monitored and evaluated at various stages of implementation.

7.3.2. Specific objectives of the Management Plan

The specific objectives of the Nammal Lake Game Reserve management plan for effective implementation of the policies, objectives and action programmes are mentioned below. Success indicators and timelines may be assigned to these objectives during the development of workplans.

- To provide guidelines and set priorities for a baseline biodiversity assessment and to make the data accessible to the stakeholders for future management and research;
- To provide management planning and operational guidelines to the PA staff for the achievement of specific objectives for enhanced management;
- To help implement existing wildlife legislation in addition to meeting international conservation obligations;
- To protect and improve local status of the wildlife species of the Lake in general and endangered and flagship species and their associated habitats in particular;
- To maintain close liaison with PA authorities for the improvement of existing infrastructure, communication and administration for effective law enforcement;
- To provide opportunities for engaging communities in planning and management for effectiveness of the conservation and protection efforts of the Lake;
- To create alternate sources of income and energy for the traditional users to improve their quality of life and minimise their subsistence and dependence on the natural resources;
- To help build the professional capacity of the staff for effective administration and natural resource management;
- To enhance eco-tourism and improve visitors' facilities and services;
- To help improve scientific research on species and habitat management;
- To explore new avenues for improved management of the PA through developing partnerships and establishing linkages with local, national and international donors and partners; and,
- To enhance awareness of local communities and to build their capacity for improved resource management and exploring alternative livelihoods.

8.0. Strategic Plan for Management

Nammal Lake Game Reserve faces a number of anthropogenic pressures. Several pressures are rooted in social and economic issues that are far too wide ranging and endemic for any meaningful intervention at a site specific level. Poverty, for instance, is pervasive in the region as is social class. Political influence, too, is rooted in land ownership and results in direct control of the Lake. However, a few meaningful steps can still be initiated to promote an improved condition of the Lake.

8.1. Management interventions

8.1.1. Objectives of management interventions

The major objectives for these management interventions are to:

- Clarify roles and responsibilities of various government line agencies at the provincial level to resolve issues of resource ownership conflicts in wetlands conservation;
- Enhance coordination between various partners in wetlands conservation in order to effectively address site level management issues; and,
- Help build the technical skills and knowledge of the staff of government line agencies and other partners in improved management of wetlands.

8.1.2. Strategic Interventions

8.1.2.1. Improving stakeholders coordination at the provincial and site level

- Establishment of Punjab Provincial Wetlands Management Committee. A Provincial Wetlands Management Committee needs to be formulated to promote wetlands conservation at the highest level within the province. This will not only facilitate the implementation of various wetlands related international conventions, national policies and provincial rules and regulations but will also effectively enhance coordination among various stakeholders in order to clarify their roles and responsibilities, which should be clearly defined in the Terms of References of the Committee. The Committee members should include nominations from various Departments including Punjab Irrigation and Power Department, Punjab Forestry, Wildlife, Fisheries and Tourism Department, Punjab Planning and Development Department, Punjab Environmental Protection Agency and representatives of WWF-Pakistan under the Chairmanship of Provincial Secretary Forestry, Wildlife, Fisheries and Tourism Department, Government of Punjab.
- Establishment of Salt Range Wetlands Complex Conservation and Coordination Committee: At the site level, "*Salt Range Wetlands Complex Conservation and Coordination Committee*" should be formulated under the Chairmanship of Deputy Director (Wildlife) Salt Range, in order to guide wetlands conservation, with representatives of other relevant line Departments, in addition to the terms of reference defined for each Department. The Committee will be responsible for increased coordination at the site level which will promote partnerships and linkages in order to strengthen individual wetlands conservation. The Terms of References for the Committee should be clearly defined in order to improve the status of wetland, which will meet more regularly to discuss management, ecological and social issues. Specific discussions in the Committee should be held in the presence of respective group of stakeholders.

8.1.2.2. Improving law enforcement in the area

- Establishing check posts: There is a need to establish at least two check posts at the exit points of the Lake in order to reduce illegal poaching and other activities.

- Enhancing community-based watch and ward mechanism: Community-based watch and ward mechanism needs to be established in collaboration with Site Level Wetlands Management Committee through deputing additional Community Wildlife Watchers. The financial resources can be generated through various eco-tourism ventures in the area. This will not only promote community-based conservation in the area but will also develop a sense of ownership of the resources. This mechanism is especially needed during winter season, as far as the migratory birds are concerned.
- Incorporating wetlands related issues in existing legislations: There is a need to suggest wetlands related rules and legislation in the existing Punjab Wildlife Act, 1974 to provide protection to wetlands and associated biodiversity. During the course of implementation of Pakistan Wetlands Programme, several issues of concern has emerged which needed legal support, addressed only through the revision of provincial laws.
- Enhancing awareness level of the stakeholders: A well targetted and focused awareness campaign in the entire range needs to be launched, in order to sensitise masses regarding the existing rules and regulations. It is essential as the local communities can successfully contribute in effective law enforcement.

8.1.2.3. Strengthening knowledge, skills and technical capacity of the field staff

- The professional field staff of the Punjab Wildlife and Parks Department, deputed at Nammal Lake which is meant to provide protection to resources, need to be provided with equipment e.g. Binoculars, Spotting Scope, GPS, Camera and wireless communication sets, etc. This is important not only in terms of law enforcement, but also good for keeping records and monitoring purposes.
- The professional field staff of the Punjab Wildlife and Parks Department and the community Wildlife Watchers, needs to be properly trained in wildlife identification techniques, survey techniques, data recording, compilation and reporting, use of GPS, camera, binoculars and spotting scope, first aid, emergency services, wildlife handling and mass capture and effective watch and ward. In addition, the field staff needs to be properly trained in communication tools in order to effectively address the issues of illegal poaching and hunting. Transport facility should be provided to the field staff and equipped with necessary security weapons at check posts to avoid illegal wildlife trafficking and other related practices.
- Keeping in view the lack of knowledge of the rules and regulations within the field level staff, there is a need to improve the basic level of understanding. It is therefore strongly recommended that specific trainings for the staff of Punjab Forest, Wildlife, Fisheries and Tourism Department is organised in defining relevant Acts with specific reference to their powers, authorities and areas.

8.1.2.4. Generating funds for sustainable management of wetlands

- There has been a lot of discussion globally to value the goods and ecological services being provided by these wetlands, but enough needs to be done. Improving the knowledge regarding these wetlands and to further manage them effectively requires financial resources on a long-term basis. Fund-raising campaigns need to be launched within Pakistan and internationally and sensitising various groups and stakeholders for effective and sustainable use of the natural resources.
- Project proposals should also be developed keeping in view the issues, problems and threats being faced by different wetlands. These proposals need to be submitted to national and international donors for funding wetland protected areas.
- In order to ensure government support and keeping in view the resource ownership of the relevant line departments, PC-I needs to be formulated and submitted for funding.

This will streamline wetlands conservation within the country and ensure the implementation of the National Wetlands Policy objectives as well.

8.2. Ecological interventions

8.2.1. Objectives of Ecological Interventions

The major objectives of ecological interventions are to:

- Establish monitoring protocols for the regular assessment of ecological needs and upgrade information in the national and international databases regarding Nammal Lake Game Reserve;
- Maintain and improve the ecological integrity of the Nammal Lake Game Reserve through improved ecological interventions related to reducing harmful practices (pollution, hunting / poaching, illicit cutting, unsustainable extraction of NTFPs, encroachment etc.); and,
- Promote the sustainable use of natural resources for the local communities living in and around the Lake boundaries.

8.2.2. Strategic interventions

8.2.2.1. Setting up of physical and socio-ecological benchmarks

- There is a need to establish baseline information regarding the Nammal Lake Game Reserve. These should include studies on small and large mammals, amphibians and reptiles, fish, birds, zooplankton and phytoplankton and terrestrial vegetation. In addition, detailed GIS based studies, socio-economic studies and water quality studies should also be made part of the baseline assessment. These studies will not only decsribe the status of the species in the Lake but will also set benchmarks for future studies, in order to make comparisons.

8.2.2.2. Regular monitoring of major wildlife species

- Nammal Lake Game Reserve host diversity of migratory birds during winter season. The first arrival of birds largely depends on the weather in the breeding areas but normally takes place between September to October and back migration starts during February to March. In this regard, it is important to know the bird abundance and diversity during arrival and then back migration to their breeding regions. In this case, regular assessment of migratory birds at Nammal Lake should be conducted twice during migratory season.
- In order to comply with the International obligations and standards and to feed information into international databases, there is a need to conduct mid winter waterfowl census according to set times and formats. This is essential to get a quick snapshot of the bird diversity of all the wetlands of Pakistan including the Nammal Lake Game Reserve.
- Predators in the region are severely persecuted as they are considered harmful for their livestock. The local communities are unaware of their ecological role in controlling wild populations of small and large mammals. Carnivore populations need to be monitored and efforts should be initiated to install camera traps in order to determine the presence/ absence of the carnivores living in the catchment areas of the Lake. Their presence in the area reflects a healthy and well balanced ecosystem.

8.2.2.3. Developing management plan for Nammal Lake Game Reserve

- Ramsar Convention has well established guidelines for developing management plans of wetlands protected areas. A management plan for Nammal Lake should be developed based on the Ramsar Guidelines for a period of at least 10 years. The

guidelines are followed in order to keep the uniformity of documents of the Salt Range wetland protected areas. The proposed management plan should clearly define the roles and responsibilities of all the relevant line departments, partnerships with other organisations and a funding mechanism to sustain interventions.

8.2.2.4. Improving watch and ward mechanism to provide protection

- The existing staff of the Punjab Wildlife and parks Department deputed for the conservation of wildlife resources of the region need to be activated for strengthening watch and ward mechanism. This should especially be carried out during migratory seasons of birds in order to avoid hunting and other practices including fishing during migratory season. Illegal hunting of major wildlife species especially wetlands related, which are not covered in the existing rules and regulations, should be taught to the field staff for improvement in watch and ward.
- In addition to the existing staff, at least 3 community activists need to be designated as Honorary Wildlife Watchers, which should be notified by the Director General, Punjab Wildlife and Parks Department, with all the powers and authorities in order to share responsibilities and provide a sense of ownership to the communities. These should carefully be selected from the region and properly trained in watch and ward. This should provide a very good example of community based conservation. In addition, Raid Parties in collaboration with local community activists, should be formulated to monitor the area during specific active seasons.
- With strong implementation of rules and legislations in the region through field staff, there is also a need to enhance awareness level of the local communities and stakeholder regarding the significant wildlife of the region and the role of the biodiversity in the livelihoods of the local communities. In this regard, it is strongly recommended to celebrate at least a few significant environment days, conduct nature club activities through green school programmes and a mass awareness programmes through dissemination of promotional and awareness material.
- Promotional material plays a key role in enhancing the knowledge of the stakeholders. Extensive hunting, without any bag limit and number of days, species and the site is one of the common problems, this Lake is facing. One way of doing is to raise the awareness level of the hunter by teaching them with hunting code of ethics. All those hunters, who are registered with the Punjab Wildlife and Parks Department and gets license, should also get a copy of the hunting code of ethics, recently developed in collaboration with Conservation and Hunting Association of Pakistan (CHAP).

8.2.2.5. Protecting wetlands vegetation through wise use

- Natural-resource based community products should be developed and promoted in order to generate income for the local communities. The products will also be displayed at various community resource centres for improved marketing of the local skills.
- Awareness-raising regarding the wise use of these wetlands resources should be carried out in the area. These natural reeds also provide roosting places for a diverse group of birds especially during migratory season.

8.2.2.6. Notifying no activity zone during migratory season in the Lake

- Fishing in Nammal Lake Game Reserve should be banned immediately during migratory season and this case needs to be discussed in Punjab Provincial Wetlands Management Committee. This disturbs the migratory birds and their population has declined to significant levels during the current mid-winter waterfowl census and other occasional observations.

- Information and awareness boards needs to be installed at significant places close to the lake in order to create awareness amongst the masses regarding the significance of migratory birds and the disturbance caused to them during fishing.
- Watch and ward mechanism should be in place in collaboration with local community activists and field staff, where strict monitoring of the lakes will be carried out especially during the migratory season.

8.2.2.7. Protecting catchment area of the Lake

- "Forest Protection Committees" should be notified within the region to promote and protect unique ecosystem of the region. This may include members principally from the communities, local CBOs and NGOs but one representative should also be included from the government line agencies for verification and field effectiveness. These Committees will have a well defined ToRs regarding the roles and responsibilities, areas to be covered and decisions to be taken.
- "Forest Protection Committees" will also help promote community-based forest Protected Areas in the region in close collaboration with existing CBOs/VCCs. This will develop a sense of ownership and should fully provide support to the communities from the government agencies to effectively promote this concept in the region, which will ultimately enhance the water availability to the Lake.
- In collaboration with local communities and stakeholders, forest check posts should be established at key point within the region, especially at the exit point in order to strictly control the export of timber and fuelwood from the region. This practice should be strictly monitored and effective measures should be adopted to stop any illegal practice.
- Energy plantations should be promoted within the region, at the farm lands to reduce pressure on the natural forests. In addition, a close collaboration needs to be developed with the local representatives of the Punjab Forest Department, for supply of plants and technical advice.
- Locally made fuel efficient stoves should be promoted in the region in collaboration with different conservation and development organisations to reduce at least 30% of pressure on natural forests and to reduce health hazards amongst the women and the children.
- Biogas Plants should be installed extensively within the region at the household level, as this is the most sustainable form of alternate energy, needed by the communities. It should be provided at the household level especially having at least 2-3 Livestock Units. This process will further reduce the level of fuelwood cutting from these forests.
- Solar Energy Units should be installed at appropriate places to conserve the natural forests of the region. As the initial investment is high, which also requires up gradation and maintenance with the passage of time; but this is considered as one of the most sustainable forms of energy. In this regard, communities are also motivated to contribute their share at least 20-30% of the total investment, which will enable them to take ownership of the units.
- In order to conserve the Nammal Lake and to reduce erosion from streams entering into the lake, indigenous plantations need to be promoted in collaboration with local communities, SVDP, nature clubs and District Government. This may not only help reduce erosion but will also provide a source of additional fuelwood to the local communities but a great care is needed to extract wood from such vulnerable areas.

8.2.2.8. Conserving rangelands in the catchment areas

- There is a need to establish detailed community consultations and regular interactions to discuss the possibility of reviving the traditional systems of grazing – rotational grazing

system. It has several advantages and may contribute well in the overall ecology and management of the area.

- Awareness and community consultations are needed for watch and ward, to avoid grazing in the catchment area, which ultimately affects the quality and quantity of water in the lake in the longer run. This may also reduce the competition between domestic and wild animals and will maintain the health of the ecosystem.

8.2.2.9. Promoting indigenous fish fauna in the Lake

- During baseline assessment, it was found out that non-native fish species were introduced in Nammal Lake to generate funds from fishing. It is therefore recommended that introduced fish species should be gradually removed, as this is against the PA rules and regulations. It is strongly recommended to study the harmful impacts of exotic fish species in the region, so as to make an effective case for their removal. This will not only help in Nammal Lake case but it has wider implications to other Protected Areas of the region as well.
- The issue of exotics and contracting out the fish to contractors also need to be discussed in the Punjab Provincial Wetlands Management Committee for policy level decision, as this affects the migratory bird population to a great extent.

8.2.2.10. Removing invasive and non-native species in and around the Lake

- The case of removal of exotics from in and around the Protected Area needs to be discussed and highlighted in the Punjab Provincial Wetlands Management Committee for policy level decision. This case should be presented in the context of wetland protected areas.
- Promote the plantation of native plants (*Acacia modesta, Olea ferruginea*) in areas of high concentration of *Dodonea viscosa* and *Prosopis* sp. to recover non-invasive flora and climax species of the region.
- A research study should be conducted to utilise *Prosopis* sp. for different uses, especially for fuelwood, export for use as coal in brick kilns and explore other options to use in the particle board industry.

8.2.2.11. Preventing pollution from entering into the lake

- Better Management Practices (BMPs) need to be discussed with the farmers adopting harmful agricultural practices, living in the close vicinity of the lake. Farmer schools also need to be established, for effective decision making, as WWF – Pakistan has extensive experience working with the farmers on BMPs.
- Awareness and capacity-building are the most efficient ways of handling this issue, preferably through the Farmer Schools and already established VCCs. The farming community should be taught in collaboration with local agriculture extension workers regarding the harmful impacts of various pesticides and fertiliser use and their ultimate impact in ground water quality, which directly affects them.

8.2.2.12. Securing water for wetlands

- Cropping patterns need to be studied in the areas dependent on the wetland to find out the water requirements by different crops and to lobby for water efficient crops in the region.
- Drip Irrigation System should be installed for efficient use of water for agriculture crops. This should initially be installed for demonstration purposes in order to assess the efficacy of the system. This should be accompanied by a small research study showing its effectiveness, before it is widely practiced by the communities in the region.
- A well targeted awareness campaign should be launched in the entire region for water conservation for their livelihoods.

8.3. Social Interventions

8.3.1. Objectives of Social Interventions

Any efforts towards initiating community participation need to be carefully chosen with a long-term view rather than short-term project implementation aims. Communities in the region follow occupations that have been handed down to them over generations and with low literacy and few economic development opportunities, as there are limited alternatives for them. Any change in livelihoods initiated for the duration of a short-term project are likely to make little permanent mark on changing the extraction patterns that characterise anthropogenic pressure on the Nammal Lake Game Reserve. Since the area is characterised by high levels of poverty, especially among communities that use the Protected Area's resources, promoting people's participation can play a key role changing the management and use of the Lake's resources.

The main objectives of Social Interventions are to:

- Organise local communities into Village level Wetlands Conservation Committees for improved management of the natural resources of the Nammal Lake Game Reserve;
- Improve the social maturity of the established committees through registration as Community Based Organisation (CBOs) for their efficient involvement and in improved management of the existing natural resources of the area;
- Promote collaborative management approaches with local communities through signing partnership agreements and dialogues to reduce harmful practices for improving biodiversity conservation and community development; and,
- Enhance conservation awareness level of the local communities living in and around the Protected Area for effective management of the resources.

8.3.2. Strategic Interventions

8.3.2.1. Empowering and mobilising local communities for effective decision making

- It is therefore high recommended to organise communities (CBOs / VCCs) with respect to the management of natural resources of the Protected Area, so that the communities may take ownership of the resources.
- Comprehensive training programme for these CBOs / VCCs is essential in office and project management, proposal development and negotiations with donors etc. which will further enhance their level of decision making regarding resource management.
- Sign Terms of Partnerships with established CBOs / communities for implementation of wetlands management interventions. This will ensure their resource ownership.
- Social maturity index for the established communities need to be developed, tested and implemented in order to ensure their sustainability and determine their strengths and weaknesses.
- A local representation would be ensured from the region in the Punjab Provincial Wetlands Management Committee to represent local communities at the highest forum within the province.

8.3.2.2. Improving livelihood opportunities and alleviating poverty

- A wide range of training opportunities i.e. enterprise development, micro-finance, kitchen gardening, nursery raising, orchard development, poultry farming, apiculture, livestock management through vaccination and de-worming, establishing vocational training centres and improved NRM practices may be provided to the local communities for improvement in their livelihood

- Typha looms, Mazri products, handicrafts are a few major livelihood development initiatives that should be promoted by enhancing increased access to market.
- A well established eco-tourism promotion programme in the region needs to be implemented. This should be implemented by providing facilities in the region e.g. bird hides, briefing centre, promotional material, community resource centre, camping facilities, traditional cuisine and guest houses, bird watching, local products display and several other initiatives including the training of guides and porters etc. In addition, visit to wilderness areas, cultural hotspots, historical gardens, spirtual places and many others should be explored and could be brought in the form of package for the visitors. This should be promoted through websites, different groups, schools and NGOs/ GOs and international visitors. A revenue generation and distribution mechanism also needs to be established to ensure its sustainability.

8.3.2.3. Promoting efficient and sustainable sources of energy

- There is a dire need to make an assessment of the wood usage by these communities and initiate the process of providing alternate energy units (Biogas plants, fuel-efficient stoves, solar energy units including solar cookers, solar geysers etc.) in order to protect the remaining natural forests of the Protected Area. In addition, there is a need to negotiate at least 20-30% of the total cost of the unit with the local communities so as to enhance the level of ownership.
- Energy plantations (agro-forestry) also need to be established in order to overcome the issues of fuelwood in the region. Every household who owns land should meet their energy requirements from their own farmlands.

8.3.2.4. Lobbying for enhanced government investment in the region

- This region lacks access to government funds due to several policy and political reasons. This area is rich in resources and district government should move ahead in order to promote this region in terms of its biodiversity, landscape, resources and potential for agriculture and other human capital

8.3.2.5. Enhancing awareness of the local communities and stakeholders

- A school level education programme needs to be established within the Protected Area. These include the establishment of Nature Clubs which may help in organising various school level events and where children can be involved in green activities. These young students can become the future leaders of conservation in their respective areas and act as agents in their sphere.
- Introductory and interactive education material needs to be produced in local languages to enhance the value of the biodiversity of the Protected Area. These should include posters, small booklets, brochures, and activity books for school going children. Other promotional material can also be developed in this regard.
- Installing standard Protected Area signage at appropriate places within the region may also contribute in raising awareness of the local communities. Information and sign boards need to be introduced at various places to avoid road kills of wildlife species especially the reptiles etc.
- Exposure Visits are an important tool in creating awareness amongst the local communities, where a wide range of initiatives are being undertaken in order to address NRM related issues in the region. This has proved very effective and is recommended for the local communities and other stakeholders to WWF – Pakistan's sites in the other regions.

9.0. Implementation Plan

9.1. Summary of Interventions

There are 69 interventions that have been grouped together in three major components for effective implementation of the management plan for Nammal Lake Game Reserve. These include Management interventions, Ecological interventions and Socio-economic interventions and are presented in the form of a matrix (Table 18). Table 17 not only describes the priority of an individual intervention (Low, Medium and High) but also describes the responsibilities of the primary and secondary stakeholders in order to guide implementation of these prescriptions. In addition, duration reflects the time frame which is required to complete the activity. The duration of the activity is defined as Short-term (< 2 years), Medium-term (2-5 years) and Long-term (> 5 years).

The time frame for this management plan is at least 10 years. It is intended that all all the interventions will be implemented during this time frame, which will maintain and improve the integrity of the Lake as described in the definition of a Protected Area. The Interventions mentioned are either being implemented by relevant government line agencies, local partners, WWF-Pakistan or local communities. In addition, a few other interventions are either being implemented or will be implemented in collaboration with partners. The priority assigned to each intervention can be further used for guidance in the implementation.

Funding to implement interventions of this management plan can be sought from a range of potential donors through developing proposals, co-financing, in kind contributions from existing programmes and building partnerships with other government line agencies.

Table 18: Matrix showing interventions, their priority rating and responsibilities of each implementing partner for the implementation of Nammal Lake Management Plan

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
1	Management Interventions						
1.1.	Lack of coordination between line agencies – resource ownership conflicts						
1.1.1.	Establish Punjab Provincial Wetlands Management Committee under the Chairmanship of Secretary Forest, Wildlife, Fisheries and Tourism Department with representatives from other relevant Departments.	High	Punjab Wildlife and Parks Department	Line Departments, WWF – Pakistan	√	-	-
1.1.2.	Establish "Salt Range Wetlands Complex Conservation and Coordination Committee" under the Chairmanship of Deputy Director (Wildlife) Salt Range Region.	High	Punjab Wildlife and Parks Department, WWF - Pakistan	Punjab Forest Department, Punjab EPA, Punjab Fisheries Department, Others	√	-	-
1.2.	Weak Law Enforcement						
1.2.1.	Establish at least two check posts at exit points with the provision of effective wireless communication tools	High	Punjab Wildlife and Parks Department	Punjab Forest Department	-	√	-
1.2.2.	Nominate at least 3 community activists as "Honorary Community Wildlife Watchers".	High	Punjab Wildlife and Parks Department	WWF - Pakistan	-	√	-
1.2.3.	Revise / update Punjab Wildlife Act, 1974 to incorporate wetlands related issues and suggestions.	Medium	Punjab Wildlife and Parks Department	WWF - Pakistan	√	-	-
1.2.4.	Initiate a well targeted awareness campaign for effective implementation of rules and regulations.	Medium	WWF - Pakistan	Punjab Wildlife and Parks Department	-	-	√
1.3.	Lack of field equipment and technical skills of the field staff						
1.3.1.	Provide necessary field equipment to the staff of Punjab Wildlife and Parks Department. The equipment includes GPS, Digital Camera, Binoculars and Spotting Scope in addition to other wireless communication sets at check posts.	High	Punjab Wildlife and Parks Department, WWF – Pakistan	SVDP, Others Donors e.g. UNDP – GRIP	-	√	-
1.3.2.	Provide training to Field Wildlife Watchers in "Wildlife Identification Techniques, Survey Techniques, Data Recording and Compilation, Use of Binoculars and Spotting Scope, First Aid, Emergency Services, Wildlife Handling and mass capture, Effective Watch and Ward".	Medium	WWF - Pakistan	Punjab Wildlife and Parks Department	-	√	-
1.3.3.	Organise specific trainings for the staff of Punjab Forest, Wildlife, Fisheries and Tourism Department in defining Punjab Wildlife Act, 1974 with specific reference to their powers, authorities and regions.	Medium	Punjab Forestry, Wildlife, Fisheries and Tourism Department	Consultants	-	-	√
1.4.	Lack of finances for effective management of the wetland						
1.4.1.	Launch fund-raising campaigns, nationally and internationally to	High	Punjab Wildlife and	Government of Punjab	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	manage wetlands and their resources		Parks Department, WWF - Pakistan				
1.4.2.	Develop donor funded projects for national and international funding	High	WWF - Pakistan	Government of Punjab	-	-	√
1.4.3.	Help develop PC – I's for development projects for the region	High	Punjab Wildlife and Parks Department	WWF - Pakistan	-	√	-
2	Ecological Interventions						
2.1.	Inadequate baseline information of Nammal Lake biodiversity						
2.1.1.	Conduct baseline studies covering all the physical and the socio-ecological parameters for establishing benchmarks for future studies and trends.	High	WWF - Pakistan	Punjab Wildlife and Parks Department	√	-	-
2.2.	Lack of regular monitoring of major wildlife species						
2.2.1.	Conduct a regular assessment of Migratory Birds at Nammal Lake twice during migratory season.	High	WWF - Pakistan	Punjab Wildlife and Parks Department	-	√	-
2.2.2.	Conduct mid winter waterfowl census in a quick snapshot visit during January each year to comply with the Wetlands International obligations	High	WWF - Pakistan	Punjab Wildlife and Parks Department	√	-	-
2.2.3.	Monitor carnivore populations preferably through camera trap installations in order to determine the presence/ absence of the carnivores living in the catchment area of the Lake.	Medium	Punjab Wildlife and Parks Department	WWF - Pakistan	-	-	√
2.2.4.	Determine the impact of hunting of major wildlife species for putting forward an effective strategy in order to reduce illegal activities.	Medium	WWF – Pakistan, PMNH, ZSD	Punjab Wildlife and Parks Department	-	√	-
2.3.	Lack of management plan of Nammal Lake Game Reserve						
2.3.1.	Develop a management plan based on the Ramsar Guidelines (guidelines localised according to the conditions) for a period of at least 10 years in order to keep the uniformity of the plans	High	WWF - Pakistan	Punjab Wildlife and Parks Department	√	-	-
2.3.2.	The proposed management plan should clearly define the roles and responsibilities of all the relevant line departments, partnerships with other organisations and a funding mechanism to sustain interventions.	High	WWF - Pakistan	Punjab Wildlife and Parks Department	-	√	-
2.4.	Illegal Hunting and Poaching of Wildlife in the Nammal Lake Game Reserve						
2.4.1.	Watch and ward mechanism should be strengthened especially during migratory seasons (Birds) in order to avoid hunting and fishing during migratory season by deputing additional watchers from the community.	High	Punjab Wildlife and Parks Department	WWF – Pakistan, VCCs	√	-	-
2.4.2.	Awareness raising campaigns need to launched, especially celebrations of significant environment days, nature club activities, mass awareness programmes.	Medium	WWF - Pakistan	SVDP, VCCs, CBOs	-	-	√
2.4.3.	In order to sensitise the hunters about the hunting code of ethics, a	High	CHAP	Punjab Wildlife and	-	-	√

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	booklet developed by Conservation and Hunting Association of Pakistan (CHAP) should be provided along with license.			Parks Department			
2.4.4.	Illegal hunting and poaching of major wildlife species especially wetlands related species, which are not covered in the existing rules and regulations, should be taught to the field staff for improvement in watch and ward. In addition, Raid Parties in collaboration with local community activists, should be formulated to monitor the area during specific active seasons	High	Punjab Wildlife and Parks Department	WWF – Pakistan, SVDP	-	-	√
2.5.	Fishing in the Nammal Lake						
2.5.1.	Discuss the issue of fishing in Punjab Provincial Wetlands Management Committee.	High	WWF – Pakistan, Punjab Fisheries Department	Other members of the Wetlands Management Committee	-	√	-
2.5.2.	Design and install information and awareness boards at significant places around the Lake	High	Punjab Fisheries Department	WWF – Pakistan	-	√	-
2.5.3.	Watch and ward mechanism should be in place in collaboration with local community activists and field staff	High	Local VCCs, Punjab Fisheries Department	WWF – Pakistan	-	√	-
2.6.	Removal of wetlands/aquatic vegetation						
2.6.1.	Natural resource based products should be developed and displayed at different Community Resource Centres and to improve marketing of the products	High	WWF – Pakistan, local vendors, Punjab Forest Department	Punjab Wildlife and Parks Department	-	√	-
2.6.2.	Design and install information and awareness boards at significant places around the Lake with regards to wise use of wetlands resources	High	WWF - Pakistan	Punjab Forest Department	-	√	-
2.7.	Forest cutting in the catchment areas of Nammal Lake Game Reserve						
2.7.1.	"*Forest Protection Committees*" should be notified within the region to promote and protect unique ecosystem of the region. This may include members principally from the communities, local CBOs and NGOs but one representative should also be included from the government line agencies for verification and field effectiveness.	High	WWF – Pakistan, Punjab Forest Department	Punjab Wildlife and Parks Department	-	√	-
2.7.2.	Check Posts should be established at key points within the region, especially at exit points in order to strictly control the export of timber and fuelwood from the region.	Medium	Punjab Forest Department	Punjab Wildlife and Parks Department	-	-	√
2.7.3.	Section 144 should be established within the region, as and when the need arises in collaboration with the District Government.	Low	District Government	Punjab Forest Department	-	√	-
2.7.4.	Community-based Forest Protected Areas should be promoted in the region in close collaboration with existing CBOs/VCCs, in order to develop a sense of ownership and provide support to the communities	Medium	VCCs, WWF - Pakistan	Punjab Forest Department	-	-	√

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	from the government agencies to promote this concept in the region.						
2.7.5.	Energy plantations should be promoted within the region, at the farm lands to reduce pressure on the natural forests. In addition, a close collaboration needs to be developed with the local representatives of the Punjab Forest Department, for supply of plants and technical advice.	High	VCCs, CBOs, WWF - Pakistan	Punjab Forest Department	-	√	-
2.7.6.	Locally made fuel efficient stoves should be promoted in the region in collaboration with different conservation and development organisations to reduce at least 30% of pressure on natural forests and to reduce health hazards amongst the women and the children.	Medium	VCCs, CBOs, WWF - Pakistan	Punjab Forest Department	-	-	√
2.7.7.	Biogas Plants should be installed extensively at the household level, as this is the most sustainable form of alternate energy, needed by the communities. It should be provided at the household level especially having at least 2-3 Livestock Units.	High	VCCs, WWF - Pakistan	Punjab Dairy Development Council	-	√	-
2.7.8.	In order to conserve the lake and to reduce erosion from Nullahs entering into the lake, indigenous plantations need to be promoted in collaboration with local communities, Sanjh Development Organisation and District Government. This may not only help reduce erosion but will also provide a source of additional fuelwood to the local communities but a great care is needed to extract wood from such areas.	Medium	Sanjh Development Organisation, WWF – Pakistan, SVDP, VCCs	Punjab Forest Department	-	-	√
2.8.	Livestock grazing in and around the Lake						
2.8.1.	There is a need to establish detailed community consultations and regular interactions to discuss the possibility of reviving the traditional systems of grazing – rotational grazing system.	High	WWF – Pakistan, Sanjh Development Organisation, VCCs	Punjab Forest Department	-	-	√
2.8.2.	Awareness and community consultations are needed for watch and ward, to avoid grazing in catchment areas, which ultimately affects the quality and quantity of water in the lakes. This may also reduce the competition between domestic and wild animals and will maintain the health of the ecosystem.	Medium	WWF – Pakistan, Sanjh Development Organisation, VCCs, CBOs	Punjab Forest Department, Punjab Livestock Department	-	√	-
2.9.	Hazards of introduced fish species at Nammal Lake						
2.9.1.	Introduced fish species should be gradually removed, as this is against the PA rules and regulations.	High	Punjab Fisheries Department	Punjab Wildlife and Parks Department	-	-	√
2.9.2.	The issue of exotics and contracting out the fish to contractors also need to be discussed in the Punjab Provincial Wetlands Management Committee for policy level decision.	High	Punjab Fisheries Department	WWF – Pakistan, Punjab Wildlife and Parks Department	-	√	-
2.9.3.	Study the harmful impacts of exotic species in the region, so as to make an effective case for their removal.	Medium	WWF – Pakistan, Punjab Fisheries Department	Punjab Wildlife and Parks Department	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
2.10.	Presence of invasive / no-native species in and around the Protected Areas						
2.10.1.	The case of removal of exotics from in and around the Protected Areas needs to be discussed and highlighted in the Punjab Provincial Wetlands Management Committee for policy level decision.	High	Punjab Forest, Wildlife, Fisheries Departments	WWF - Pakistan	-	-	√
2.10.2	Plantation of native plants should be promoted in areas of high concentration of *Dodonea viscosa* and *Prosopis* sp. to recover non-invasive flora and climax species	High	Punjab Forest Department	SVDP, VCCs, WWF - Pakistan	-	-	√
2.10.3	A research study should be launched to utilise *Prosopis* sp. for different uses, especially for fuelwood, export for use as coal in brick kilns and explore other options to use in the particle board industry	Medium	WWF - Pakistan	Academia	-	√	-
2.11.	Non-biodegradable pollution originating from a broad range of human activities						
2.11.1.	Better Management Practices (BMPs) need to be discussed with the farmers adopting harmful agricultural practices, living in the close vicinity of these lakes. Farmer schools also need to be established, for effective decision making	Medium	Punjab Agricultural Extension Department	Sanjh Development Organisation, WWF – Pakistan, Farmer Schools	-	-	√
2.11.2.	Awareness and capacity-building campaigns should be launched preferably through the Farmer Schools and already established VCCs. The farming community should be taught in collaboration with local agriculture extension workers regarding the harmful impacts of various pesticides and fertiliser use and their ultimate impact in ground water quality.	Medium	WWF – Pakistan, VCCs, Farmer Schools	Punjab Agricultural Extension Department	-	-	√
2.12.	Excessive groundwater extraction for use in agricultural crops						
2.12.1.	Cropping patterns need to be studied in the region to find out the water requirements by different crops and to lobby for water efficient crops in the region.	Medium	Sanjh Development Organisation, Punjab Agriculture Department	VCCs, CBOs	-	√	-
2.12.2.	A well targeted awareness campaign should be launched in the entire region for water conservation.	High	WWF - Pakistan	Sanjh Development Organisation, Local Communities	-	-	√
3	Socio-economic Interventions						
3.1.	Lack of community empowerment, ownership of resources						
3.1.1.	It is therefore high recommended to organise communities (CBOs / VCCs) with respect to the management of natural resources of the Protected Area, so that the communities may take ownership of the resources and use them wisely.	High	WWF – Pakistan, Local partners	PRSP, other organisations, NRSP	-	√	-
3.1.2.	Comprehensive training programme for these CBOs / VCCs is essential in office and project management, proposal development and	High	WWF - Pakistan	PRSP, NRSP	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	negotiations with donors etc.						
3.1.3.	Sign Terms of Partnerships with organised communities for implementation of wetlands management interventions	High	WWF - Pakistan	Communities	-	-	√
3.1.4.	Develop a social maturity index for the organised communities in order to ensure their sustainability and determine their strengths and weaknesses.	High	WWF - Pakistan	Communities	-	-	√
3.1.5.	A local representation would be ensured from the region in the Punjab Provincial Wetlands Management Committee to represent local communities at the highest forum within the province	High	WWF - Pakistan	VCCs, NRSP, Sanjh Development Organisation	√	-	-
3.2.	Poverty and Limited Livelihood Opportunities						
3.4.1.	A wide range of training opportunities i.e. enterprise development, micro-finance, kitchen gardening, nursery raising, orchard development, eco-tourism, poultry farming, apiculture, livestock management through vaccination and de-worming, establishing vocational training centres and improved NRM practices may be provided to the local communities for improvement in their livelihood.	High	WWF – Pakistan	Government Line Agencies	-	√	-
3.2.2.	Typha looms, Mazri products, handicrafts are a few major livelihood development initiatives that should be promoted by enhancing increased access to market.	High	WWF - Pakistan	NRSP, Sanjh Development Organisation	-	√	-
3.2.3.	A well planned and comprehensive eco-tourism plan should be launched keeping in view the existing potential and facilities available in the region.	High	WWF – Pakistan, District Government, STFP	Punjab Forestry, Wildlife, Fisheries and Tourism Department	-	√	-
3.3.	Lack of alternate sources of energy						
3.3.1.	There is a dire need to make an assessment of the wood usage by these communities and initiate the process of providing alternate energy units (Biogas plants, fuel-efficient stoves, solar energy units including solar cookers, solar geysers etc.) in order to protect the remaining natural forests of the Protected Area. In addition, there is a need to negotiate at least 20-30% of the total cost of the unit with the local communities.	High	Livestock Department, Government of Punjab, Pakistan Dairy Development Council, WWF - Pakistan	Government of Pakistan's major initiatives	-	√	-
3.3.2.	Energy plantations (agro-forestry) also need to be established in order to overcome the issues of fuelwood in the region. Every household who owns land should meet their energy requirements from their own farmlands.	Medium	Punjab Forest Department	WWF - Pakistan	-	√	-
3.4.	Lack of developmental initiatives in the region						
3.4.1.	This region lacks access to government funds due to several policy and political reasons. This area is rich in resources and district government should move ahead in order to promote this region in terms of its	High	District Government	Donors, Government of Punjab	-	√	-

#	Issues / Interventions	Priority	Responsibility		Duration		
			Primary	Secondary	Immediate	Medium-Term	Long-Term
	biodiversity, landscape, resources and potential for agriculture and other human capital. Lobbying at the district and provincial level should be carried out by the communities to have more funds to alleviate poverty.						
3.5.	Lack of public education and awareness						
3.5.1.	A school level education programme needs to be established within the Protected Area through conducting Nature Club activities which may help in organising various school level events and where children can be involved in green activities.	High	WWF – Pakistan	Punjab Education Department, Government of Punjab	-	√	-
3.5.2.	Introductory and interactive education material needs to be produced in local languages to enhance the value of the biodiversity of the Protected Area. These should include posters, small booklets, brochures, and activity books for school going children.	High	WWF – Pakistan	Punjab Wildlife and Parks Department, Punjab Education Department	-	√	-
3.5.3.	Installing standard Protected Area signage at appropriate places within the region may also contribute in raising awareness of the local communities. Information and sign boards need to be introduced at various places to avoid road kills etc.	High	WWF – Pakistan	Punjab Wildlife and Parks Department	-	√	-
3.5.4.	Exposure Visits are an important tool in creating awareness amongst the local communities, where a wide range of initiatives are being undertaken in order to address NRM related issues in the region. This has proved very effective and is recommended for the local communities and other stakeholders to WWF – Pakistan's sites in the other regions.	High	WWF – Pakistan	Other large programmes and conservation and development projects by different aid agencies	-	√	-