Comprehensive Management Action Plan for Wular Lake, Kashmir

Final Report

Prepared for the :

Department of Wildlife Protection
Govt. of Jammu & Kashmir

By :

Wetlands International - South Asia

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COMPREHENSIVE MANAGEMENT ACTION PLAN FOR WULAR LAKE, KASHMIR

Submitted by :

Wetlands International - South Asia
A-25, (2nd Floor), Defence Colony
New Delhi – 110 024

Tel : +91 11 24338906, 32927908
Fax : +91 11 24338906
E-mail : wisaind@del2.vsnl.net.in
URL : www.wetlands.org

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Executive Summary

Wular Lake, the largest freshwater lake within River Jhelum basin plays a significant role in the hydrography of the Kashmir valley by acting as a huge absorption basin for floodwaters. The lake with its associated wetlands is an important habitat for migratory waterbirds within Central Asian Flyway and supports rich biodiversity. It is a major fishery resource in the valley supporting a large population living along its fringes. The wetland also generates revenue to the state government through fisheries and auctioning of water chestnut, fodder, and other economically important species. The catchment of the lake supports coniferous forests, and alpine pastures adding to the natural beauty and biodiversity of the wetland area. Recognizing importance of the wetland for its biodiversity and socio economic values, the Wular Lake was designated as a Wetland of International Importance under Ramsar Convention in 1990.

The processes and functions of Wular Lake are inextricably linked with the hydrological regimes of River Jhelum. Almost all the lakes located within different altitudinal gradients are directly or indirectly interlinked with River Jhelum. The impacts within the river system upstream and downstream are bound to have impacts on overall ecological functioning and socio-economic benefits derived from these wetlands. An integrated water resources management approach recognizing interconnectedness of wetlands with their catchments is imperative for their sustainable management.

Sectoral developmental activities have, however, failed to recognize the immense role of the Wular Lake leading to its degradation. Revenue centric approaches followed aimed at short term economic gains without realizing their long-term implications on the overall sustainability of the lake ecosystem. The developmental activities in the upstream reaches have further created severe downstream impacts, thereby threatening the tenability of the overall ecological and economic efficiency of resource utilization. Despite wetland based livelihoods, particularly tourism being the major sectors of economic growth in the valley, no attempts have been made for the management of Wular with Jhelum basin into developmental planning. The major thrust has been on the Dal Lake ignoring Wular although the largest wetland within Jhelum basin. Although the state government has recently constituted Wular and Mansbal Development Authority under aegis of Department of Tourism, the current institutional arrangements are ineffective coordinated actions for integrated

management. Local communities, central to lake management have been ignored in the planning and implementation process.

Lack of understanding of the values and functions of Wular Lake and its associated wetlands have led to conversion of its large area for agriculture, settlements, plantations and other developmental activities. All along the periphery, particularly in Sonawari the wetlands were drained through government sponsored programmes for agriculture development. Bunds were built up at various lake contour levels for the protection of crops and settlements against floods thereby fragmenting the lake ecosystem and changing its ecological character. Measures undertaken for flood protection, without considering connectivity of wetland and the role of Wular in hydrological regimes, have led to quick drainability and impairment of their capacity to moderate high flows and ability to retain water during the lean season. Catchment degradation leading to soil erosion and its deposition in the lake has further decreased water absorption capacity of the lake ecosystem. The increasing demand for firewood has brought a vast area of the lake under willow plantations mainly through the government sponsored schemes which have contributed to shrinkage of the lake area, degradation of resource base and overall poverty of marginalized communities depending on these resources for sustenance.

The approach followed for formulation of comprehensive management action plan on Wular Lake emphasizes on development of effective institutional mechanisms for conservation and management of Wular Lake within Jhelum Basin. Interlinkages of hydrological processes and biodiversity conservation have been assessed to develop strategies for sustainable resource management aiming at livelihood improvement of the communities while maintaining the ecosystem integrity. Although the data was grossly inadequate, broad trends emerged based on critical evaluation of information from various sources. Collation of existing information augmented through rapid surveys, intensive community consultations and participatory resource appraisals indicated the following:

- The area of lake as per topo sheets of 1911 was 217.8 sq km which includes 58 sq km of associated marshes. The area was reduced from157.74 sq. km to 86.71 sq km during 1911 to 2007. Overall there was reduction the lake area by 45% mainly due to conversion for agriculture (28%) and plantation (17%). Further associated marshes were reduced by 70% again due to conversions for agriculture and settlements.

- The role of Wular Lake to regulate flows has drastically reduced due to reclamation, siltation and interventions to enhance drainability of water for upstream flood mitigation. The lake presently builds up storage during winter months when the flows are in the lean phase and the high flows during summer are untapped. This situation has led to increased floods and droughts in the valley. This has also enhanced idling period of the river hydropower projects located downstream of Wular.
- One fifth of the water holding capacity has been lost over last three decades due to siltation from degraded catchments and wetland conversions for agriculture and willow plantations.
- Direct discharge of solid and liquid wastes from the settlements all along River Jhelum mainly from Srinagar city and other towns in the upstream area have led to degradation of water quality and health hazards to the communities living around the Wular Lake
- Decrease in water levels and degradation of its quality has led to decline in fish and waterbird diversity, shifting of vegetational belts and drastic loss in productivity of some economically important species. Invasive species have proliferated leading to decline in native species particularly *Schizotheorax* sp. and *Nelumbo*
- Decline in resource base and limited opportunities for livelihood diversification have led to poverty and reduced quality of life of communities living around the lake and its catchments. The prevalence of poverty between 41% – 52% within these communities is quite high compared to the state average of 3.91%
- Lack of well defined policy and regulatory mechanisms for integrated management has led to cross sectoral conflicts and overall degradation of wetland and its resources

Adopting New Guidelines of management planning for Ramsar site and other wetlands, the management planning framework developed seeks a balance between ecosystem conservation and livelihood security to the communities. It also seeks to ensure planning and implementation through an effective institutional mechanism to harmonize planning at various levels with participation of all concerned stakeholders to achieve the objectives of integrated conservation and wise use. Overall there are five components focused on land and water resources management, biodiversity conservation, ecotourism development, livelihood improvement and institutional development. Specific projects have been developed for each of the five

components and implementation mechanisms have been clearly defined to achieve the management objectives as identified under the action plan. Overall project duration is five years. Prioritization of activities has been also carried out based on analysis of key issues and mitigation of problems for regeneration of the lake ecosystem providing ecological, social and economic benefits. Cross analysis benefits of the action plan has been carried out to assess the feasibility of the interventions and efficiency of investment.

The implementation of the CMAP would lead to following benefits:

Ecological

- Reduction in overall soil loss from degraded watersheds through enhancement of dense forest cover to 40% of direct catchment area, reduction in area under degraded pastures and erosion enhancing agro practices to less than 1% of the catchment area and reducing harvest of fuel wood by 50%
- Rejuvenation of hydrological functions of Wular lake through 54% enhancement to present water holding capacity and restoration of hydrological connectivity to the marshes
- Water quality of Wular improved to B category as per CPCB designated best use criteria through management of sewage and sewerage from adjoining settlements and water quality regulations
- Allocation of water for human and ecological purposes through formulation and operationalization of stakeholder endorsed water management plan
- Enhancement of biodiversity through wildlife waterbird conservation
- Enhancement of water bird population through control of poaching, strengthening existing protected area network and habitat improvement
- Optimization of economically important plant species through water level enhancement
- Control of invasive species through effective flushing of lake

Socioeconomic

- Enhanced availability of 0.33 Mcum of small timber, 0.55 Mcum of firewood and 2,200 cum of leaf fodder to 8,500 hill households through restocking of 7,436 ha of degraded forests and agro forestry in 1,000 ha of croplands/ homesteads

- Enhanced availability of 800 MT of fuelwood to 32,000 lakeshore households through development of 500 ha of village woodlots
- Reduced fuelwood consumption by 30% through usage of fuel saving hearths by 4,000 hill and 16,000 lakeshore households
- Enhancement of annual capture fisheries production by 800 MT and culture fish yield by 1300 MT leading to an increase in annual income by Rs. 34,000 for 2,300 fisher households
- Community led management of lake fisheries and aquatic vegetation resources through establishment and operationalization of 24 cooperatives
- Enhanced access to fisheries infrastructure (landing, storage and processing facilities) to 2,200 fisher households through strengthening of 9 landing centers and creation of 4 fish processing and value addition units around Wular Lake
- Enhanced incomes of 6,000 hill and 8,200 lakeshore households by Rs. 35,000 / annum through operationalization of micro enterprise based on sustainable use of locally available natural resources
- Improved quality of life of 18,600 household through access to safe sanitation and drinking water facilities
- Opportunities of livelihood diversification to 8,000 lakeshore households through development of ecotourism

Institutional

- Establishment of an integrated policy framework for conservation and development of Wular and associated wetland
- Establishment of separate and accountable funding mechanism for conservation and management of Wular
- Enhanced awareness of decision makers and stakeholders on values, functions and attributes of Wular
- Enhanced technical and managerial capacity of WDA, government agencies and communities to implement wetland conservation and management initiatives
- Establishment of monitoring mechanisms for implementation of Action Plan
- Establishment of Hydrobiological and GIS laboratory for effective monitoring

Cost Benefit Analysis

An investment plan with an outlay of Rs. 386.39 crore over a period of five years has been proposed for conservation and management of Wular Lake. Water management, which is critical to lake rejuvenation has been allocated 72% of the overall investment, followed by 10% for catchment conservation. Sustainable resource development and livelihood improvement has been allocated 7% of the budget. The components on biodiversity conservation and institutional development have been apportioned 4% each of the budget. Three percent of the budget is earmarked for ecotourism development.

Economic analysis of the management action plan has been carried out to assess the overall efficiency of investments. Assessment of costs and benefits has been carried out using the tools of market and non-market evaluation. Estimation of Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio of the proposed investment has been carried out for assessment of investment efficiency.

Project costs have been estimated using the existing schedules of forestry and engineering and market rates. The costs have been annualized and indexed using an inflation rate of 5% per annum. The direct benefits accrued in terms of direct incremental gains through project implementation have been evaluated using tools of market and non market valuation. Project efficiency indicators have been assessed using a time frame of 20 years and a social discount rate of 5%. The annual phasing of costs is indicated in Fig 1.

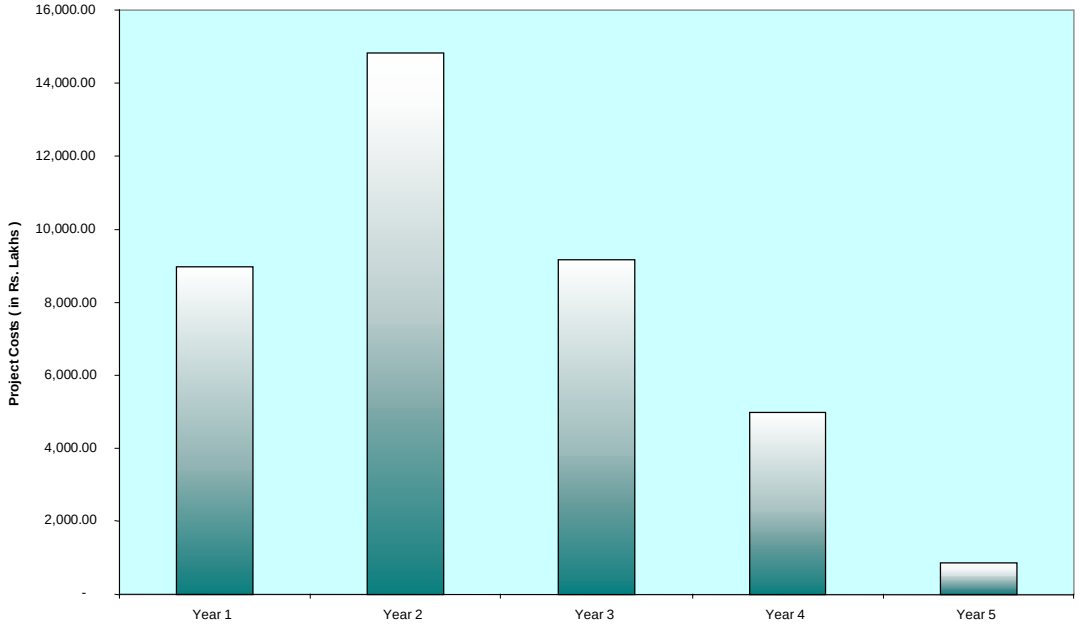


Fig 1. Annual phasing of costs

Economic assessment of project costs and benefits indicates that the project would break even within 12 years of implementation, and would be able to transfer tangible economic benefits equal to the total investment made to the local communities within this period. Benefits through ecotourism would contribute to nearly 40% of tangible benefits, followed by enhanced availability of timber and non timber forest produce and enhancement of lake fisheries. As most of the benefits are contingent on restoration of hydrological regimes, there is a lag of around 3 years before the stream of benefits actually begins flowing from the project. The high investment efficiency of the management plan is indicated by a benefit cost ratio of 2.74, an internal rate of return of 6% and Net Present Value of Rs. 268.34 crore at the end of 20 years. Sensitivity and risk analysis carried out indicate that the project remains economically viable even with a 20% increase in costs and as a high probability (86%) of reaching the envisaged benefits. Graphical representation of costs and benefits is presented in Fig 2:

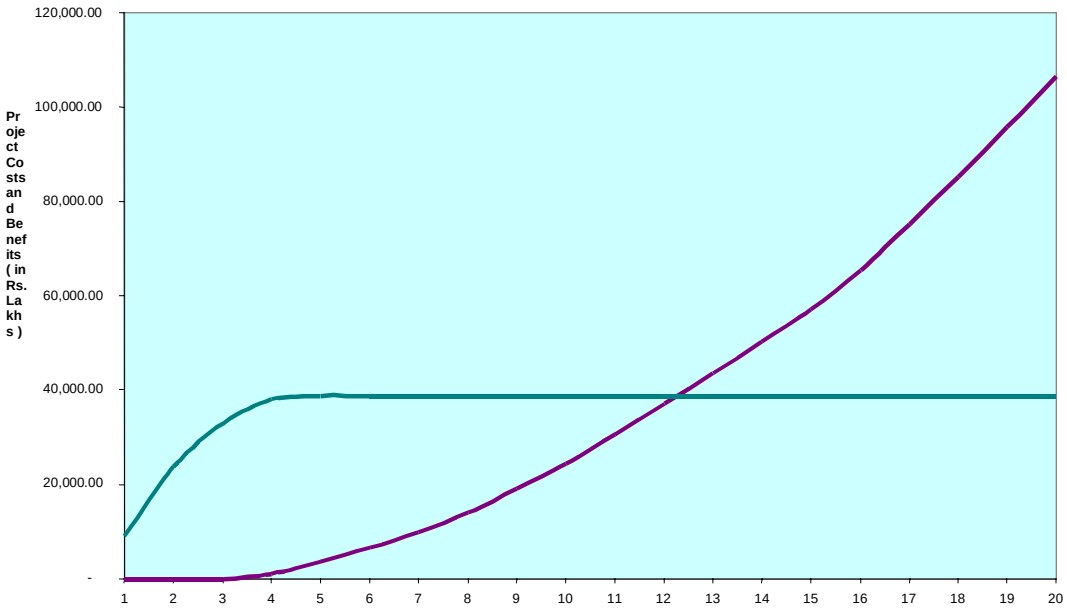


Fig 2. Cost - Benefit Projections

Recommendations

Institutional Set up

Establishment of Wular Development Authority

Wular Development Authority (WDA) be established in the Department of Wildlife Protection under overall administrative control of Department of Forests, Government of Jammu and Kashmir located in Civil Secretariat. The Department of Wildlife Projection is recommended to be the nodal agency as they are already involved in management of Ramsar sites in India including Wular Lake which was designated as Ramsar site in 1990.

The WDA - Governing Body would serve as executive board chaired by Chief Minister / Chief Secretary and responsible for overall policy directions and performance. The Wular Steering Committee, the high level empowered committee will be responsible for inter agency cooperation and overall achievement of the project aims. A Project Implementation Committee consisting representatives from the line departments of the Government of Jammu and Kashmir involved in Wular Lake be established with administrative and other support provided by WDA. Scientific and Community Advisory Groups be constituted to advise on implementation of management action plan. A project management unit comprising various teams including catchment area, water management, fisheries development, biodiversity conservation, community development and financial management be established for planning and implementation of specific projects under management action plan.

The Chief Executive, WDA will be the conveyor of the committee.

Water Management

Enhancing water holding capacity

Ningli Plantation currently occupying 27.30 sq km need be removed for enhancement of water holding capacity. The removal of plantation would help enhancement of water level by at least one meter which is critical to restoration of biodiversity. Selective dredging in critical areas and channels dropping into the lake would further create space for biodiversity enhancement. Improvising hydrological connectivity with existing marshes would further help water absorption capacity of the wetland system to control flooding.

Water quality improvement

Implementation of River Jhelum Conservation Plan (JRCP) as already approved in principle by the Ministry of Environment and Forests (MoEF) would help in the interception and the treatment of sewage before its outfall in River Jhelum. Under CMAP three sewage treatment plant at Bandipora and adjoining villages, 18200 low cost sanitation units in 44 peripheral villages are proposed. Wetland mediated techniques would help to control diffused sources of pollution in 10 villages on the southern part of the lake. Besides community based solid waste management facilities be provided in some key localities to control dumping of solid wastes in the lake.

Environmental flow assessment at basin level

For long term management it is critical to consider conservation and sustainable development of Wular Lake within Jhelum basin which essentially is linked with hydrological regimes. Scenario based approach on assessment of water demand for human purposes such as agriculture, drinking water, hydropower generation etc. as well as ecological purposes including fisheries, waterbird, floodplain conservation be developed.

Catchment Conservation

Erosion control

Treatment of 7436 ha of critically degraded forests in four watersheds of direct catchment area through aforestation in 3718 ha of fallow land, aided regeneration in 2788 ha and small scale engineering measures. Management of high altitude pastures by regenerating 4500 ha of pasture lands by fodder and forage plantations; and small scale engineering measures to augment the soil conservation measures by construction of check dams, vegetative spurs and gully plugging; Development of alternate sources of energy by raising village woodlots, promotion of smokeless hearths and construction of mini hydel project.

Biodiversity Conservation

Waterbird conservation

Strengthening the existing network of protected areas and establishment of new bird sanctuaries in the unprotected areas in the stretch of Malgaon – Saderkoot Bala – Ajas as bird sanctuary / community reserves would help protection of resident and migratory species from Central Asia. This would provide protection to the important

bird sites and combating poaching. Subsequently additional sites such as Bathi, Shahgund Kuch, Rawkuch, Gouchiri, Gundijahagir having significant importance in terms of bird population be include as additional bird areas for protection. Additionally these areas would provide basis for promoting ecotourism and generating awareness about the importance of Wular and associated wetlands.

Wildlife Conservation

Establishment of wildlife / bird sanctuaries in the Wular catchment

There have been a number of killings of human beings and severe injuries to many people due to wild animal attacks in Baramullah and Bandipore districts. This has sometimes led to killing of highly endangered wildlife animals. Creation of wildlife sanctuary in the Erin catchment which is the summer habitat of Hangul adjoining Wangat Wildlife Sanctuary would be critical to reduce the man animal conflicts and save the endangered species. Further this would provide sufficient space to wild animals to stay back in protected areas. Creating a network of rescue and rehabilitation centres around Wular Lake adjoining villages and trapping the wild animals would prevent them from damaging the livestock and human beings. These rehabilitation centres would also help the Wildlife Protection Department to trap the stray animals and put them in the rehabilitation centres till the snow starts melting and release them in the remote areas during spring.

Development of network of mobile rescue teams with mobile vans and captures equipment and medicines for restocking would facilitate rehabilitation of rare and threatened wild animals and bird species. It is also proposed to create a full fledge high altitude breeding centres for rare and threatened wildlife animals at Chitternar, Bandipore in the premises of Kashmir Forest Training (KFT) School at Chitternar for restocking and rehabilitation of highly threatened and rare species.

Harmukh, in the pathway of migratory birds should be also declared as a bird sanctuary for protection of birds. A detail survey and compensation modalities need to be developed before declaration.

Ecotourism Development

Development of recreational facilities such as boardwalk, nature trails, guided boat rides, angling spots, landscape gardens and facilities for aquatic sports in the lake would be an effective tool for diversification of livelihood opportunities for local communities and generating awareness about importance of Wular Lake within

Jhelum Basin. Educational and visitor interpretation services to be established at the critical locations particularly along the bund known as third line of defence to facilitate closer look at the Wular and enjoying the boat rides within the lake. Specific training programmes for various target groups would be part of ecotourism activities. Signages, communication and transport facility and visit to catchments would be part of ecotourism development.

Livelihood improvement

Sustainable fisheries development through enhancement of fish yield and diversity would be critical to livelihood improvement of the communities. Establishment of *Schizothorax* fish seed farm to revive fast dwindling native fish species. Restocking in the lake would help its revival not only in Wular but also in the entire river system along with its associated wetlands. Strengthening landing centres for monitoring the yield, provision of improved crafts and gears, enhancing live fish storage capacity and post harvest management would ensure sustainable fisheries development. Revival and strengthening fish cooperative societies proposed to reduce exploitation by the middleman and increase incomes of the local communities who depend upon these resources for their livelihoods. Additional and alternate of income generation opportunities have been proposed through a number of community based micro enterprises with inbuilt mechanisms for supporting credit needs as well as achieving financial and technical self reliance through investment into infrastructure and skill base.

1. Introduction

1 INTRODUCTION

1.1 Purpose of Comprehensive Management Action Plan

The Comprehensive Management Action Plan (CMAP) formulated outlines the commitment of Government of Jammu and Kashmir for conservation and management of Wular Lake within Jhelum River Basin. The CMAP has been prepared through comprehensive hydrological, ecological and social assessments involving state government departments, community organizations, research institutions and local communities. The information collected from various sources has been analyzed in consultation with experts and concerned government agencies for identification of key issues and strategies for formulation of CMAP.

The CMAP is based on evaluation of ecological and socio-economic features of Wular and associated wetlands within Jhelum River Basin. A critical analysis of these features provides the rationale for identification of objectives including the factors governing these features. These steps are critical to understanding of the basic characteristics of lake ecosystem and its dynamics within the river basin. Adopting this approach helps to undertake measures for development of specific action plan for sustainable management which can be monitored through indicators sensitive to changes in the ecosystem.

Panoramic View of Wular

The main emphasis of CMAP is on restoration of Wular Lake for ecosystem conservation and livelihood security of the communities dependant on the lake resources for sustenance. The plan emphasizes on ecotourism as a potential tool to conserve lake and its rich biodiversity while providing economic incentives to the local communities. Integrated Water Resources Management (IWRM) approach provides framework for coordinated action at the Jhelum Basin level to achieve harmonization of sectoral plans for conservation and wise use of Wular Lake. Additional / alternate income generation programmes have been proposed for the sustained economic development of the region with the focus on social equity and gender sensitivity. The plan is based on adoption of a community based approach to resource management with facilitation from government agencies and scientific institutions in terms of technical and financial resources.

The 'New Guidelines for Management Planning of Ramsar Sites and Other Wetlands' as adopted in the 8th Conference of Parties of the Ramsar Convention on Wetlands have been applied for diagnostic assessment of wetlands considering ecological and socio-economic features of wetlands and their catchments (Ramsar, 2002). Guidelines of Global Environment Facility, World Bank and Asian Development Bank have been used for formulation of ecologically feasible and economically viable plans for long-term management of Wular and associated wetlands. Sectoral development plans of the state and central governments as well as information available with

implementing agencies have been critically reviewed to assess the impacts of the plans and programmes in the project area and to develop strategies for integrated management.

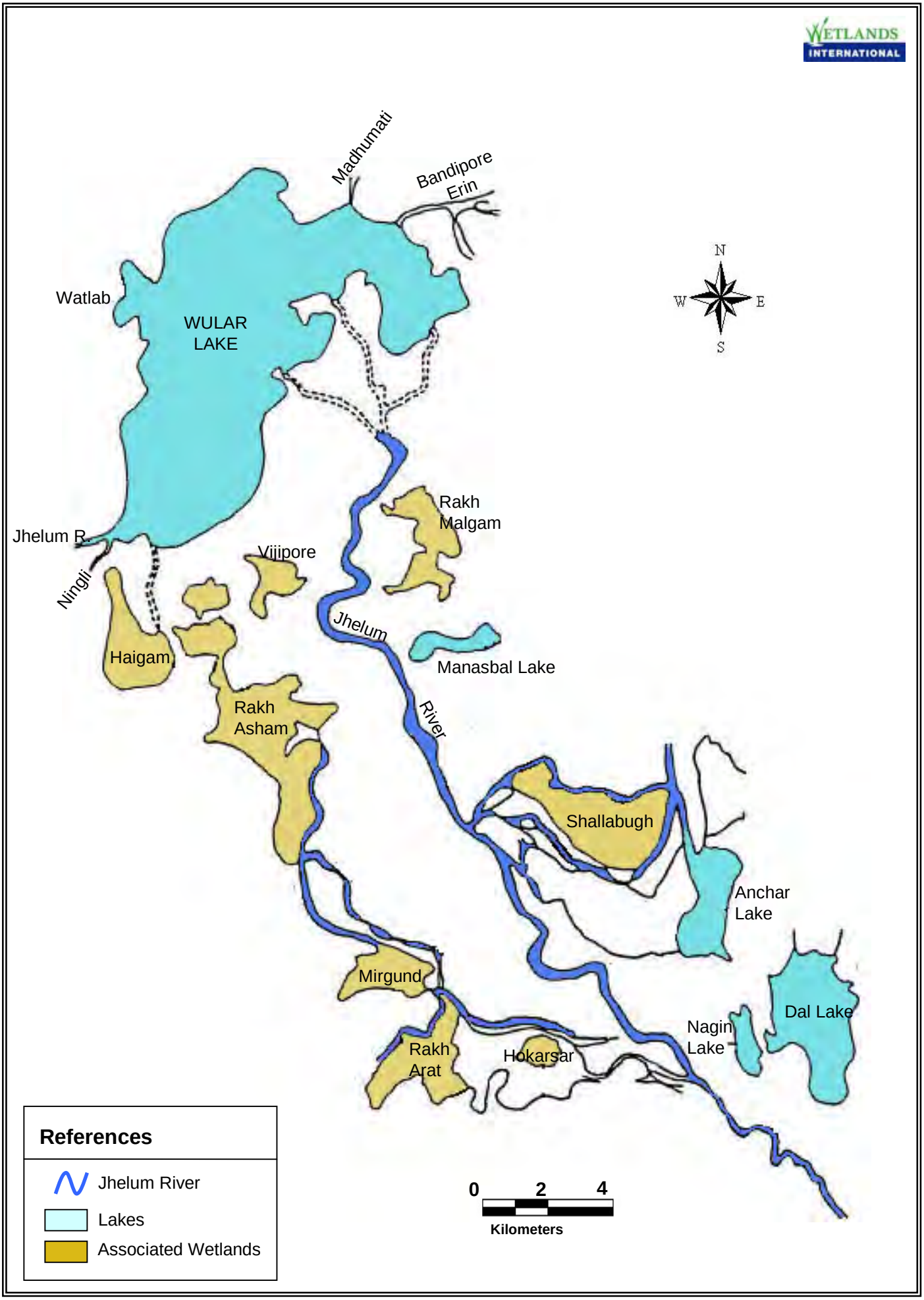
The CMAP aims at mainstreaming of wetlands of Kashmir valley in the national developmental planning process. Planning Commission in its approach paper for 10th Five Year plan (2002) has emphasized on enhancement of natural resources for sustainable livelihoods. Emphasis has been laid on the fact that mere expansion of production of goods and services and consequent growth of per capita income has not yielded desired results, leading to a shift from in the current management practices to specific focus on social development. Development process aimed at enhancing efficiency of resource utilization and economy's productive capacity involving both physical and human resources to attain the desired social ends is envisaged as the primary objective of the planning process. Realizing this, the present CMAP emphasizes on improving livelihoods of socially and economically weaker sections of the society which are entirely dependent on wetlands for their livelihoods. The CMAP has a special focus on poverty reduction through sustainable resource development and is in line with the approach followed by Planning Commission in its 10th Five Year Plan.

Planning Commission in its approach paper of 11th Five Year Plan has emphasized on restructuring policies to achieve a new vision based on faster, more broad based and inclusive growth. Tourism development has been identified as one of the key areas in the developmental sectors, which is highly relevant in case of Kashmir valley to identify new opportunities for economic growth and development. Wular Lake, once one of the largest lakes in Asia, has not received much attention from a tourism perspective. Eco restoration of the lake is linked with rehabilitation of River Jhelum and needs much larger focus in overall developmental planning process. Considering the limitations of further development in the conventional sectors of the state economy and uniqueness of Kashmir valley, a lot of emphasis has been given in CMAP on ecotourism development.

1.2 Project Area

Wular Lake is located 34 km northwest of Srinagar city at an altitude of 1,530 m amsl between $34^0$20' N latitude and $70^0$24' E longitude. It is elliptical in shape with a maximum length of 16 km and breadth of 7.6 km. The lake is surrounded by high mountainous ranges on the northeastern and northwestern sides, which drain their runoff through various *nallahs*, prominent being Erin and Madhumati (Map 1.1). On the eastern and southern sides are the low lying areas of Sonawari which used to get inundated almost every year until numerous criss-crossing embankments were constructed along River

Wular Lake



Map 1.1 : Wular and Associated Wetlands

Jhelum. The lake area thus reclaimed has in the recent past been brought under cultivation of paddy and plantations of willow, poplar and fruit trees. On the western side in the Sopore-Watlab section, lowlying areas have also been brought under paddy cultivation. On the eastern side of the lake is an island which was raised and shaped by a famous ruler of Kashmir, Zainul-Abidin, who ruled Kashmir from 1420-1470 AD.

Wular is a shallow lake with a maximum depth of 5.8m. The lake area has not been properly investigated although several estimates exist. As per the Directory of Wetlands of India (MoEF, 1990), the area of the lake is 189 sq km. The Survey of India maps of 1978 indicate the lake area to be only 58.7 km in winter. Taking into consideration, the highest flood level of 1,579 m, the present lake area has been computed to be 173 sq km. The revenue records, however, indicate the lake area to be 130 sq km.

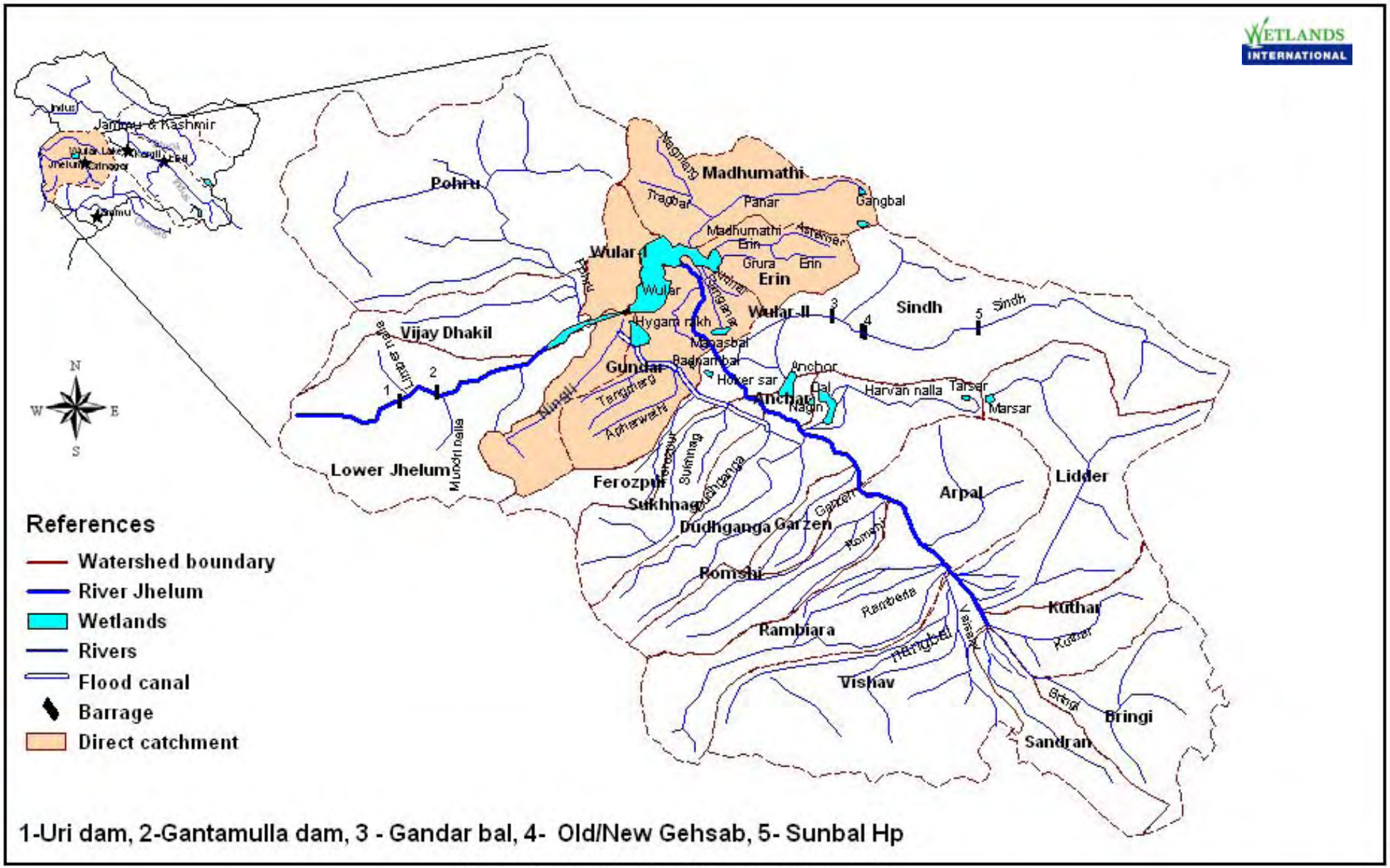
Wular Lake forms a part of River Jhelum basin which is a sub basin of Indus River (Map 1.2). The Jhelum basin extends to 12,777 sq km of which six watersheds with an area of 1,144 sq km drain directly into the lake forming its direct catchments (Map 1.3). The entire Jhelum Basin including the direct catchments is highly degraded and contributes to heavy load of silt into Wular leading to its shrinkage and reduced water depth. The lake is surrounded by 31 villages within districts of Bandipore and Baramulla with a population of 10,964 households as per 2001 census. The inhabitants of these villages depend directly or indirectly on the lake resources for livelihoods. More than half of the lakeshore population falls below poverty line with limited access to safe drinking water and sanitation facilities. Twenty six villages of nomadic origin inhabit the hills around the lake.

Wular with its associated wetlands supports rich biodiversity and provides important habitats for migratory waterbirds within Central Asian Flyway. The lake is the largest fisheries resource in Kashmir Valley supporting livelihoods of large human population living along its fringes. Regulation of hydrological regimes of the basin through Wular and its associated wetlands protects the Kashmir valley from floods as well as maintains flows to support agriculture and hydropower generation. The wetland also generates revenue to the state government through harvesting of water chestnuts, which grows profusely in the lake area. The catchments of the lake support coniferous forests, alpine pastures and orchards, adding to the natural grandeur of the wetland. Recognizing importance of the wetland for its biodiversity and socio-economic values, the lake was designated by India as a wetland of international importance under the Ramsar Convention in 1990.

1.3 Terms of Reference

Recognizing the importance of the Wular Lake within the River Jhelum Basin in ecological and economic security of the region, Government of Jammu and Kashmir engaged Wetlands International South Asia (WISA) to formulate Comprehensive Management Action Plan (CMAP) for Wular Lake. The CMAP aims to contribute to the eco restoration of Wular Lake to facilitate the social and economic development of the state while conserving rich biodiversity. The following ToR has been proposed for formulation of CMAP:

Map 1.2 : Location of Jhelum Sub-basin within Indus Basin



Map 1.3 : Wular Lake within Jhelum Basin

Land and Water Management

a) Catchment Conservation

- Identification and prioritization of critical microwatersheds based on assessment of land use, land cover and slope characteristics
- Suggest measures for treatment of prioritized microwatersheds to control soil erosion and regulate flow regimes through biological, limited engineering and other appropriate measures.
- Propose measures for management of high altitude pastures to control erosion
- Identify alternate sources of energy to reduce to reduce pressure on forests

b) Integrated Water Management

- Propose measures for enhancement of water holding capacity based on assessment of water and sediment balance
- Develop strategies for rejuvenation of existing wetlands within floodplains of Wular to mitigate floods
- Develop action plan for restoration of area under willow plantation and other encroachments
- Suggest measures for improvisation of water quality through provisions of adequate sanitary facilities, solid waste management, sewage treatment including use of wetland mediated techniques.
- Formulate water management plan considering human and ecological demands.

Biodiversity Conservation

- Develop an action plan for conservation of waterbirds through habitat improvement and protected area networking / community reserves
- Develop an monitoring mechanisms for assessment of migratory and residential waterbird populations
- Propose measures for strengthening protected area networks for conservation of rare / endangered species
- Suggest measures to control of invasive species and their economic utilization

Socioeconomic Development and Livelihood Improvement

- Analyze livelihood assets, vulnerability context and opportunities for interventions for livelihood improvement of wetland dependant communities
- Suggest measures for enhancement of fish yield and diversity using appropriate techniques
- Propose measures for management of aquatic vegetation for food, fodder, fuel and other uses
- Develop strategies for sustainable horticulture and agro forestry development within catchments for provisioning of timber and non timber forest products
- Develop strategies for additional income generation through micro enterprise based on sustainable use of wetland resources and innovative wetland mediated technologies.
- Design an ecotourism development plan based on carrying capacity of the wetland system.
- Suggest measures for improvement of quality of life of stakeholders through improved access to social and economic infrastructure

Institutional development and capacity building

- Propose an institutional mechanism for rationalizing and harmonizing planning and management practices to achieve integrated conservation and management of wetland
- Develop an effective monitoring and evaluation framework to ensure integrated conservation of wetland and livelihood improvement of dependant communities
- Develop action plan for communication, education and public awareness on values and functions of wetland and need for their conservation and sustainable use
- Develop action plan for enhancing technical and managerial capacity of state government agencies, research organizations, non governmental organizations and local communities for wetland management

1.4 Approach and Methodology

Almost all the wetlands in Kashmir are directly or indirectly connected longitudinally and altitudinally with River Jhelum. Most of the tributaries of Jhelum originate from glaciated lakes and govern the base flow of the river. The functions and processes of valley lakes are linked with those of glaciated and pine forest lakes. Changes in land uses within the catchments effecting hydrological processes will have a profound impact on the biodiversity and socioeconomics. Therefore, management of these lakes cannot be addressed at patch level without recognizing interconnected of wetlands with their catchments at river basin level.

River basin level planning requires understanding of the carrying capacity of the river basin with a view to produce desired goods and services from limited resource base and achieve equitable quality of life while maintaining desired environmental quality in the region. The planning for sustainable development calls for trades off between desired production and consumption levels. It also emphasizes on development of supportive mechanisms within the generative capacity while maintaining the environmental quality. The challenge, therefore, is to conserve wetland ecosystems along with their rich biodiversity while providing sustained economic benefits to the communities dependent upon these resources for their sustenance.

River basin approach has been adopted to address the management problems of Wular Lake taking into account the external, natural and induced factors and their influence on the ecosystems. Wular Lake and its resources are essentially adapted to the hydrological regimes and vulnerable to changes due to anthropogenic pressures. The emphasis for successful management of the lake, therefore, is on maintenance of ecosystem characteristics and sustainable utilization of its resources for the benefits of stakeholders, particularly local communities. Integrated management planning therefore aims at bringing together stakeholders at all levels and to consider their needs and aspirations while ensuring sustainability of wetland ecosystems within the Jhelum River Basin. The broad approach followed for formulation of management action plan on Wular Lake should take into consideration the following:

- Adopting river basin approach for conservation and sustainable development of wetlands.
- Integration of biodiversity into regional planning to minimize impacts of developmental activities

- Participatory approaches involving local communities, scientists, NGOs and concerned organizations to ensure sustainability of activities
- Adopting preventive measures by combating the problems at source rather than curative measures
- Revival of indigenous knowledge and traditional practices which are cost effective for management of wetland biodiversity
- Application of knowledge based techniques for restoration through research and development activities
- Periodic monitoring and evaluation with focus on achieving the goals and objectives rather than merely activities.

The 'New Guidelines for Management Planning for Ramsar Sites and other wetlands' as adopted in the meeting of 8th Conference of Parties to the Ramsar Conventions have been applied to develop the management planning framework. These guidelines emphasize on evaluation of ecological and socioeconomic and cultural features to identify factors, objectives and operational limits for effective restoration and management of the lake ecosystem. Application of these guidelines involved a comprehensive understanding of ecological and socioeconomic features based on elaborate social processes. WISA carried out rapid assessments and extensive Participatory Rural Appraisal (PRA) exercises and socioeconomic surveys in selected villages within the valley as well as in the hill areas to identify the critical ecological issues, socioeconomic conditions of the communities, resource linkages and their needs and aspirations. The evaluation of the features led to the identification of the management objectives. The critical problems confronting the lake were thoroughly analysed to develop rationale for the management objectives. The targets under each management objective were quantitatively defined wherever possible.

A team of experts having wide ranging experience in various aspects of management of wetlands were engaged to provide technical inputs for CMAP after consultations with stakeholders and rapid field surveys. The CMAP broadly focuses on biodiversity conservation and maintaining ecological processes and functions through land and water management. Sustainable resource development for livelihood improvement is proposed to be achieved mainly through fisheries development, economic utilization of vegetation and micro enterprise development based on value added wetland produce. Special emphasis has been laid on ecotourism development as an important tool for awareness generation on wetland values and functions and having potential of providing economic benefits to the local communities. Institutional development and community participation are envisaged as cross cutting components to achieve sustainable development of wetlands.

1.5 Structure of Project Report

The CMAP broadly includes five sections. Section One of the report summarizes the need for conservation and management of wetlands within Jhelum River Basin based on extensive information collected from various sources. Section Two highlights the rationale and scope of the project based on available information and rapid surveys carried out on ecological, socio-economic and institutional aspects. A critical review of the features has been carried out to define rationale for identification of objectives and outlining approach and strategies for management planning of wetlands. Section Three of the report summarizes the management planning framework of the project with clear-cut goals, objectives, targets, indicators and strategies. Section Four of the report outlines the planned interventions and activity programme. Section Five provides activity wise costs and workplan for various components.

2. Rationale and Scope

2. RATIONALE AND SCOPE

2.1 Wetlands of River Jhelum Basin

Wular and associated wetlands form a part of River Jhelum basin, which is a sub basin of Indus River. The trans-national basin extends to an overall area of 33,300 sq km within India and Pakistan and covers 3% of the overall Indus Basin area. Khadanyar Gorge, a geological fault zone and location of distinct changes in hydrological regimes divides the Jhelum basin into two segments. The upper segment of the basin extending to an area of 12,777 sq km drains the entire Kashmir Valley.

The basin is bowl shaped forming an elongated depression between the Great Himalayas in the north east and the Pir Panjal ranges in the south west. The Pir Panjal ranges separate the basin from the great plains of Northern India whereas the Great Himalayas separate the valley from Ladakh. The highest mountain peaks enclosing the basin have an elevation of more than 5,300 m amsl on the Great Himalayan side and more than 5,500 m amsl on the Pir Panjal side. Important peaks surrounding the basin are Nanga Parbat and Tosh Maidan in the north; Mahadev, Gwash Brari and Amarnath in the South; Kazi Nag on the north west and Harmukh on the east.

View of River Jhelum

The physiographic features of the basin change rapidly with the altitude. At the topmost fringe of the basin are the glaciers which serve as the main source of water for the basin. Forests are mainly located between 1650 – 3500 m amsl, with distinct species changes along with the altitudinal gradient. Deodar – kail forests are located within 1650 – 2600 m amsl, followed by the fir forests found within 2600 – 3500 m amsl. Tree line on the upper fringes of southern and south western forests is dotted with alpine pastures locally termed as margs. Gujjers and Bakkerwals, nomadic tribes raising livestock for sustenance dot these pastures. Tangmarg, Gulmarg, Khilanmarg and Sonmarg are the principal pastures within the basin. During the spring when the snow melts, flowers of all colours appear in the margs creating a stunning panorama of colours.

The rest of the basin area forms a vast plain consisting of Kashmir valley and its four side valleys, namely the Lolab, Lidder, Sind and Kishenganga. With an area of 4,865 sq km and altitude ranging from 1400 – 1650 m amsl, the Kashmir Valley is the demographic and economic hub of the basin, inhabited by more than 85% of its total population The Karewas (Wudars) are the unique physical feature of the Kashmir Valley. These are flat topped terraced features, developed in morainic deposits of the Pleistocene glaciation. Primarily freshwater deposits found as low flat mounds or elevated plateaus, the Karewas are formed of clay, sands and silt of lacustrine origin. The Karewas account for nearly 50% of the overall valley area and extend from Kulgam in the south east to Baramulla. The Karewas on the left bank of River Jhelum are extensive and massive till the Northern west end, whereas they are quite few in number and smaller in extension on the right bank. These alluvial land features provide conducive environment for growth and development of temperate fruits including apple, almonds and walnuts, as well as saffron. The Karewas on the right bank are mostly flat topped, whereas those on the north west and west are sloping along the flanks of Pir Panjal range (Map 2.1).

Wetlands of Jhelum basin are mainly of three different types with respect to their origin, altitudinal situation and nature of biota they contain. Basically all are high altitude wetlands (altitude 1585-4000 m amsl) as compared to those located in the plains of India (altitude <500 m amsl). The first series of the lakes (Alipathar, Sheshnag, Kounsarnag, Tar Sar, Mar Sar, Vishansar, Gangbal, Kishna Sar, Kyo Tso, Panggong Tso, etc.) situated on the inner Himalayas between 3000 – 4000 m amsl altitude are glaciated lakes which have probably originated during the third Himalayan glaciation. The second series of lakes (Nilnag) are present in the lower fringes of Pir Panjal ranges and have come into existence due to tectonic activities. They occupy the latitudinal ranges between 2000 to 2500 m amsl right in the midst of pine forests. The third series designated as the valley lakes (Dal, Anchar, Mansbal etc.) situated at the altitudinal zone of 1585 – 1600 m amsl are the valley lakes which occur all along the course of river Jhelum.

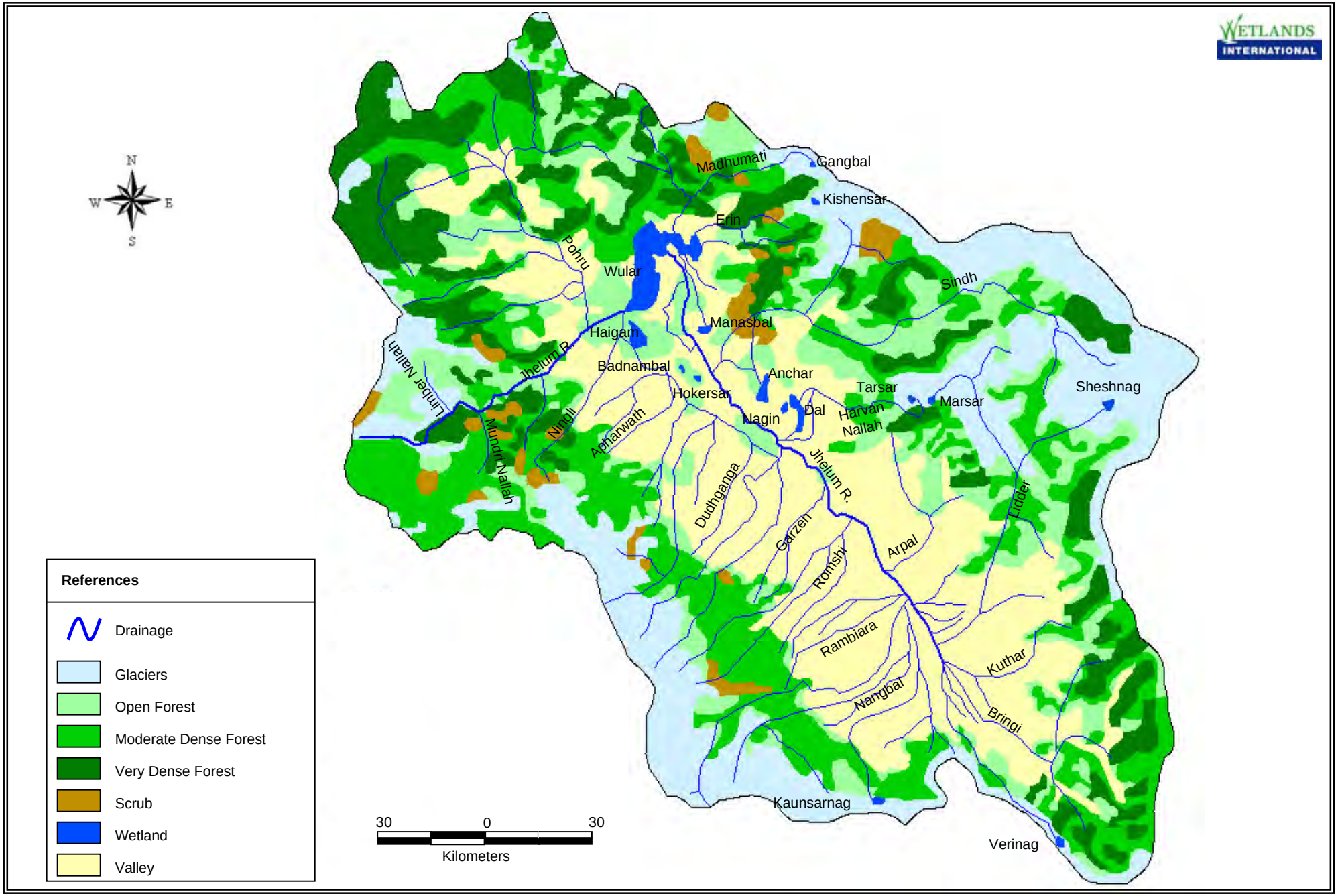
Almost all the wetlands in Kashmir are longitudinally and altitudinally interconnected. Most of the tributaries of Jhelum originate from glaciated lakes and govern the base flow of the river. The functions and processes of valley lakes are linked with those of glaciated and pine forest lakes. Changes in land uses within the basin therefore have a profound impact on the processes and functions of the wetlands. Management of these lakes cannot be done at patch level without addressing the river basin.

2.2 Wular Lake: Ecological and Socioeconomic Features

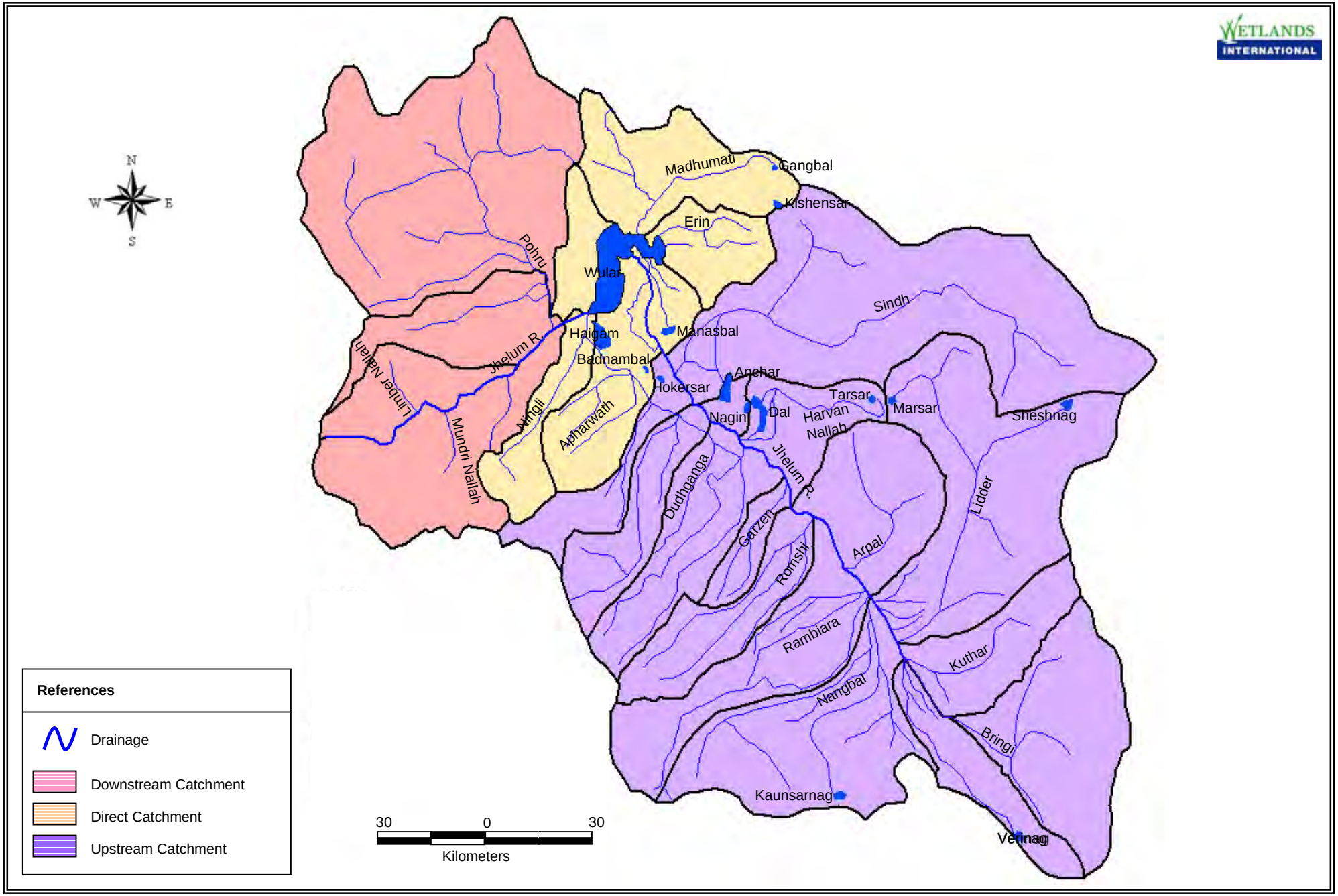
2.2.1 Wetland Catchments

The catchments of Wular Lake are essentially linked with the entire Jhelum Basin, which extends to an area of 12,777 sq km comprising 24 watersheds. The basin can be broadly classified into following three sub catchments (Map 2.2).

a) Wular upstream sub catchment comprising 14 watersheds of River Jhelum prior to its entry into Wular, extending to 8,627 sq km
b) Wular direct sub catchment comprising 6 watersheds directly draining into Wular extending to 1,144 sq km.
c) Wular downstream sub catchment comprising 3 watersheds of River Jhelum below Wular extending to 3,006 sq km.



Map 2.1 : River Jhelum Drainage Basin



Map 2.2 : Wular Catchment

Forests account for 5,348 sq km area of the River Jhelum catchment. The forests, being temperate, are dominated by coniferous trees. Deodar (*Cedrus deodara*), Kail (*Pinus excelsa*), Silver fir (*Abies webbiana*), Kachil (*Picea morinda*) and Birch (*Betula utilis*) are the key species found in these forests. Excessive harvesting and over exploitation of Deodar has led to its virtual elimination, and it presently comprises less than 0.4% of the total area. The area under Deodar is presently colonized by Kail, propagated through the Forest Department plantations in the last two decades. Kail forms the principal species on the lower altitudes whereas fir dominates the higher reaches and shady ravines. The conifers form the dominant component of the canopy throughout except in certain moist patches where deciduous species viz walnut, ash and bird cherry occur in abundance. The tree growth ends with birch and junipers. Alpine pastures fringe the tree line at higher altitudes.

Forest Area within Wular Catchment

Agriculture and horticulture account for 38% of the basin area. Rice is the primary food crop of the basin grown cultivated in 35% of the gross cultivated area. There is a single cropping pattern within the entire basin. The other important crops grown in the valley include oilseeds, mainly mustard and pulses. Horticulture accounts for 18% of the gross cropped area and is the mainstay of the economy of the state. The total area under horticulture within the basin extends to 1,749 sq km, of which 65% is under fresh fruits primarily apple and rest under dry fruits (walnut and almonds).Maize, the staple food of Gujjers and Bakerwals is cultivated in the hills and accounts for 26% of the area. Maize is a kharif crop sown during May – June and harvested in September – October. The rich harvest of the crop is mainly based on application of heavy doses of animal fertilizer.

The Jhelum Basin is inhabited by 5.4 million people living within its 34 towns and 2846 villages. The population concentration is within the valley, which accounts for 84% of the total population, with the rest sparsely distributed within the hills. Consequently, the population density of the valley at 947 persons per square kilometer is nearly 8 times higher than that of the hills. Based on the census estimates of 2001, 91% of the urban population lives besides River Jhelum.

Assessment of land use within basin indicates the following:

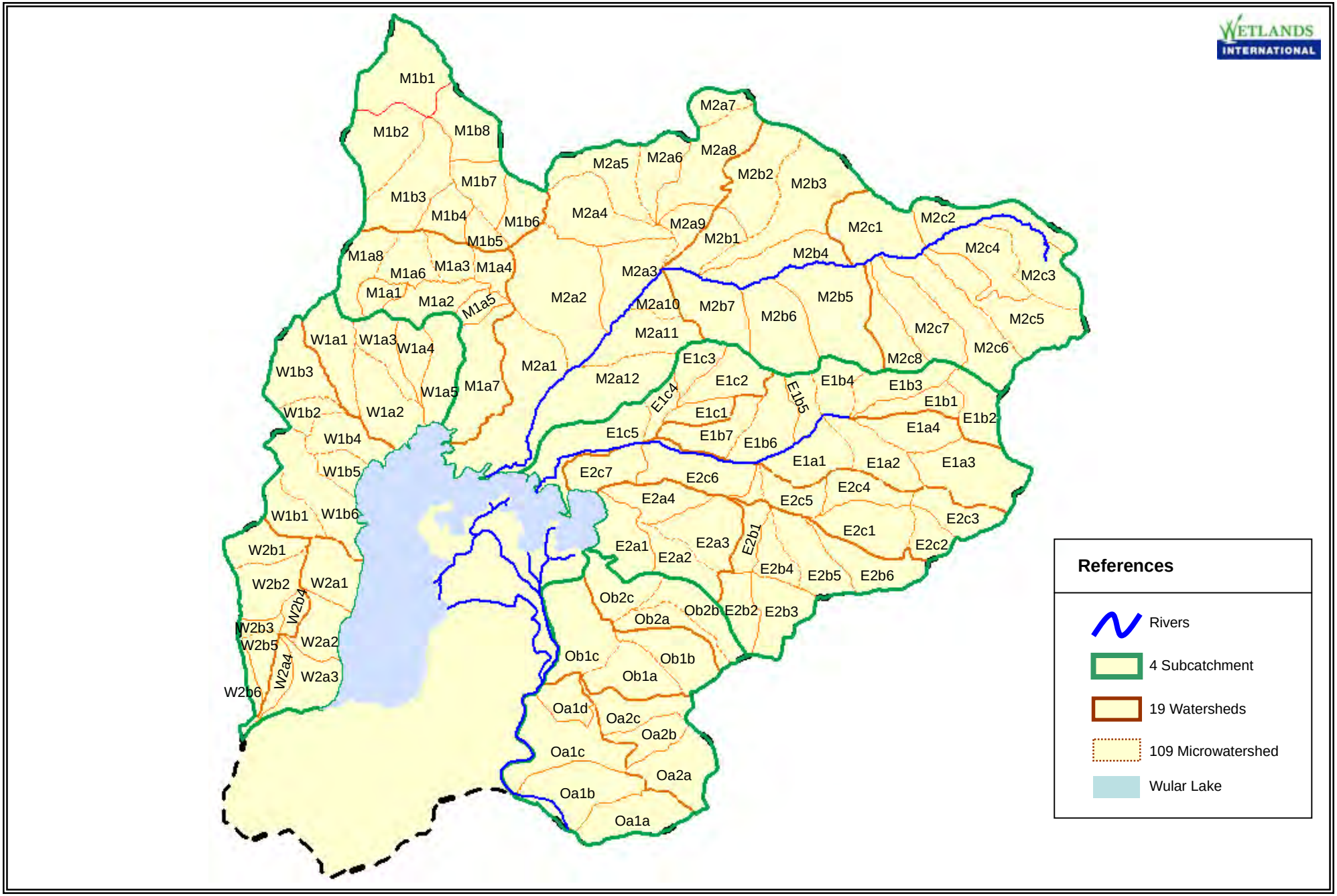
- Rapid degradation of forests due to over extraction for fuelwood and over grazing of the pastures leading to soil erosion and consequent sedimentation and loss of water holding capacity of the wetlands
- Run off from agricultural fields subjected to heavy dose of fertilizers and getting washed off into the lake leading to severe problems of eutrophication
- Application of pesticides and other chemicals in the horticulture crops which finally leaches into the lake leading to deterioration of water quality.
- Rapid increase in population encroaching upon wetland area leading to its shrinkage

Realizing the interconnectivity of the wetland regimes with the river flows, river basin approach needs to be adopted for management planning for Wular Lake. This requires treatment of the entire catchment of river Jhelum for control of soil erosion and regulation of flow regimes. However, the direct catchments need to be undertaken on a priority basis considering the present scope of project.

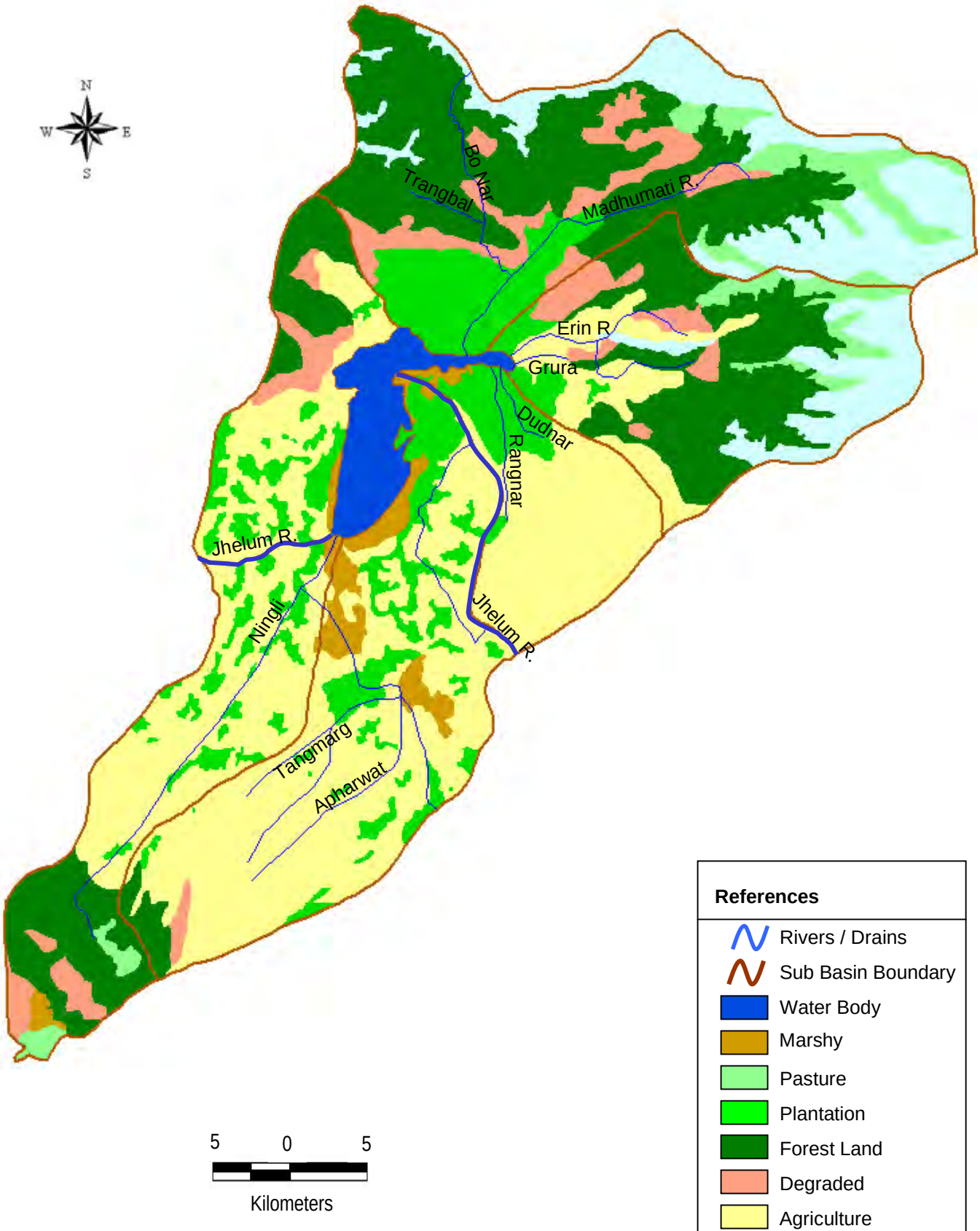
The direct catchment extending to 1,144 sq km comprises 6 watersheds. Madhumati and Erin watersheds located on the northern periphery of Wular, account for 32% and 20% of the catchment area respectively. Madhumati or Bod Kol as it is called in the higher reaches rises from the northern slopes of Harmukh glacier with its feeder streams spread over vast areas between Nagmarg in the west and Sarbal Nag in the east. It is a closed valley till village Bonakut where it spreads laterally into an alluvial triangle where a number of villages and hamlets have settled. Vija Nar and Harpat Nar join Bok Kol at Panar. Madhumati drains into Wular near Dacchigam passing through Kalusa Bridge. Erin catchment is contiguous to Madhumati on its northern side. The nullah is formed from the drainage of Shir Sar and Sukha Sar draining through Chitrar Nala, Titwan Kain Nullah, Kubnai Nar which meet at Isrur tar to form Erin. Erin watershed can be further delineated into 5 sub watersheds and 33 microwatersheds. Similarly, Madhumati watershed can be classified into 5 sub watersheds and 43 microwatersheds.

The southern tip of Wular is enclosed by Ningli and Gundar watersheds. Ningli drains highly erodible Karewas whereas Gundar watersheds are influenced by the drainages of Tangmarg and Apharwath, the famous alpine pastures of Kashmir. The lake is flanked on the left and right by a series of short and flashy drains. The western flank drainage forms the Wular 1 watershed, whereas Wular 2 is formed of the right bank drainage. Wular 1 is separated from Pohru catchment by a ridge , and is also called the Zaingeer illaqa , after the name of an old irrigation canal that drains the irrigated agricultural lands of the watershed. Wular 2 is drained by Gurthajan Nar, Rang Nar, Kol Nar, Bod Nar, Gujjar Nar and Dudh Nar. These drains form extensive marshes on both sides of River Jhelum and play an important role in governing hydrological regimes, apart from sustaining rich biodiversity. Wular 1 and 2 watersheds can be further classified into 4 and 5 watersheds and 20 and 13 microwatersheds respectively. Micro watershed level delineation map of the four of the six watersheds based on the drainage map of the area is presented as Map 2.3.

The land use of direct catchment is dominated by forests which account for 39% of the overall area (Map 2.4). Agriculture and horticulture account for 30% and 10% of the overall area respectively. Pasture account for 8% of the total area. Eleven percent and three percent of the watershed area is under glaciers and high altitude lakes (Table 2.1).



Map 2.3 : Catchment Delineation



Map 2.4 : Land Use of Wular Direct Catchment (1993)

Table 2.1: Land use of direct catchment of Wular Lake

Watershed Name	Total Watershed Area	Glaciers	Forest	Agriculture	Horticulture	Pasture	Wetland
Wular 1	14,647		2,000	8,600	2,500		1,547
Erin	23,161	6,300	10,400	4,500	800	1,161	
Madhumati	36,868	6,000	19,110	4,500	3,500	3,758	
Wular 2	8,939		2,000	5,300	839		800
Ningli	14,591		4,000	5,000	1,500	4,091	
Gunder	16,195		7,000	6,000	1,800		1,395
	114,401	**12,300**	**44,510**	**33,900**	**10,939**	**9,010**	**3,742**

The following are the key features of direct catchments of Wular:

- Forests extend over 445 sq km of the direct catchment area. The forests, being temperate, are dominated by coniferous trees. Deodar (*Cedrus deodara*), Kail (*Pinus excelsa*), Silver fir (*Abies webbiana*), Kachil (*Picea morinda*) and Birch (*Betula utilis*) are the key species found in these forests.

- Alpine pastures, extending to 8750 ha, located above the tree line are unique features of the catchment. Several ethnic groups as Gujjars , Bakkerwals, Pohloos (shepherds) and Doombs (herdsmen) use the pasture lands as grazing areas for sheep and other cattle. Of the seven recognized nomadic routes, Bakkerwals enter the direct Wular catchment through route 5 and spend part of their summer in the alpine pastures before proceeding to Gurez and beyond. Some of the important alpine and sub alpine pastures in the direct Wular catchment are:

  From Chewa to Gurura Village: Hamwas, Lundi, Dakbat, Rangdori, Sarwas, Larmarg, Zadsar, Kanidalan, Aragan, Salban, Kanzdor, Sarbalsar, Seonar, Kubbi

  Gurura to Nadihal: Jaban, Gangbal, Hapatnak, Salnai Nar, Gugurwain, Dadan, Mukarpathri

  Bandipora and Ashtangu: Chitarnar, Semthan Tsochalpather, Chitrikain, Sarebal, Rangdaur, Razdhainangar, Chandafi, Nangmarg, Gobaidehak, Traghal, Lashkut, Viji Gali, Madhumatisar, Nunwan, Koraginal, Kanzalwan, Gurez

- Agriculture land are spread over 339 sq km. Of the total area, only 55% is provided with irrigation facilities, the rest being entirely rainfed. Rice is the main crop grown in the irrigated areas; while maize and oilseeds are grown in the rainfed areas with very low agricultural yield. Presence of perennial sources of water from Erin and Madhumati Nullahs has facilitated development of an effective irrigation system in the entire area. Aragam and Garura canals irrigate inner valleys of the two important areas of Gurura and Aragam downstream. Similarly Jinder canal system emanates from Erin and runs across the barren slopes to irrigate sizeable areas of the catchments. The canal system supports rich paddy cultivation in the forms of well laid out terraces, which also lend scenic beauty to the hinterland. Above the irrigated areas, dryland farming is practiced in 15,350 ha, primarily under maize and pulses.

Catchments of Wular Lake are highly degraded. Against more than 50% of very dense forests in the 1950s, presently only 30% remain under dense forest cover. Approximately 30% of the catchment area is bare and denuded.

The following key factors have been identified based on assessment of land use changes:

- **Conversion for agriculture and horticulture development:** A Rapid increase in the population has accelerated the need to bring more area under agriculture and horticulture development at the cost of forests. As per assessments carried by the State Department of Environment, the forest area has declined by 6.2% during 1950 – 1997, with a concomitant 13% increase in area under agriculture.

Conversion of the Lake Area

- **Increasing dependence for energy:** Kashmir valley has one of the highest dependence in forests resources for meeting their energy requirements. The average annual per capita consumption of fuelwood in Kashmir is one of the highest levels in the country. However, the regenerative capacity of the forests has come down sharply owing to the degradation, and at present the forests are capable of meeting only 20% of the fuelwood demand. The forest line therefore has shrunk along the margins. For example, in Kuhnis village situated at the banks of Wular, the forest line has receded by 0.8 km during last 30 years, whereas the women of nearby Panzgam village trudge 2 km more to reach the forests.

- **Adoption of erosion intensifying agropractices in catchments:** Nearly 30% (4,600 ha) of the area under dryland agriculture is under severe erosion as these are ploughed across the contours. This has resulted in creation of channels, nullahs and gullies contributing high sediment load into the lake. High fertilizer intensity in horticultural lands contributes to overall nutrient enrichment of the water sources, which ultimately flow into Wular.

Degradation within Wular Catchment

- **Degradation of high altitude pastures:** The pastures under the Wular direct catchment are under constant pressure of the nomadic grazers with enormous number of low yielding cattle and sheep moving from meadow to meadow in search of grass. Over use of pasture land has resulted in spread of weeds like *Euphorbia wallichi, Senecio chrysanthemoids, Slipa sibrica, Sambucus wightiana* and *Rumux* spp. This has led to reduction in grazing area as well as fodder production. Presently, 2000 ha of the pasture land is identified as severely eroded, 2,500 ha as moderately eroded and 4,100 ha as under slight erosion.

- **Quarrying:** Quarrying is an intensive activity in the direct catchment, particularly along the Bandipora – Srinagar road in the Sadarkote Sector. During the course of survey, 78 stone quarries were identified of which 69 were concentrated in Sadarkote Bala. These quarries run throughout the year and dislodge tremendous quantity of loose stones, pebbles and slush which enter into the lake bed during the monsoon seasons. Besides, sand and bajri mining is also taken intensively within the Madhumati Nallah catchment near Kaloosa. These activities severely alter the natural siltation profile of the catchment.

Quarrying Activity

Degradation of the catchments has contributed to high levels of erosion. Assessment of erosion intensity carried out by the Forest Department using 1997 remote sensing imagery integrating information on slope, aspect, and land use reveals that 43% and 19% of the catchment area falls under high and moderate erosion categories (Table 2.2):

Table 2.2: Erosion intensity classification for Direct Catchment of Wular Lake

Watershed Name	Total Watershed Area	Erosion Intensity Class 1 (Low Erosion)	Erosion Intensity Class 2 (Moderate Erosion)	Erosion Intensity Class 3 (High Erosion)
Wular 1	14,647	3,000	1,000	10,647
Erin	23,161	16,000	6,161	1,000
Madhumati	36,868	19,600	9,980	7,288
Wular 2	8,939	939		8,000
Ningli	14,591	3,700	2,200	8,691
Gunder	16,195		2,295	13,900
	114,401	**43,239**	**21,636**	**49,526**

2.2.2 Hydrological Regimes

River Jhelum Drainage System

Hydrological regimes of Wular Lake are primarily linked with Jhelum and its tributaries. River Jhelum, a part of the Indus River system, is a transnational river flowing through India and Pakistan. The river flows for 992 kms before merging with the Chenab and subsequently into Indus River before draining into Arabian Sea through the Indus Delta. Along its course, the river within its upper reaches is also known as Vyeth and Koshur Darya.

River Jhelum arises within the Pir Panjal ranges located near Banihal from Verinag spring. Several freshwater streams arising from the south eastern part of Pir Panjal mountains meet together with flows of River Arpal from the north east and Bringi and Sanderen from the south east to from River Jhelum at Khanbal. Lidder River, arising from Lake Sheshnag and flowing through Pahalgam Valley joins the Jhelum at Gur near Anantnag. At Sangam, the Jhelum is joined by two of its tributaries in the left bank, namely the Vishav and Rambiara. Both tributaries arise from the Pansal mountains. Vishav arises from the Konsarnag Lake and before joining Jhelum carries the flow of all the streams arising from the northern slopes of Pir Panjal Mountains between Sidau and Banihal Pass. Rambiara arises from the Nandansar and Baghsar Lakes of the Pir Panjal mountains. Jhelum is next joined by tributaries Arpal on its right bank at Charligund and Romshi on its left bank.

Jhelum at Srinagar is joined by Tsunth Kul, which connects the Dal Lake receiving flows of Tarsar through Telbal Nullah. River Dudhganga, arising from the eastern slopes of Pansal Mountains meets River Jhelum on its left bank at Chhatbal. Below Srinagar, River Sind joins Jhelum at Shadipur. River Sind, rising from the Gangbal Lake on Harmukh Mountains and flowing through Zojilla and Amarnath peaks, is the longest tributary of River Jhelum. It braids into numerous branches at Durham, forming extensive lakes and marshes of which Anchar is the largest. Sindh joins River Jhelum after leaving Anchar. Jhelum thereafter flows through Wular Lake, entering at Baniyari and exiting at Sopore. Between Asham and Baniyari the river is connected through several small streams draining the Asham and Malgom marshes. Upstream of Sopore, the river is joined by the tributaries of Sukhnag and Ferozepur Nullah. These tributaries rise at Palas and join Trikulabal which then joins Ningal which rises in the Apharwat peak above Gulamarg.

Beyond Sopore, the first tributary to join Jhelum at its right bank is Pohru. Pohru River is formed by the junction of Kahmil and Lolab streams at Moghulpur village, and meets river Jhelum at Doabgah. About 15 kms Doabgah, Jhelum is joined by Mundri and Buniyar streams along the left bank and Limber nullah on its right bank. After this, the river enters the Khadangar Gorge, where it supports run of the river schemes for hydropower generation at Ghantmulla. Jhelum thereafter follows a westerly course for 120 kilometers joining Kishenganga at Domel in Muzaffarabad. Kishanganga rises from the eastern end of Tilail valley and flows through Gurez valley and Drawar before meeting Jhelum. Below Muzaffarabad, the Jhelum turns south, and after being joined by Kunihar River continues upto the town of Jhelum in Pakistan. It is thereafter joined by River Poonch on its left bank. River Jhelum joins Chenab at Jhang Maghiana in Pakistan. The Chenab River thereafter continues to flow till Panjnail in Pakistan, where it meets Indus. The river finally falls into Arabian Sea after braiding and forming the Indus Delta, known for its rich mangroves forests extending to over 6,000 square kilometers.

Water Inflows and Outflows

There is a marked absence of detailed information on hydrological regimes of Wular. The present assessment is based on analysis of the following information made available through the weekly discharge records of State Irrigation and Flood Control Department:

- River Jhelum at Baramulla from 1922 to 1993
- River Jhelum at Sopore from 1985 to 2003
- River Jhelum at Asham from 1990 to 2003
- Nallah Madhumati from 1990 to 2003
- Erin Nallah from 1990 to 2003

In addition to the above, historical records on Wular Lake collected through State Archives for the period 1900 – 60 were analyzed for trend analysis. Concomitant flow observation periods have been used to analyse trends in water inflow, outflow and water holding capacity. Analysis of water inflows and outflows collected at various stations from 1922 – 2003 highlights the following:

- River Jhelum is the largest contributor of water inflows (88%) into Wular, the rest being from the immediate catchments and precipitation. Similarly, the outflows through River Jhelum is the highest (96.9%), the rest accounted for by human abstractions (1.7%) and evapotranspiration (1.4%).

- There is a high temporal variability in inflows and outflows. Eighty percent of the inflows and 86% of the outflows take place in summer (Fig 3).

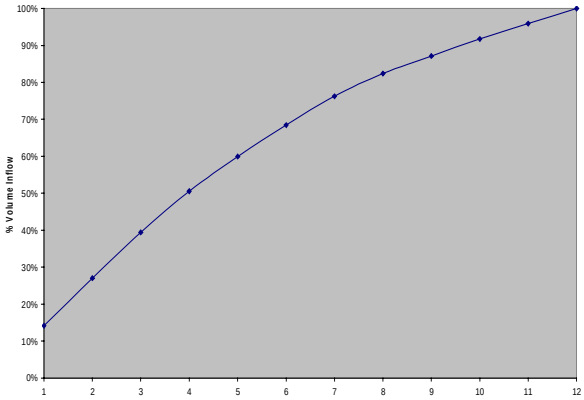


Fig 3: Temporal distribution of wetland inflows

- The net outflows from the Wular (measured at Sopore) are higher than the inflows (Fig 4). The wetland system is a net absorber of water from September to February, which is then released during March to June. During a flood year, the net outflows from the wetlands system are positive, which is reverse in the case of a drought year leading to periodic floods and droughts. The storages are usually built during the winter months, when the flows are already in the lean phase.

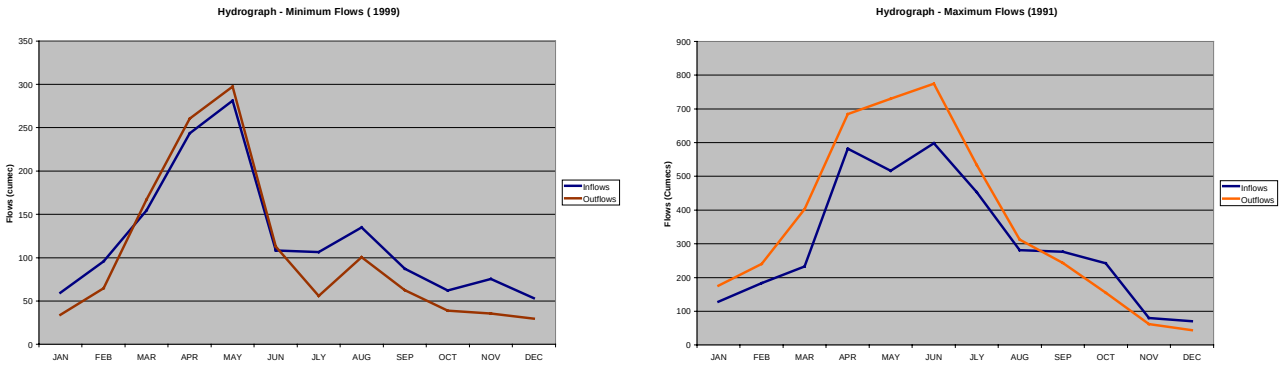


Fig 4: Trends of inflows and outflows for drought and flood years

The quick drainability of water can be attributed to the following hydrological interventions:

- Removal of rocky wedge below Baramulla which was a natural barrier to Wular outflows thereby maintaining lake levels.
- Dredging in the downstream reaches of River Jhelum (Sopore to Baramulla) during 1912 - 15 to enhance water outflows and reduce flooding risk to the major upstream settlements, particularly Srinagar City. Further dredging was undertaken by Department of Irrigation and Flood Control at Pohru – Jhelum confluence in early 80s to mitigate flooding caused by the river.
- Conversion of marshes associated with Wular for agricultural purposes under the government sponsored Grow More Food programme implemented in the 1950s.
- Construction of an outfall channel involving widening and deepening of the downstream reaches under Wular Barrage Project in early 80s.

- Assessment of flow trends of River Jhelum at Baramulla indicate that the lowest discharges occur during October to February, when 1 – 5% of the annual runoff is discharged every month. At the maximum discharge during May and June , more than 15% is discharged very month with the maximum peaks exceeding 1500 cumecs. Despite a moderate mean discharge, high peak flows of above 1000 cumecs also occur during August. This trend is in difference to the rain fall pattern of the upstream Baramulla and Srinagar stations, which peak in March and subsequently hover around 50 mm. Flows appear to be strongly linked to temperature which rises from March – July, thereby inducing melting of the glaciers and corresponding high flows till June. The flow trends of River Jhelum for the period 1922 – 2000 indicate the following:

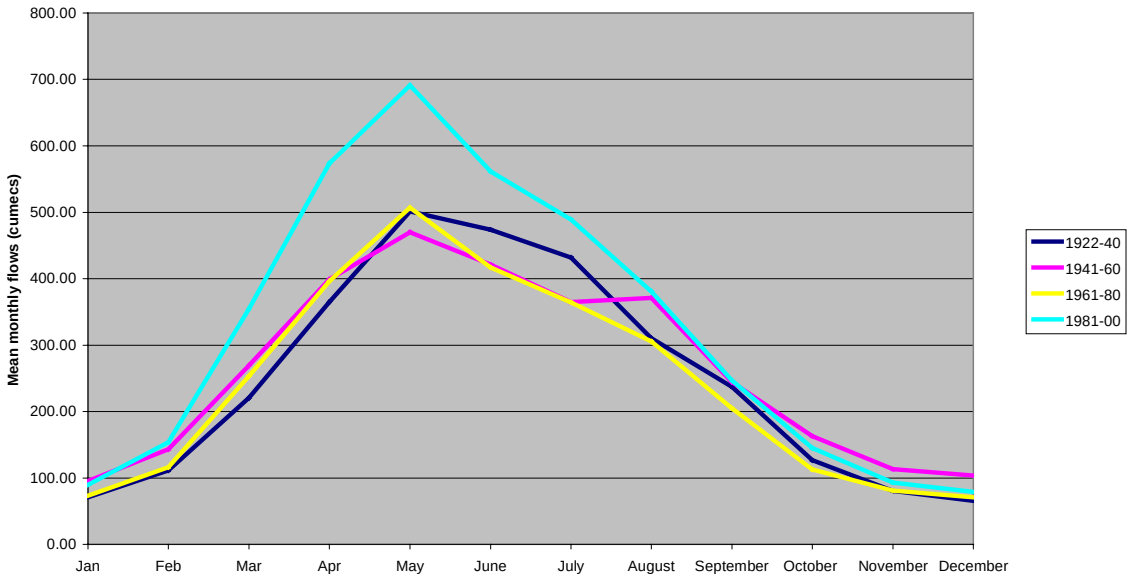


Fig 5: Trends of mean monthly flows of River Jhelum at Baramula

◊ **Peaking of summer flows:** The high flow periods during 1922-40 were distributed across the months of April to July, which has consequently changed to flow peaks in May (Fig 5).

◊ **Early onset of high flows:** The flows have started building up in late February in the 1980 – 2000 which used to be delayed till March in 1922 – 40.

◊ **Smoothening of secondary peaks:** The secondary flow peaks have been gradually losing their prominence and are no longer discernible in the 1981 – 00 flow observations. This indicates loss of hydrological function of the wetlands which used to absorb high flows and augment the lean flows.

◊ **Enhanced variability of flows:** The number of years with high flows (mean + 2 Standard Deviation) increased from 1 during 1922 – 40 to 9 during 1980 – 2000. The number of low flow periods (mean – 1 Standard Deviation) increased from 18 to 31 during the same period (fig 6).

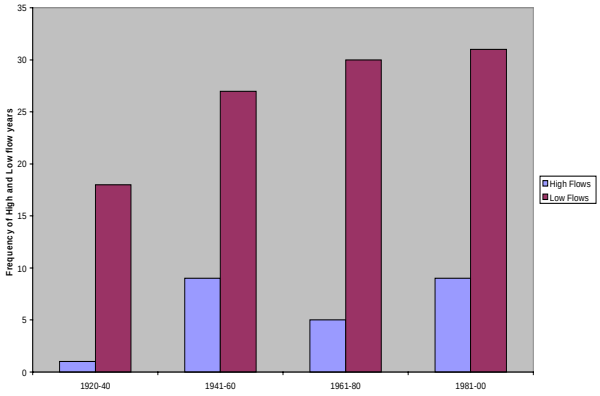


Fig 6: Frequency of high and low flow months of River Jhelum at Baramulla

These changes are indicative of changes in hydrological regimes caused due to loss of marshes, degradation of catchments and wetlands and climate change. There has been a progressive reduction in the capacity of the wetlands to regulate flow regimes. This has led to enhanced flooding and quick drainability within the basin. The high flows largely remain untapped due to reduced retention capacity of the basin attributed to loss of upstream marshes and wetlands. This trend is likely to enhance situations of hydrological extremities, viz droughts in the lean seasons and floods in the high flow seasons.

- River Pohru is another distinct feature influencing the water regimes of Wular. The 60 km long river with an overall catchment area of 2,030 sq km has an insignificant lean season flow. However, the river becomes flashy during floods and the flood flow currents cut across the main River Jhelum flow in a manner that the Pohru flow acts as a temporary water barrier to impede flow of River Jhelum leading to a back afflux in the upstream portion of River Jhelum. Local communities living at the confluence refer to the phenomenon as “a proposal of marriage between River Jhelum and Pohru which is continuously refused by the later”.

An assessment of the impact of Pohru was attempted through the mean 10 daily hydrographs of rover Jhelum flows at Sopore, location upstream of confluence point and Baramula, a downstream location (Fig 7). The only contributing flows in the mid course is through the Pohru River. It can be observed that during mid April – early May period, the flows of River Jhelum at Sopore indicate a decreasing trend, whereas they increase at Baramulla. This can be attributed to a hydrological wedge created due to fast flowing currents of Pohru. The river therefore helps maintain

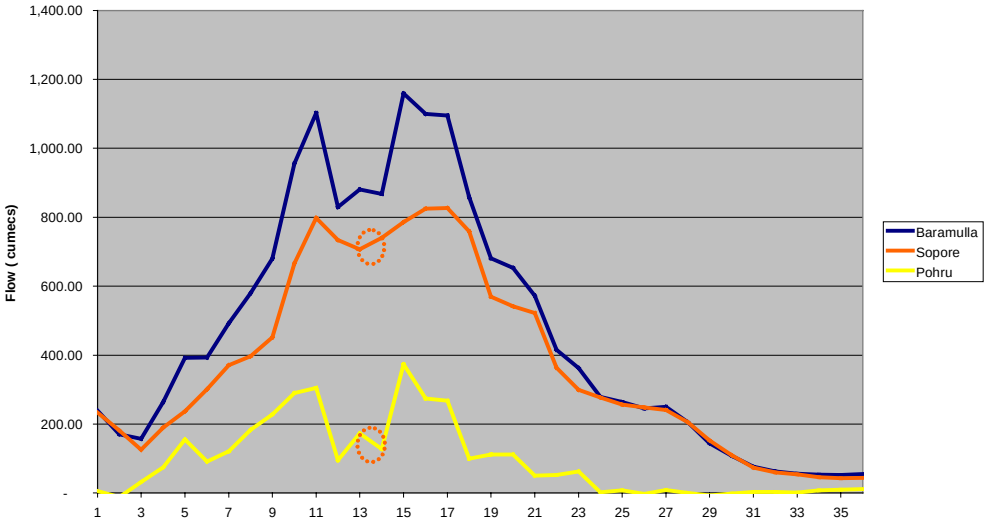


Fig 7: Effect of River Pohru on Flows of River Jhelum in flood years

water levels of the lake during high flow periods despite situations of quick drainability created through dredging of the downstream sections.

Water Holding Capacity

No systematic baseline surveys are available to assess the overall water holding capacity of the Wular system. Assessments based on ground surveys and spot elevations obtained through satellite data, indicate the following:

- The total water holding capacity of the Wular at normal lake levels (1576 meters) is 340 Mcum. The storage available between the average winter levels and summer levels is of about 170 MCM. The lake waterspread undergoes a significant fluctuation between the summer and winter months. The average area has been estimated as 54 sq km, which declines to 24 sq km during the lean period and increases to 89 sq km during summer months. Maximum part of the storage is achieved when the lake levels reach beyond 1574 m amsl (Fig 8).

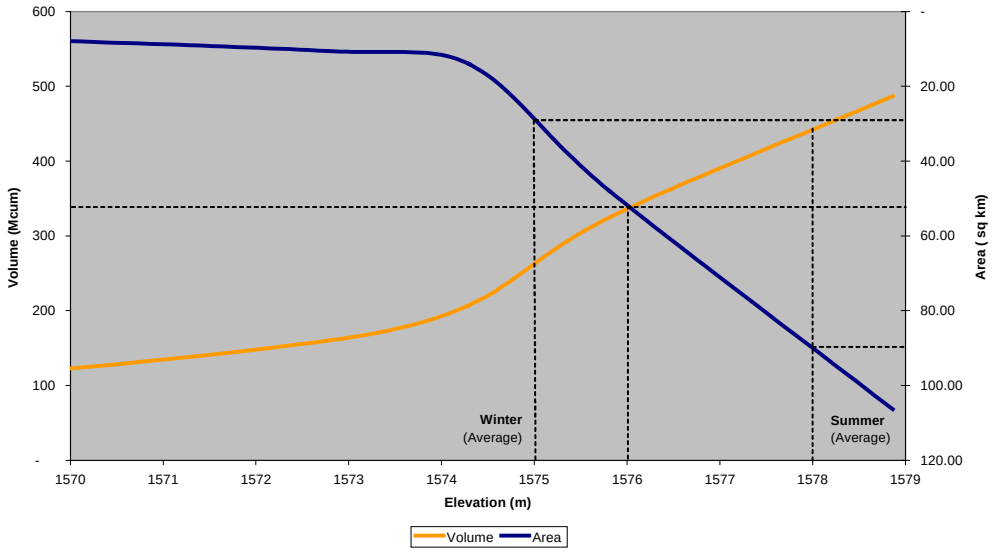


Fig 8 : Area Capacity curve for Wular Lake

- The average lake depth varies from less than 3 feet in the southern segment of the lake to more than 16 feet in the northern segment. The lake has less than 1 meter depth in the north eastern portion where the river Jhelum enters the wetland and in the southern section, between Baniyari and Shahgund (Map 2.5).

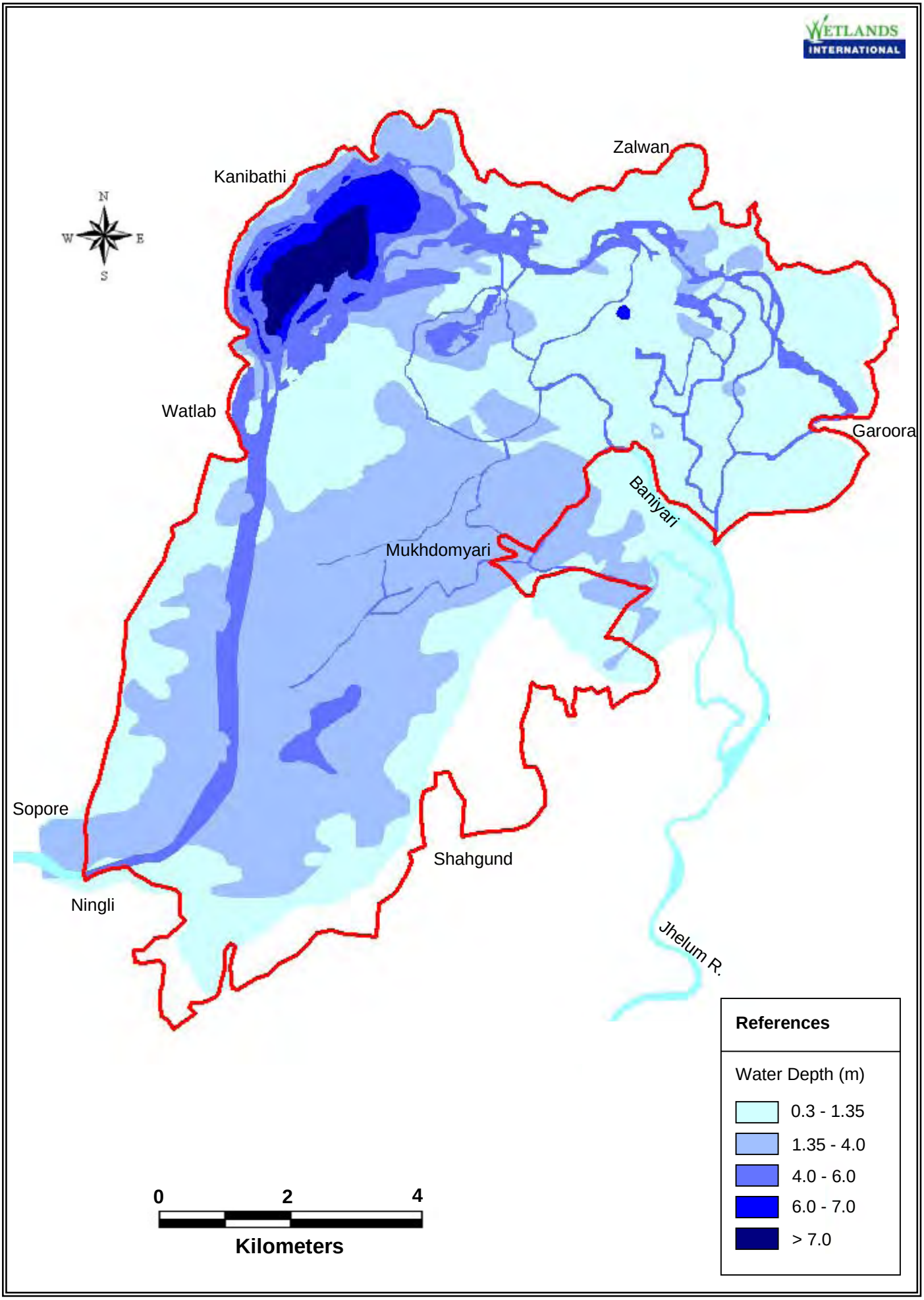
- A comparison of the stage volume relationship derived for the Ningli Barrage project, indicates a loss of 91.56 MCM of capacity at 1,579 amsl elevation (maximum water level) during a period of last 30 years. Thus about one fifth of the water holding capacity has been lost over the last three decades. This is equivalent to an annual lake sedimentation rate of 2,470 acre feet. This loss of capacity is attributed to the following factors:

  ◊ *Shrinkage of lake area:* A comparison of the SOI toposheet of 1911 and imageries of 2007 indicates an overall reduction in wetland area by 45% (157.74 sq km to 86.71 sq km) during this period (Map 2.6 & 2.7). Changes between various land use categories within wetland and associated marshes is presented below:

Table 2.3: Land use changes in and around Wular

Land use categories	Area (sq km)		Net change in land use
	1911	2007	
Water	91.29	75.23	-16.06
Marsh	66.45	11.48	-54.97
Plantation	0.66	27.30	26.64
Agriculture	0.38	44.25	43.87
Settlements	0.43	0.95	0.52
	159.21	159.21	
Associated Marshes	58.67	17.67	-41.00
	217.88	176.88	-41.00

◊ *Lake siltation:* Although there is no specific information on erosion from catchments which are under pressure due to extensive deforestation and quarrying in some pockets, yet it is clear that huge amount of silt from various sources is deposited in the lake leading to reduction in its water holding capacity. This is further enhanced by construction of embankments for flood control in the peripheral areas which prevent fanning of the sediments in the floodplains and its direct deposition into the lake. This is quite evident through remote sensing survey studies which indicate northward shifting of course of River Jhelum after Baniyari due to heavy silt deposition at the inlet.



Map 2.5 : Water Levels of Wular Lake 2006 - 2007

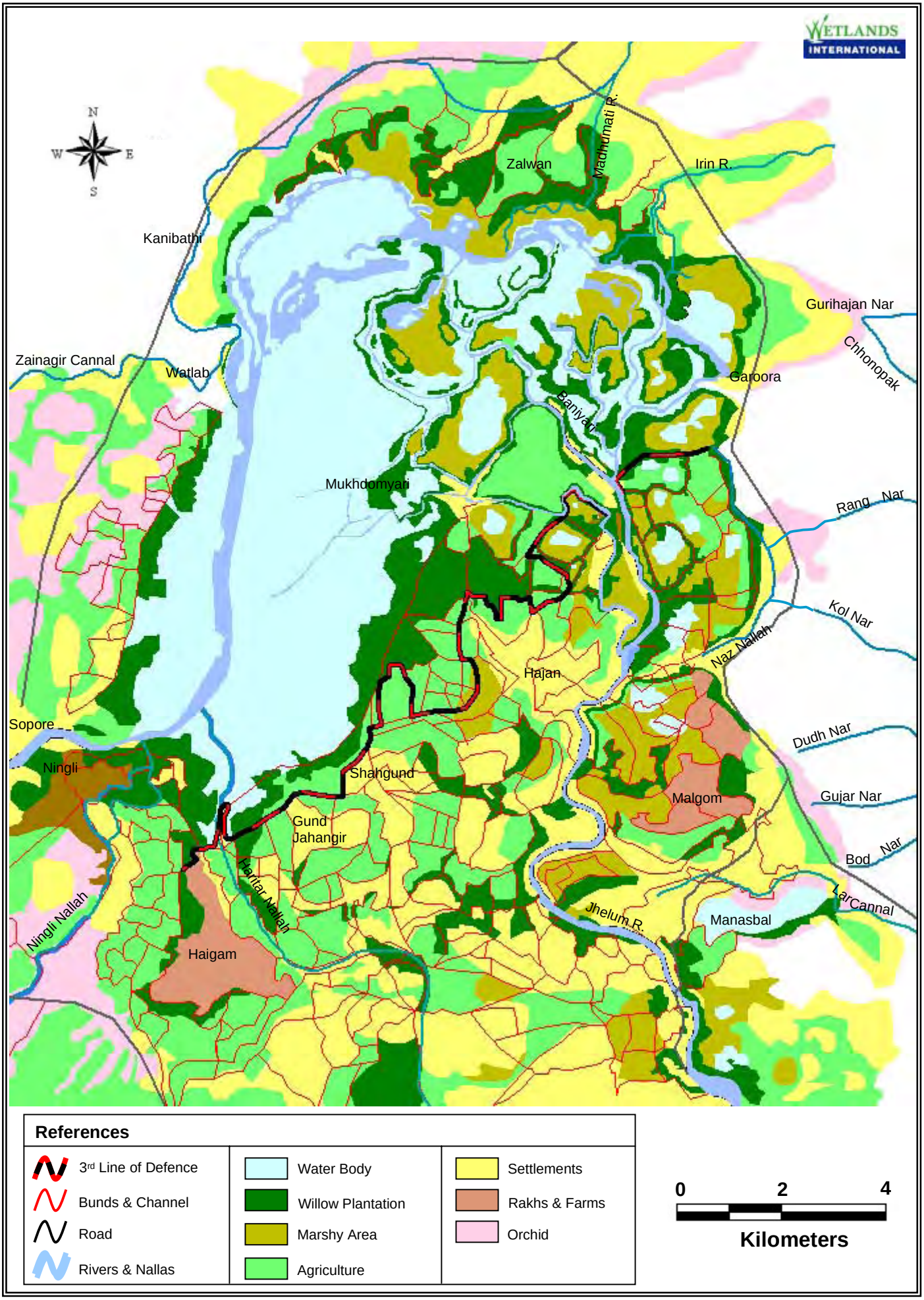
References

Settlements	Water Body	Agriculture
Nallah	Marshy Area	Rakhs & Farms
River	Mixed Agri/Horti	Plantation

3 0 3

Kilometers

Map 2.6 : Land Use Map of Wular Lake 1911



Map 2.7 : Landuse Map of Wular Lake 2007

Loss of water absorption capacity of Wular is directly linked to flooding in its peripheral areas. Structural approaches adopted by construction of embankments for flood mitigation has aggravated flooding due to combined effects of siltataion and conversion of marshes. Wular and its associated marshes acted as a great sponge at the head of River Jhelum which held up the floodwaters and oozed dry during winters. The nature and role of wetlands has not been clearly understood by the developmental planners although the importance of Wular in the hydrography of Kashmir has been often quoted. The marshes as elsewhere were considered as obstacles in the process of development, and hence converted for more profitable uses as agriculture. Huge chunks of marshes have been even lately reclaimed for settlements of expanding population Srinagar City. Often short term strategies were developed as is quite evident from the resettlement of populations from Dal Lake to Mir Gund and other marshes, without understanding their interconnectivity and critical role n overall water management for the region. Having relocated these colonies in the wetland areas subjected to periodic inundation, flood protection schemes were designed leading to fragmentation of the wetland regimes. The most prominent of the embankments is the third line of defence having a height of 1580 m amsl which hydrologically isolates the marshes from the main lake.

Water Abstractions

Irrigation and water supply are the primary water uses linked with the hydrological regimes of Wular. In the downstream reaches, the water from the river is used for hydropower generation. Details of the water use are as follows:

- **Irrigation:** Water from Madhumati Nullah is withdrawn through the Zainagir Canal in its head reaches and is further augmented by lifting lake waters at Watlab to irrigate the entire agricultural area situated in the Zainagir block of tehsil Bandipora and Sopore. This canal is designed to carry 10 cumecs flow. However, this is utilized to an extent of 7 cumecs at present during irrigation season. This scheme therefore utilizes 128.81 MCM of water annually form overall lake water availability.

  Besides the Zainagir Canal, there are numerous lift irrigation schemes operational in the reclaimed marshes in the southern lake fringes. The same pumping stations are also used for dewatering purposes in the periods of inundation. At present there are 47 pumping stations, of which 14 stations having capacity of 470 cusecs are operational lifting water from the river Jhelum and / or the marshes.

Zainagir Canal

- **Water Supply:** A 4 MGD lift water supply installation at Watlab draws its raw water requirements from the lake to supply drinking water needs of Sopore town and Villages between Watlab and Sopore. Another rural water supply scheme at Tarzoo Sopore also utilizes 0.17 MGD of lake waters for its raw water requirements. Water supply schemes lead to withdrawal of 6.94 MCM of lake waters annually

Water Lift Station at Watlab

- **Hydropower:** The outflows from the lake are also utilized for generating hydro Electric power in the series of run off the river installations, namely Lower Jhelum Hydro electric Project (105 MW capacity located at Ghantamulla), Uri Hydro Electric Project Phase 1 (480 MW capacity located at Uri,) and Uri Hydro Electric Project Phase 2 (240 MW capacity also located at Uri). The former two projects have already been commissioned, whereas the third is under construction. These installations, being of run off the river type function as per the availability of water of River Jhelum in the downstream reaches.

  The entire Kashmir valley suffers a serious deficit of power presently, with the peak power availability being less than one tenth of the demand. Power development in the basin is also regulated through the Indus Water treaty that prevents creating storages on the river and its tributaries for any developmental purposes, including hydropower and irrigation. Therefore, run of the river schemes are the only source of hydropower generation in the basin, which are augmented by gas turbine based schemes for providing power during the winter months. The total installed capacity of the basin is 904.6 MW, 81% of which is accounted for by hydropower. It is also worthwhile to note, that of the total installed hydropower capacity, 80% is accounted for by the two projects on Jhelum, i.e. Uri I and Lower Jhelum Projects.

  Water storage in Wular has a direct bearing on the availability of water in the river for hydroelectric power generation. Changes in the hydrological regimes, particularly lowering of flows during the lean seasons have tremendously affected the power generation capacity of the state. The two downstream projects, i.e. Lower Jhelum and Uri have water requirement of 7,000 and 8,000 cusecs respectively. Lowering of discharges in the lean seasons, particularly during late October to February when the discharge reduces to 2,000 cusecs forces closure of 75% installed capacity of these projects and consequent huge economic loss.

Conversion of wetlands which acted as natural reservoirs for regulating flows has led to loss of water holding capacity of the basin. This is particularly true about conversion of wetlands in upstream areas particularly in rapidly expanding urban centers around Srinagar. This has been expressed clearly by the communities around Wular Lake that changes in flow regimes has led to enhanced frequency of floods and droughts. This also has an implication for maintenance of the current

water use pattern which is strongly linked with overall water availability and moderation of flows.

Water Quality

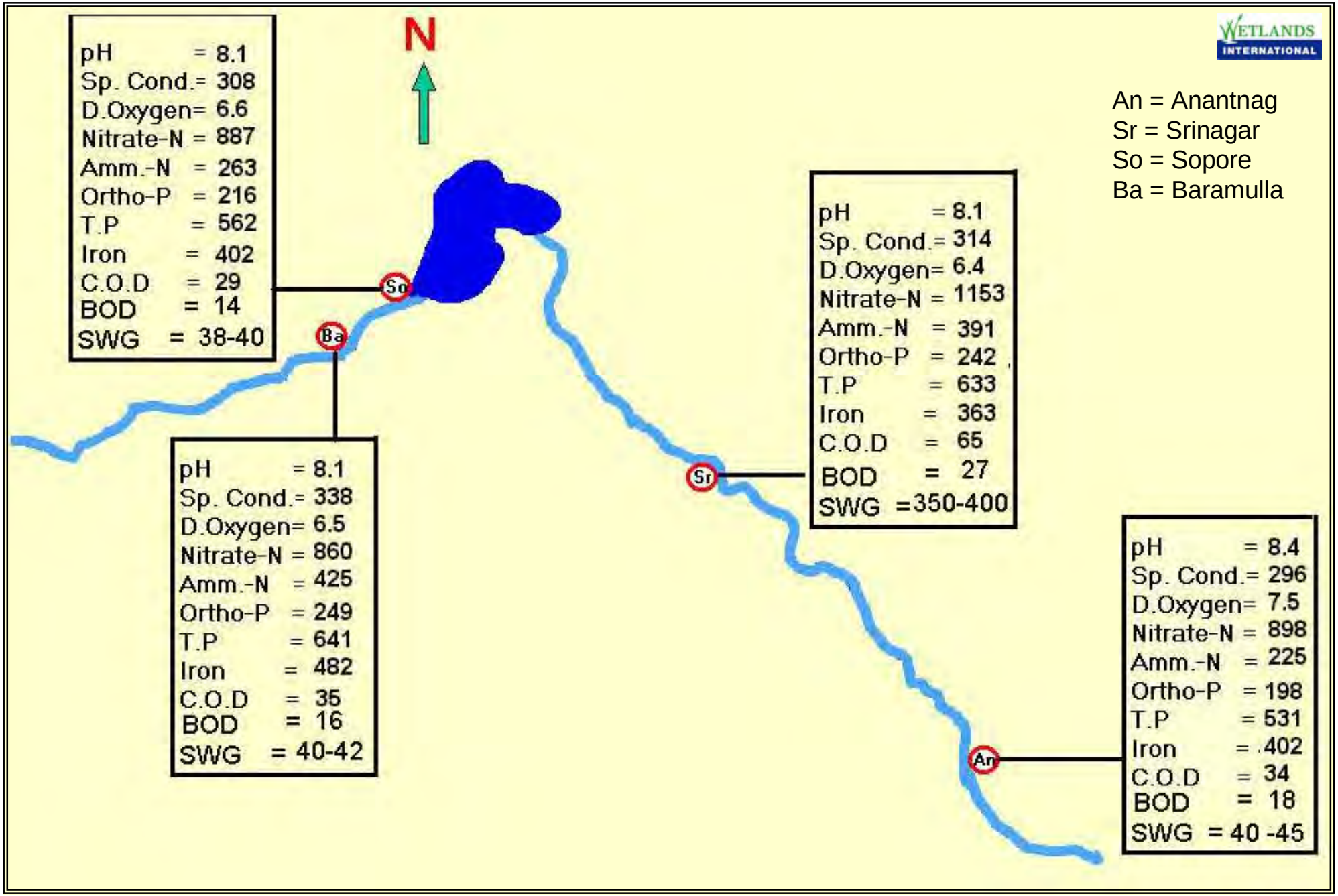
A review of information from the studies on water quality indicates that valley lakes in general are alkaline in nature with relatively higher amounts of calcium, magnesium and other ions and are thereby categorized as hard water systems. The valley lakes are essentially shallow basined profusely covered by aquatic vegetation. Almost all the lakes are eutrophic in nature with high concentrations of biologically important nutrients. Studies by Trisal (1977, 1981, 1987) Trisal and Kaul (1983) Kaul and Trisal (1984) on several lakes of Kashmir indicate that high pH values prevalent during summer associated with high temperature and higher bicarbonate alkalinity lead to the precipitation of C_aCO_3 from the dissolved bicarbonates. The importance of $CaCO_3$ precipitation as a scavenger of some inorganic nutrients by co-precipitation and an agent removing dissolved organic matter by absorption has already been well emphasized by many researchers.

In contrast high altitude lakes above 2000 m amsl located away from human population and with prevailing low temperatures are oligotrophic having low ionic concentrations and devoid of vegetation. Water quality of these lakes falls under 'A' category as per Central Pollution Control Board's (CPCB) Designated Best Use Criteria and do not need any kind of treatment.

Wular being at the terminus of the drainage system acts as receptacle for pollutants flowing downstream from highly urbanized areas. Discharge of solid, liquid and other wastes from human settlements all along the River Jhelum are finally deposited in the Wular Lake. The carcasses of dead animals thrown directly into River Jhelum finally get accumulated in the Wular Lake creating a health hazard. Heavy dosages of fertilizers and pesticides used in agricultural fields besides spraying chemical in orchards for pest control are ultimately washed into Jhelum flowing into Wular Lake. There are no regulations or guidelines for disposal of solid wastes including carcasses throughout the River Jhelum. The sewerage system is generally lacking throughout the valley except in some parts of Srinagar. All the channels, streamlets and other aquatic bodies directly or indirectly draining into River Jhelum deposit heavy load of pollution in Wular Lake.

State Pollution Control Board has been monitoring water quality at 10 locations within the River Stretch covering mainly Anantnag and Srinagar districts. The downstream of Srinagar including Wular Lake has been totally neglected. A two year study carried out by National Institute of Aquatic Ecology (NIAE, 2000) under J&K Lakes and Waterways Development Authority highlights that heavy load of pollution is from Srinagar followed by Anantnag. Srinagar is the major city which discharges the maximum solid and liquid wastes followed by Anantnag, Sopore and Baramulla (Map 2.8). Similar trends have been observed in BOD and COD. Overall heavy load of domestic pollutants lead to increased concentrations of BOD, COD and drastic reductions in dissolved oxygen levels. The other physical and chemical parameters also reflect deteriorated condition of water quality.

The State Government has formulated project feasibility report involving IRAM consultants for restoration of water quality focusing on Anantnag, Srinagar, Sopore and Baramulla districts under the Jhelum River Conservation Plan (JRCP). A brief outline of the proposal has been summarized and given in the Box 1. The proposal formulated has been submitted to Ministry of Environment and Forests (MoEF) which has not been yet approved for financial support, although being accepted *in principle*. Commitment for the sewage treatment has also been made in 10th Plan by the State



Map 2.8 : Water Quality and Solid Waste Generation within Jhelum River

Government. Economic Reconstruction Authority (ERA) is proposing to include sewerage treatment for urban and rural areas under a major plan being formulated for economic reconstruction of Jammu & Kashmir state, which is likely to be supported by Asian Development Bank (ADB).

A critical evaluation of JRCP prepared by IRAM consults indicates that too much emphasis has been laid on engineering measures without integrating ecological aspects in a comprehensive way clearly indicating targets, indicators, outputs and outcomes. The focus is more on the river channel without integrating the values and functions of the floodplains into management planning. The natural floodplains along the river system play a great role in water quality improvement through their natural functioning, and aspect which has been totally ignored in the current plan. Integration of ecological aspects would ensure sustainability and improvising overall health of the river system along with its associated lakes and other water bodies.

Box 1: Jhelum River Conservation Plan (JRCP)

The Project Feasibility Report (PFR) prepared by IRAM consults on Jhelum River Conservation Project is focused on major towns including Srinagar, Anantnag, Baramullah and Sopore. The PFR has been formulated under National River Conservation Plan (NRCP), of Ministry of Environment and Forests (MoEF) as a scheme with 100% funding by Government of India.

The PFRs formulated for four towns are based on inventorization and assessment undertaken during 1997. Based on rapid surveys and investigations, pollution abatement schemes have been formulated as per the NRCD guidelines for river conservation projects. The proposals have been formulated within the framework of an integrated approach incorporating sustainable urban environmental infrastructure development with emphasis on integration of technical project elements with community participation and public awareness.

PRF prepared by the IRAM consults mainly emphasizes on appropriate treatment technologies and resource recovery from sewage, by using the treated sewage for irrigation, the sludge for manure. The JRCP programme also addresses the problems of siltation, bank erosion and agricultural runoff containing pesticide and fertilizers with the help and close interaction with the concerned nodal ministries. The project lays a strong emphasis on public participation and institutional development to sustain the programme on long term basis.

The main components of the JRCP are:

- Interception & diversion of wastewater
- Sewage treatment system
- Crematoria improvement
- Low cost sanitation
- River front development etc
- Tree plantation & afforestation
- Solid waste management
- Bio-monitoring and water quality monitoring studies
- Institutional development and training

The total cost of the project is Rs. 284.42 crores for a period of 5 years, which includes preparation of designs and detailed project repots, implementation mechanism and construction activities. The scheme will be implemented by J&K Lakes and Waterways Development Authority.

Kashmir University particularly through its Centre for Research and Development has been collecting information on water quality of Wular and some parts of River Jhelum. The physical and chemical characteristic of the Wular and its associated marshes has been studied extensively by Kundangar et al (1992), and Kaul & Trisal (1984). The analysis of information of various parameters studied highlights the following characteristics of the water quality:

- Water transparency measured as Secchi disc showed in general low values due to high turbidity caused by heavy turbulence
- Lake water is alkaline as indicated by alkalinity and pH values
- DO values vary considerably within the lake; extremely low concentrations have been recorded in some pockets receiving domestic effluents from the lakeshore households
- Concentration of divalents is high with bicarbonates being most abundant forms among inorganic anionic components
- Nitrate nitrogen is the most abundant nitrogen source. The concentration of nitrate nitrogen increases during winter and spring which may be attributed to the combined effect of nitrification at the mud-water interface
- Overall water quality corresponds to similar pattern in other valley lakes.

The water quality has deteriorated over a period of time and there has been a progressive increase in specific conductivity, orthophosphate and total phosphorus with a decline in transparency and dissolved oxygen. However, no major shift in the pH of the lake has been recorded (Table 2.4). Systematic monitoring of water quality over a long period would reflect trends in water quality changes. Based on the analysis of water quality parameters, overall, the Wular Lake Water falls within category C as per CPCB's designated best use criteria.

Table 2.4 : Water quality changes in Wular Lake during 1992 to 2006

Parameter	units	1992	2006
water temperature	^{0}C	3.1 - 25	6.3 - 27.3
Transparency	m	0.1 - 1.3	0.16 - 0.73
PH		7.1 - 9.8	7.2 - 7.7
Conductivity	μs/ cm,	57.0 - 429	118 - 3.5
Dissolved oxygen	mg/l	1.3 - 15.2	4.5 - 8.0
Chloride	mg/l	11.0 - 81.0	11.8 - 28.0
Calcium	mg/l	4.6 - 73.8	20.5 - 62.3
Magnesium	mg/l	0.8 - 35.6	12.2 - 30.1
Ammonia	μg/l	1.0 - 205	64.0 – 101
Nitrate nitrogen	μg/l	9.0 - 580	205 – 419
Ortho phosphate	μg/l	0.0 - 31.0	79 - 131.7
Total phosphorus	μg/l	0.0 - 103	180.0 – 292.5

The following key issues were identified based on assessment of hydrological regimes:

- ***Changes in hydrological regimes***

  The hydrological regimes of the wetland have undergone drastic change. The wetland presently builds storages during the winter months, when the flows are already in the lean phase. This is markedly different to the earlier trends, wherein the storages were been built during the excess flow periods and were released in the lean flow periods, thereby providing uniformity to the flow regimes. The above trend is also an indicator of quick drainability as the high flows in summer do not get an opportunity to build up storages which could be subsequently available during the lean season. Loss of marshes and catchment degradation have further reduced the capacity of the wetland to regulate hydrological regimes. The present stage of Wular is a contribution of the water resources development projects which have aimed at enhancing the outflows from the Wular Lake to achieve flood moderation in the upstream areas, and conversion of marshes for agriculture development.

- ***Loss of water holding capacity***

  The water holding capacity of the lake has declined by one fifth over the last three decades. This is a major factor leading to high drainability and reduced capacity of the wetlands to regulate flow regimes. The capacity has been further reduced due to willow plantation. Additionally, conversion of marshes which augment the overall holding capacity of the wetland system particularly in its upstream reaches has led to further deterioration of water quality.

- ***Deterioration of water quality***

  The water quality of Wular has deteriorated drastically due to discharge of high levels of untreated sewage into the wetland. Wular Lake, due to its geomorphological setting becomes a recipient of entire wastewater of the basin. Despite a rapid increase in human population, there has been no upgradation of the civic infrastructure leading to an increasingly higher proportion of wastes being dumped into the waterbodies. Presently none of the settlements have been provided with sewerage treatment facilities, the result is the discharge of wastewater directly in the water body leading to water quality deterioration.

Discharge of Sewage

- ***Water allocation focused on human uses without considering the ecological requirements***

  The entire focus of water management in the Jhelum basin is on human uses, particularly irrigation and hydropower development, ignoring water allocation for maintenance of biodiversity and overall ecological integrity of the wetlands. Water is critical to the maintenance of biodiversity and overall wetland ecosystem processes and functions. Though the Indus water treaty has prevented creation of any large water storage structures on the upstream reaches of the River Jhelum, expansion of developmental activities, are expected to gradually crowd out the water availability for maintenance of ecosystem functions. A balanced approach to allocate water for human uses and ecological requirements is critical to sustainable management of wetlands of the basin, including the Wular lake.

2.2.3 Biodiversity

Waterbirds

Strategically located at the western extremity of the Himalayan range in India and south of the Pamirs, the wetlands of Kashmir serve as important staging grounds for medium and long distance migratory geese, ducks, shorebirds, cranes and other species that breed in the northern latitudes of Central Asia and Siberia. Many of these wetlands are of international and national importance, due to the large population and diversity of waterbirds and other wetland associated birds that they support. Of these, Wular Lake and Hokersar have already been included under Ramsar Convention considering their importance based on biodiversity and socio economic aspects. More recently Wular Lake and associated marshes viz., Haigam, Hokersar, Mirgund and Shallabugh have been included in the network of Important Bird Areas (Islam and Rahmani 2004), based on their international importance for birds and all of which are not formally protected.

Waterbirds in Wular

The wetlands within the Jhelum Basin are nationally and internationally renowned for rich bird life particularly in regard to migratory ducks and geese. The Valley acts as an important staging ground for many of these species. At least 45 of the 213 waterbird species and 66 of the 118 wetland associated bird species have been reported in the region (Annex I & II). The Basin has records of 7 of the 53 globally threatened and near threatened waterbird and wetland bird species reported in the country, although none of these species are regularly observed here in recent years. Eight of 43 waterbird species are listed under the appendices of the Convention on the Conservation of Migratory Species of Wild Animals (Bonn 1982) to which India is a Contracting Party. Forty-three of the waterbird species are covered under the Central Asian Flyway Action Plan (CMS 2006).

Based on an analysis of information collected from various sources, an action plan has been developed for management of waterbirds and their habitats, which is briefly discussed in this section. The management of the wetland associated birds will largely be covered by activities prescribed for the management of the waterbirds.

Species composition and population estimation

Waterbirds can be broadly categorized into resident and migratory species. Resident species spend entire year in the valley, while the migratory species may be seasonal or international migrants. The seasonal migrants nest in the valley during April to August and then move out during August to other parts of the country. The international migrants, nest in the northern latitudes of Central Asia and Siberia (Russia, Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan, Turkmenistan, China, Mongolia). These species may stop (or stage) in the valley during southward migration to wetlands in the subcontinent and/or during northward migration to the breeding grounds. Further, some of these international migrants are non-breeding (or wintering) birds that spend entire period in the valley.

Waterbirds utilize the Wular Lake and satellite wetlands on a daily basis for different purposes. It is observed that the birds visit Wular during the night time to feed when there is no disturbance from fishing boats and hunters. During the daytime they seek refuge in the Hokersar, Haigam, Shallabugh and other adjoining wetlands. The great importance of the Wular Lake for ducks, geese and other waterbirds can be only

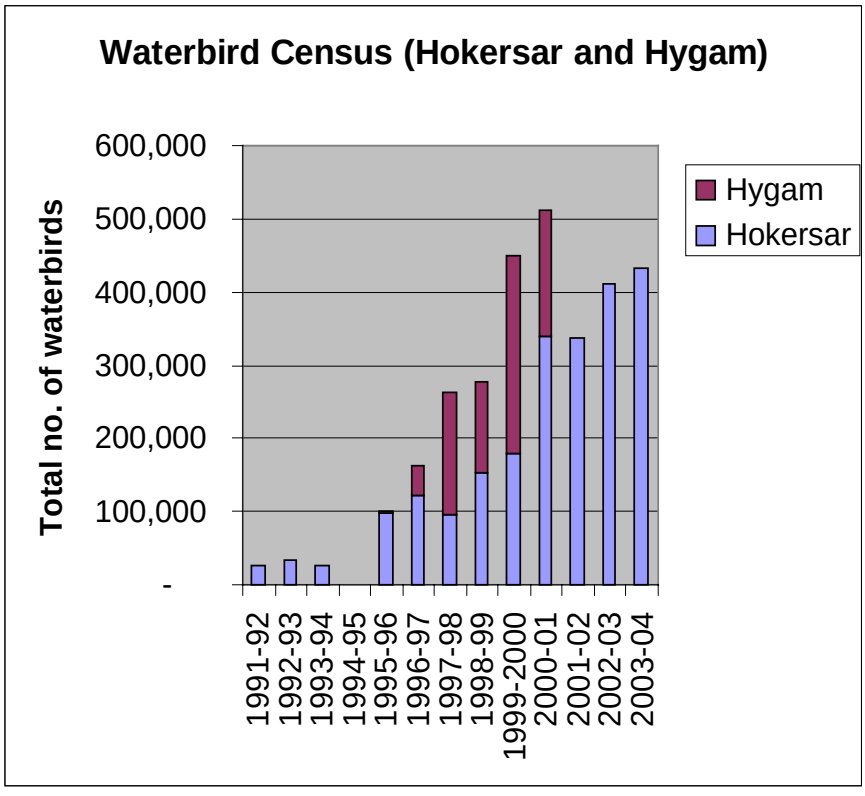


Fig 9 : Estimated total population of waterbirds during January-March annual census at Hokersar and Haigam (1992-2004) based on information provided by the State Wildlife Department.

appreciated from the results of the census work undertaken by the State Wildlife Department at Hokersar and Haigam since the early 1990s (Figures 9 and 10). The

peak count of 2000-2001 season is of 511,755 waterbirds, though in other years, the peak counts are usually between 260,000 and 450,000. However, as these counts only cover two of the sites used by the waterbirds in the day, the total abundance of waterbirds in Wular and associated wetlands is expected to be much higher.

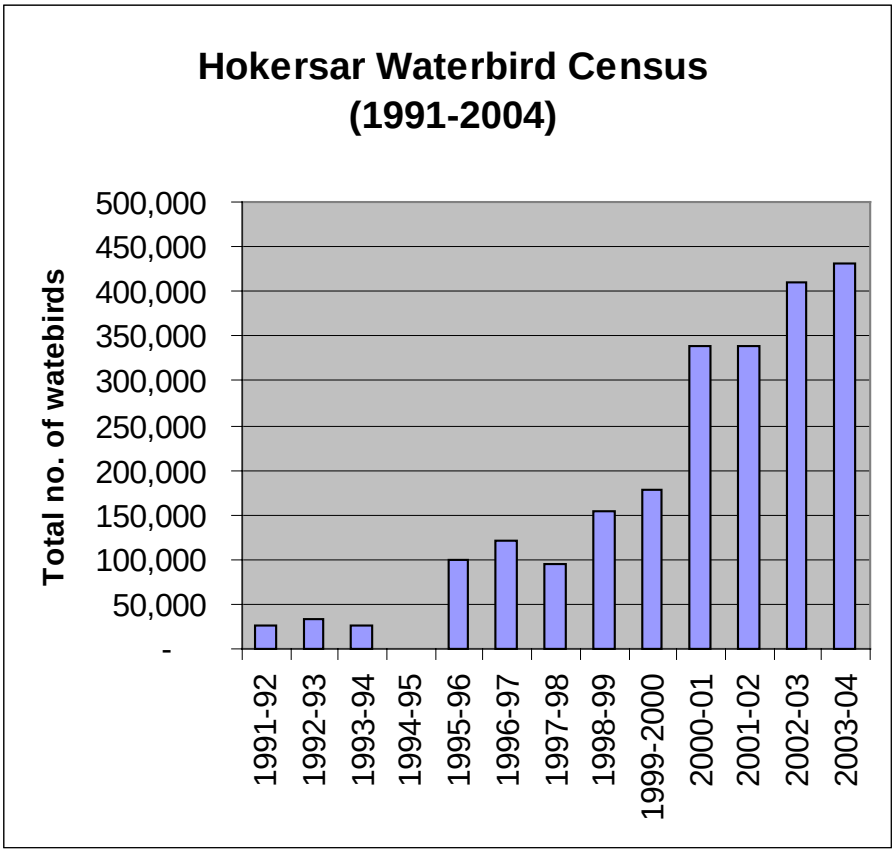


Fig 10 : Estimated total population of waterbirds during January-March annual census at Hokersar Ramsar Site (1992-2004) based on information provided by the State Wildlife Department

The latest census data on waterbirds collected by the Wildlife Department provides an indication of the predominance of some waterbird species (defined as species comprising more than 5%) include Northern Pintail, Mallard, Gadwall, Northern Shoveller, Eurasian Wigeon and Common Teal (Table 2.5). Census data from in the early-mid 1990s (Bacha, 1992; 1994) provides a comparison to recent information, and indicates that in the past the predominant species were also roughly the same, although there are variations in the relative proportion of species between these two decades. From the data in 1992 and 1994 (Fig 11), it is also evident that there are changes in numbers of a species between the years, for example, Mallard dominated in 1994 and formed 40% of the total population, although it, was less than 5% in 1992. Similarly, Eurasian Teal dominated in 1992 with over 25% of the total population whereas in 1994 the population was only 7%. The reason for these annual fluctuations may be attributed to census timing, habitat changes and food availability and weather conditions. This reiterates the need for long term data collection to understand annual variations and their linkages with habitat, climatic, hunting and other factors.

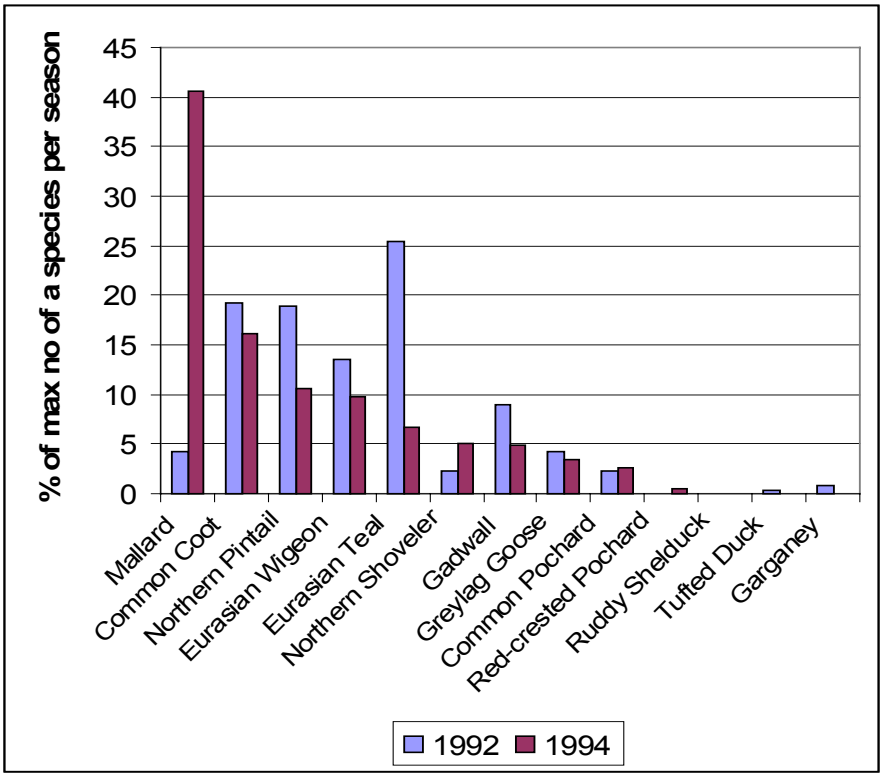


Fig 11 : Annual variations in selected waterbird species in Jhelum River Basin based on Bacha (1992, 1994)

Table 2.5: Census conducted by Wildlife Protection Department for three wetlands (February 2006)

Common name	Hokersar	Haigam	Shallabug	Total	%
Northern Pintail	67,790	180,000	44,330	**292,120**	**21.0**
Mallard	130,435	85,000	45,150	**260,585**	**18.7**
Gadwall	88,941	80,000	37,950	**206,891**	**14.9**
Northern Shoveller	68,400	85,000	31,572	**184,972**	**13.3**
Eurasian Wigeon	86,830	60,000	36,650	**183,480**	**13.2**
Common Teal	7,760	5,000	5,950	**178,710**	**12.9**
Common Coot	44,285	2,000	1,670	**47,955**	**3.4**
Red-crested Pochard	2,920	50	17,577	**20,547**	**1.5**
Greylag Goose	10,054	100	240	**10,394**	**0.7**
Common Pochard	2,590	400	5	**2,995**	**0.2**
Garganey	690			**690**	**<0.01**
Ruddy Shelduck	285		15	**300**	**<0.01**
Others	500			**500**	**<0.01**
Grand total	**571,480**	**577,550**	**241,109**	**1,390,139**	**100.0**

Most long-distance migratory waterbirds (ducks and geese) arrive in the Valley during September-October**.** Their numbers decline during February to April depending the migration patterns of different species, with most having left by May. Few individuals of some species, constituted by juveniles or injured adults may continue to stay during the northern summer months as well. Historic census data (1992 and 1994) collected by the Wildlife Department (Bacha 1992, 1994) on waterbirds collected over part of the northern winter provides an

indication of the period of northward migration of different species. Counts undertaken during 1994, from January to April indicate that the total number of waterbirds peak in February with a decline in April (Fig 12). A similar pattern emerges for counts undertaken in 1992 (Fig 13).

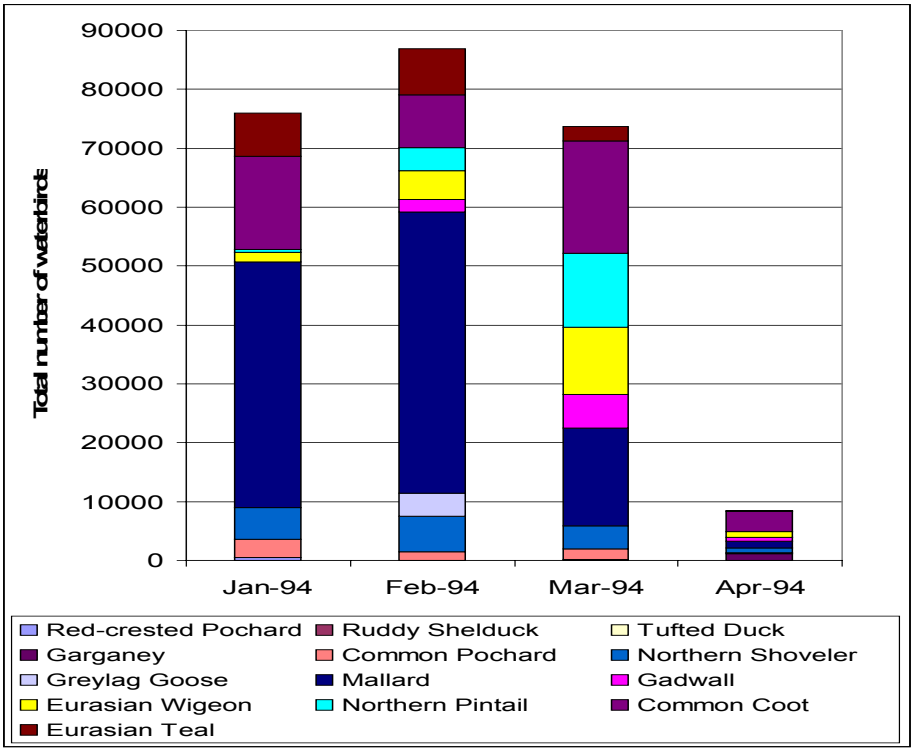


Fig 12 : Estimated monthly totals of waterbird species during January-April 1994 in the Jhelum River Basin wetlands (based on information provided by the State Wildlife Department)

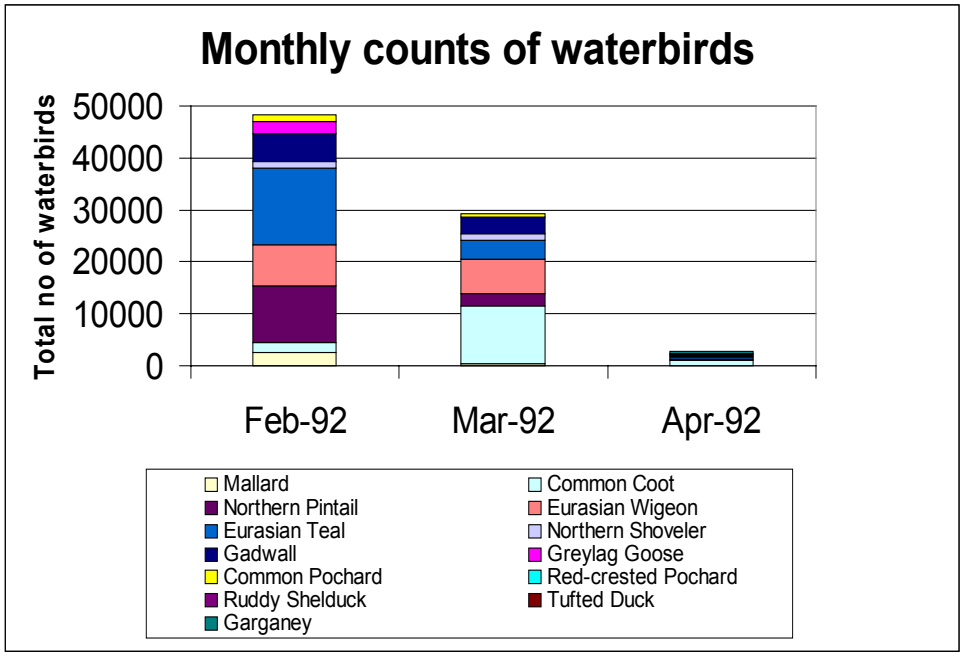


Fig 13 : Estimated monthly totals of waterbird species during February-April 1992 in the Jhelum River Basin wetlands (based on information provided by the State Wildlife Department)

Basic information on the southward migration patterns of waterbirds in the Valley is needed while information on northward migration patterns needs to be validated for the current wetland conditions. This reiterates the need for long term data collection to understand migration patterns and patterns of dependence of different species on the wetland of the Valley.

The food habits and feeding styles of these breeding species depend on a variety of aquatic vegetation (including seeds, stems, leaves and corms), aquatic and terrestrial insects and their larvae, small to large sized fish, amphibia, molluscs and slugs, crustaceans, worms and even rodents (Table 2.6). An assessment of the abundance and availability of the different prey species throughout the year at the different wetlands is required to manage these waterbirds.

Table 2.6 : Major feeding habitats and prey types of migratory waterbirds

Waterbird guild	Preferred habitat types[1]	Feeding style[2]	Food types[3]
Ducks, geese and coot	LO,LV,M,C,R	S,D,G	Co,S,L,Se,C,R
	LO,LV	B	M,Ai,A,F,Se
Shorebirds	LV,R	S	M,Ai,A,F,C,G
Gulls and terns	LO,LV,M,C,R	A,S	F,A,I,Ai,F,M,C,G

Notes:

1 - Preferred habitat types – LO - lake with open water, LV – lake with submerged/emergent vegetation and drying margins, M - marsh (vegetated body with some open channels), C – river or canal, R - rice fields, P - plantation/forest (submerged/surrounding wetlands) - information extracted from Ali and Ripley (1983)

2 – Feeding styles: D – dabbling, G – grazing, S- surface (with some digging), B – diving, A – from air

3 - Food types: (a) Vegetation – Co – corms, L - leaves, P – paddy, S - shoots, Se – seeds of aquatic plants, V – vegetable matter; (b) fauna - A – frogs, AI – aquatic insects, C - crustacea, F – fish, G- grubs, I – insects, La – larvae, M - molluscs, R – rodents, W - worms. - information extracted from Ali and Ripley (1983)

Breeding waterbirds

Twenty-two species of waterbirds, including the globally threatened Ferruginous Duck, are recorded to breed in the valley wetlands (Table 2.7). In addition to these, a range of reed and tree nesting birds (e.g. warblers and raptors) also breed in these wetlands. The historic importance of the Wular Lake and associated wetlands as a breeding ground for waterbirds can be appreciated from references to boatloads of eggs collected for sale in Srinagar and other markets in the late 1800s form different waterbirds (Mallard, coot, moorhen, etc) (Ali and Ripley 1983).

The Wular Lake mostly consists of the open water areas and the areas with submerged and floating vegetation. The open water area is largely disturbed due to anthropogenic interference and the boating. During the March-June period, large areas of Wular covered with floating vegetation serve as breeding sites for species such as Indian Whiskered Tern, Pheasant-tailed Jacana and Little Grebe. The peripheral shallow areas with longer grasses like *Typha sp*., *Phragmites sp*., etc. serve as breeding sites for species such as Moorhen, Little Bittern, Purple Moorhen, Indian Great Reed-warbler, etc. The associated marshes of Wular Lake like the Mukhdoomyari and Saderkote act as breeding grounds for a number of bird species especially Mallard. Besides, the peripheral wooded areas of Wular Lake serve as

nesting sites not only for many forest species but also for a number of wetland dependent species.

Important baseline information on the breeding biology of the some of the breeding species has been collected by the University of Kashmir. However, the current status of the nesting populations of the different species in the different wetlands is not properly understood. The main breeding seasons of the waterbirds is from March to October, with a peak during May to August for many species (Table 2.7).

The preferred nesting habitats vary between species and can be categorised into 4 main types:

a. marshes where floating nests are built in floating vegetation on water,
b. reed beds and tall grasses,
c. trees and bushes, and,
d. on the ground around streams and river channels

Four species are mainly colonial nesting species; three species of heron require trees or undisturbed reed beds while one species (Whiskered Tern) requires marshy areas, including *Singhara* beds and other floating vegetation. All the other species are largely solitary nesters.

Table 2.7 : Summary of breeding requirements and preferences of waterbirds in the Jhelum River Basin.

Sr. No	Species	Preferred habitat types[1]	Food habits[2]	Preferred nesting habitat[3]	Nesting habit[4]	Nesting season[5]
1	Little Grebe *Tachybaptus ruficollis*	LO,LV,M	F,Ai,C,M	Marsh (*Singara* beds)	S SC	April-Oct
2	Little Egret *Egretta garzetta*	LV,M,C,R	F,Ai,I,C,A	Plantation bushes/trees (around Wular)	C	July-Sept
3	Grey Heron *Ardea cinerea*	LV,M,C,R	F,Ai,I,R,M	Chinar and tall trees	C SC	March-June
4	Cattle Egret *Bubulcus ibis*	LV,M,C,R	Ai,I,A	Plantation bushes/trees (around Wular)	C	June-Aug
5	Indian Pond-heron *Ardeola grayii*	LV,M,C,R	Ai,I,F	Large reedbeds and bushes	SC	May-Sept
6	Black-crowned Night-heron *Nycticorax nycticorax*	LV,M,C,R	F,A	Chinars, large reeds	C	April-May
7	Little Bittern *Ixobrychus minutus*	LV,M,C,R	F,A,Ai,I,M, C	Large reeds and bushes	SC	June-Aug
8	Mallard *Anas platyrhynchos*	LV,M,C,R	Co,S,L,Se, C,M,Ai,A	Large reed beds and bushes	S	July-Sept/Oct
9	Ferruginous Duck *Aythya nyroca*	LV,M	Co,S,L,Se, C,M,Ai,A,F	Reed beds	S	May-July
10	Water Rail *Rallus aquaticus*	LV,M,C,R	S,Sn,P,M, AI,W	Reed beds, grasses	S	May-Aug
11	Baillon's Crake *Porzana pusilla*	LV,M,C,R	Se,I,W,M	Reed beds, grasses	S	May-Aug
12	Ruddy-breasted Crake *Porzana fusca*	LV,M,C,R	AI, M,Se,S	Reed beds, grasses	S	June-Aug
13	Purple Swamphen *Porphyrio porphyrio*	LV,M,C,R	Se,S,L,I,M, P	Reed beds, grasses	S	May-Aug
14	Common Moorhen *Gallinula chloropus*	LV,M,C,R	Se,S,M,A, A,F	Reed beds, grasses	S	May-Aug

Sr. No	Species	Preferred habitat types[1]	Food habits[2]	Preferred nesting habitat[3]	Nesting habit[4]	Nesting season[5]
15	Common Coot *Fulica atra*	LV,M,C	V,S,Se,P, W,I,M,F	Reed beds	S SC	May-Aug
16	Pheasant-tailed Jacana *Hydrophasianus chirurgus*	LV,M,C,R	Se,V,Ai,M	Marsh (*Singara* beds)	S	May-Aug
17	Little Ringed Plover *Charadrius dubius*	LV,M,C,R	I,Ai,W	Dry stream, river bed, sand bank	S	April-May
18	Eurasian Woodcock *Scolopax rusticola*	M,C	W,G,Se,S	Wooded streams	S	April-July
19	Common Snipe *Gallinago gallinago*	M,C,R,LV	W,La,M	Marsh or wet boggy area	S	late Apr-mid June
20	Common Sandpiper *Actitis hypoleucos*	LV,M,C,R	M,C,I	Ground along streams	S	May-June
21	Black-winged Stilt *Himantopus himantopus*	LV,M,C,R	M,C,I,W, Se	Marsh or wet boggy area	S SC	Apr-Aug
22	Whiskered Tern *Chlidonias hybrida*	LV,LO,M, C,R	I,Ai,F	Marsh (*Singara* beds) and other floating veg	C	June-Aug

Notes:

1 - Preferred habitat types – LO - lake with open water, LV – lake with submerged/emergent vegetation and drying margins, M - marsh (vegetated body with some open channels), C – river or canal, R - rice fields, P - plantation/forest (submerged/surrounding wetlands) - information extracted from Ali and Ripley (1983) and provided by Dr. C.M.Seth and Dr M. Shah.

2 - Food habits: (a) Vegetation – Co – corms, L - leaves, P – paddy, S - shoots, Se – seeds of aquatic plants, V – vegetable matter; (b) fauna - A – frogs, AI – aquatic insects, C - crustacea, F – fish, G- grubs, I – insects, La – larvae, M - molluscs, R – rodents, W - worms. - information extracted from Ali and Ripley (1983) and Dr M. Shah.

3 - Preferred nesting habitat - information extracted from Ali and Ripley (1983) and provided by Dr. C.M.Seth and Dr M. Shah.

4 - Nesting habit - S – solitary/single, C – colonial, SC - semi-colonial - information extracted from Ali and Ripley (1983) and Dr M. Shah.

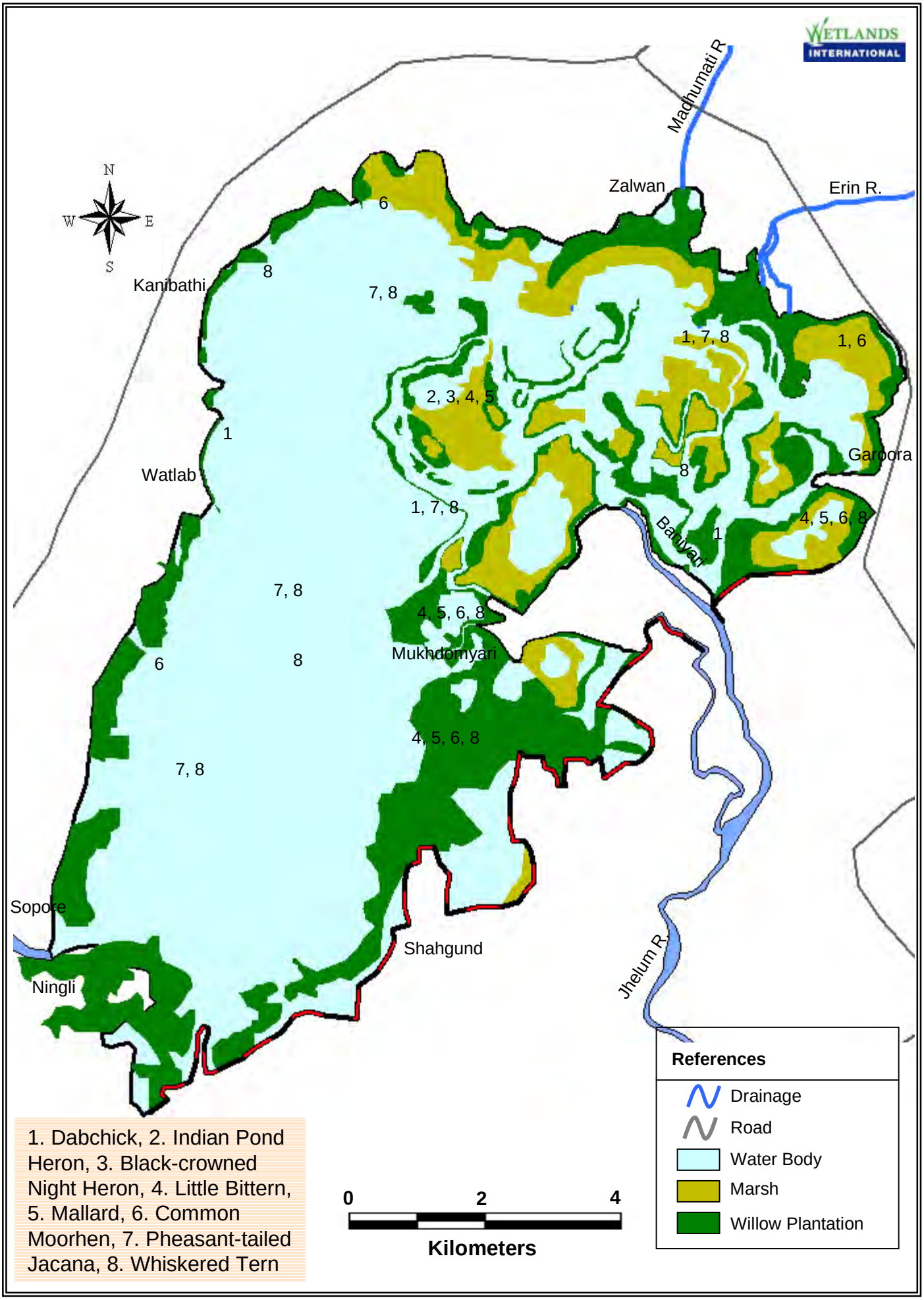
5 - Nesting season - information extracted from Ali & Ripley (1983) and provided by Dr M. Shah.

A number of factors that influence the breeding success of waterbirds include man made/natural changes of water levels during the breeding season. While no time series estimates of breeding populations and breeding success of waterbirds are available, it is quite apparent that reclamation of marshes has seriously affected nesting of many species. The absence of nesting of Whiskered Terns and other species in recent years are quite visible impacts of these alterations.

Important breeding sites

Historically, it is believed that the waterbirds bred widely across the wetlands. There has been no attempt to map their breeding distribution in the Valley. A preliminary map of the breeding locations of waterbirds of the Wular Lake is presented in Map 2.9. Information of the breeding distribution of waterbirds across the other wetlands and the current status of there breeding populations is unknown.

The information on waterbirds from various sources clearly indicates a lack of information on species and breeding site locations, preferences, prey abundance and habitat relationships that are fundamental for the development of a detailed management plan.



Map 2.9 : Waterbird Breeding Sites in and Around Wular

Threats to waterbirds and their habitats

The threats to migratory and breeding waterbirds in general include heavy poaching, loss and modification of habitats. Decrease in wetland area leading to loss of food and cover plants have led to decline in waterbird populations.

The specific threats to waterbirds are:

- Lack of formal conservation status (such as protected areas) for most sites leading to poaching. Thousands of geese and ducks are hunted by the poachers in the unprotected areas leading to their movement to protected areas such as Haigam during day and their reverse movement during night
- Collection of eggs and chicks of nesting waterbirds that constitutes a loss to breeding success.
- Degradation and destruction of the immediate forested catchments causing increased siltation, eutrophication, excessive weed infestation and degradation of water quality.
- Spread of aquatic vegetation over open water areas leading to habitat loss of birds that prefer open water.
- Heavy grazing leading to destruction of breeding and feeding grounds of birds.
- Unregulated and over fishing in some wetlands resulting in loss of fish and invertebrate prey and disturbance to migrants, seasonal migrants and resident waterbirds.
- Encroachment by agriculture and urbanisation, resulting in the decrease in the size and functions of many wetland areas affecting waterbirds.
- Discharge of domestic waste from point and non-point sources leading to habitat modifications.

The key issues identified based on assessments:

- Absence of comprehensive base line information on waterbirds necessary for trend analysis and planning
- Intense poaching in unprotected areas leading in decline in waterbird populations
- Habitat modifications due to changes in natural water regimes and human activities
- Lack of infrastructure and trained technical staff for monitoring and evaluation
- A recent risk to waterbirds and mass deaths of different migratory species to a highly pathogenic avian influenza virus (strain H5N1) from domestic poultry or other sources in east, southeast and north-central Asia, has highlighted the need for greater attention to understanding the impact of the virus on waterbirds and of the potential role of waterbirds in its spread. As the state of J&K shares international borders with Pakistan and China, countries in which the virus has been recorded, there is a high risk of incursion of the virus to the waterbirds of the Valley.

Fish diversity

Wular Lake with its large expanse of water is an important resource for fisheries. The fisheries of Wular Lake is a combination of capture and culture fisheries. The annual requirement of table fish for Kashmir is 37,000 MT as per standard nutritional requirement of 11 kg / capita / annum consumption. The current production of the state from culture and capture fisheries is 19,500 MT / annum thereby indicating a deficit of more than 50% of fish requirement. Present status of fish and fisheries of Wular Lake is briefly highlighted in the chapter.

Fishing in Wular Lake

Heckel (1844) published two volumes on taxonomic enumeration of fishes in Kashmir. He reported occurrence of 16 species, all of which were then considered new to the science. Later Das and Subla (1963-64) produced a new list of 36 species based on field work between 1961 and 1964. Further Nath (1986) listed 42 species for which no proof is available to permit assessment of the status or originality of the work. Some of the reported species have never been subsequently recorded and their presence in the valley is rather doubtful. Recent surveys carried out by NIAE, J&KLWWDA (2000) indicate occurrence of 13 species from Jhelum and associated lakes including Wular. As the taxonomy of many species is still under scrutiny the total number may increase or decrease with further investigations in the field. However, whatever the number, it is clear that several species of schizothoracinae are endemic to the region are declining both in diversity and population. List of fish species recorded form Wular and associated wetlands is given in Annex III.

An analysis of fish fauna reveals that three species are endemic to Kashmir valley viz. *Schizothorax niger* (Snow trout) *Triplophisa marmorata* and *T. kashmiriensis*. They feed on detritus, attached plant (including algae) coating of stones and rocks and the associated invertebrate fauna. They grow slowly and attain maturity at the age of 2 years. The River Jhelum has lost at least one migratory fish species, Mahaseer (*Torpi*) due to construction of Mangla dam in Pakistan. Earlier Mahaseer used to migrate upstream of Jhelum for spawning.

The first attempt to introduce trout was made in 1898 by getting fish samples from Scotland for tourist attraction. Subsequently six trout fish hatcheries were established by 1912 and two species viz. *Salmo trutta fario* and *S. gairdneri* got established in different streams. Three varieties of common carp viz. Mirror carp (*Cyprinus carpio specularis*), scale carp (*C. c. communis*) and leather carp were introduced in 1956 and they got quickly established due to their adaptive advantages to thrive under eutrophic conditions and breeding / spawning on vegetation. The commercially important fish species in Wular Lake are listed in Table 2.8.

Table 2.8: Economically important fish species of Wular

S.No	Fish species	Local name
1.	*Schizothorax esocinus*	Cherru
2.	*Schizothorax curvifrons*	Sattar gad
3.	*Schizothorax micropogon*	Chattir gad
4.	*Schizothorax niger*	Aile gad
5.	*Schizothorax longipinus*	Dape gad
6.	*Schizothorax richardsonii*	Khont
7.	*Nemacheilus sp.*	Shud gurun
8	*Cyprinus carpio communis*	Punjabi Gad
9.	*Cyprinus carpio specularis*	Scale Carp

Breeding and spawning

The breeding migration starts in March / April and the spawning takes place in April / May and even upto June (Jyoti 1973). All species of the group except *S. niger* exhibit spawning migration to the incoming streams and rivers and lay eggs in shallow pools amidst gavel and sand. Further *S. niger*, which prefers clean and cold pockets of water is the only species which has adapted itself completely to lacustrine habitat, not even showing the spawning migration towards the upper reaches of the streams. *S. niger* being a lacustrine fish does not show any spawning migration out of lake in comparison to other schizothoracine fish but shows a very low absolute fecundity which seems to be related to its non-migratory behaviour, as in migratory fish high fecundity compensates for the high mortality during the migration of both adults and juveniles. However, despite the lowest absolute fecundity, *S. niger* has the highest relative fecundity among the schizothoracine fish (Yousuf and Pandit 1989). This indicates the impact of the environmental stress on the fish. The exotic species such as *Cyprinus carpio* has adoptive advantages to utilize lake resources for its growth and dominate over other species due to its high fecundity (Table 2.9).

Table 2.9 Growth, feeding habits and fecundity of important fishes

Species	Feeding Habit	Growth attainment (mm)	Fecundity/kg body weight	Peak breeding season
Schizothorax niger	Bottom detritus (Illiophagic herbivore)	1+yr - 80mm 4+yr - 200mm	8000-23000	March-April
S curvifrons	Illiophagic Herbivore Occasionally column feeder	1+yr - 130mm 4+yr - 305mm	25000-40000	May-June
S. longipinis	Herbivore Detritophagus	1+yr - 95mm 4+yr - 288mm	25000-32000	May-June
S. micropogon	Herbivore (bottom feeder)	1+yr - 110mm 4+yr - 280mm	20000-25000	May-June
S.esocinus	Herbivore Omnivore (bottom feeder)	1+yr - 135mm 4+yr - 400mm	35000-40000	June-July
S. richardsonii	Herbivore typical bottom feeder on rocks & stones	1+yr - 130mm 4+yr - 350mm	25000-30000	May-June
Cryprinus carpio	Detritus bottom Sediments	1+yr - 280mm 4+yr - 455mm	239000-285000	May-June

This is quite evident that common carp, which was introduced in 1959, has invaded all the meandering rivers and water bodies including Wular and has driven out the endemic schizothoracids. Common carp usually spawns from May to June in beds of aquatic plants. The planktonic peaks from March to April and July to August concur with the spawning activity of summer and autumn spawners, suggesting that this adaptation in reproduction is closely related to the availability of food to young ones as well as reducing the chances of competition between the young ones of different fish species.

Feeding Habits

The feeding habit and key biological features of major commercial fish species of Wular Lake indicates that *Cyprinus carpio* has high fecundity and grows at a much faster rate compared to the other species. A study on the food of some cyprinids has

revealed that most of the cyprinids of the valley are omnivorous in habit. However, the share of different food items varies significantly in different species. Crustaceans and insects are important and preferred food items. In case of *S. esocinus* the fish-remains forms the most dominant component of the food. Macrophytes being dominant component of Wular Lake, form the bulk of the plant matter present in the gut content of the fish. Numerically algae contribute a large proportion of the food items. Segmented worms contribute to the food of the common carp and also to *S. niger* and *Orenius plagiostomus* that feed on the bottom organisms including sessile algae. *Crossocheilus diplochilus* has been found to be a mixed feeder while trout species are carnivorous in nature and feed on insects, molluscs and even on small fish.

Aijaz (2006) during his research studied seven fish species and analysed gut content on Wular Lake assessed the dependence of fish population on the available plankton. According to him variation in the feeding habits of fish seems to be related to the availability of the choicest food. The Bacillariophyceae was the preferred food item among phytoplankton, while it was Cladocera that formed important component of food of fish. The most preferred food item was *Amphora* sp., *Navicula* sp., *Cymbella* sp. among Bacillariophyceae, while amongst Cladocera the most favoured food was *Chydorus* sp., *Alonella* sp., *Graptolebris* sp., *Macrothrix* sp., and *Pleuroxus* sp.

Fish Yield

Overall seven native and two exotic species of Wular Lake are commercially important. In commercial catches the exotic carps contribute 52-67% and the local fishes (*Schizothorax* sp.) and other miscellaneous fishes of less economic importance like *Barbus conchonius* (Button), *Gambusia affinis* (Maih Gad), *Carassius carassius* (Ganga) contribute 25 – 30% of total fish catch. (Fig 14)

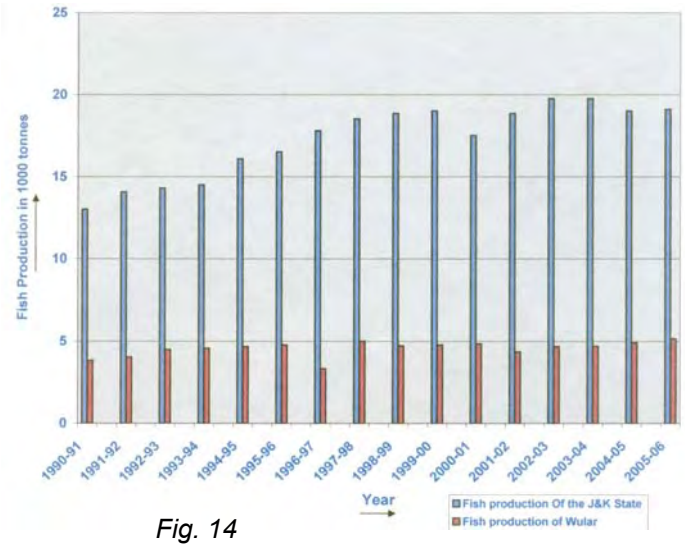
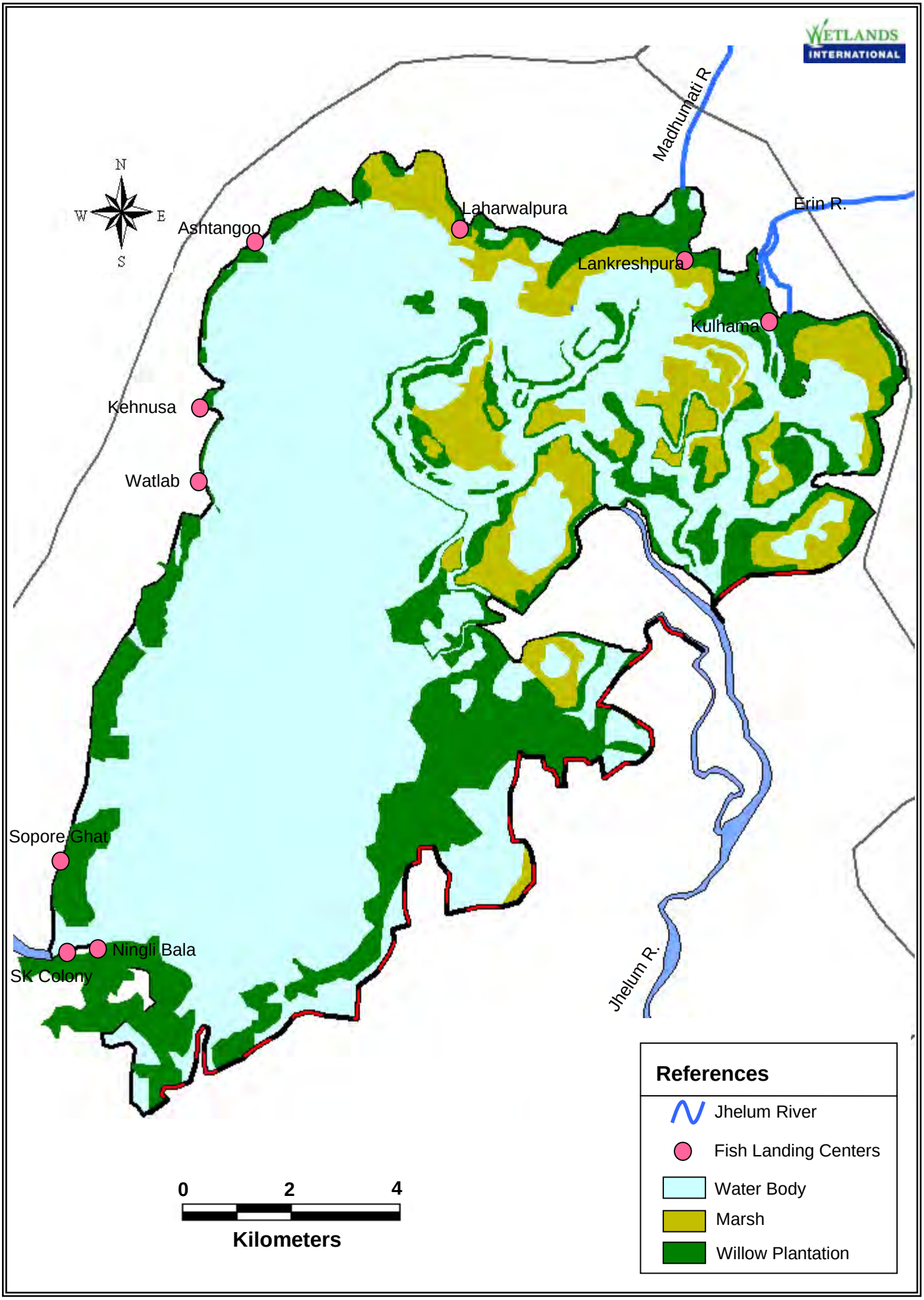


Fig. 14

The state government Fisheries Department has established nine landing centers at different locations of the lake (Map. 2.10).

These landing centres lack adequate infrastructure and facilities and even proper road connectivity. They serve merely as connecting points. Middlemen and moneylenders collect fish harvested from the fishing boats directly. As per the fisheries statistics of 2004, of Government of India, Ministry of Agriculture the fishery production of Wular Lake from 1990 – 91 ranges between 3340 to 5150 mt / annum based on fish landing estimates. The overall trend indicates increase in production with some fluctuations. Wular Lake contributes 23 to 26% of total fish production to the state of Jammu and Kashmir. Trends in species composition of Wular fisheries is shown in fig 15.



Map 2.10 : Fish Landing Centers of Wular Lake

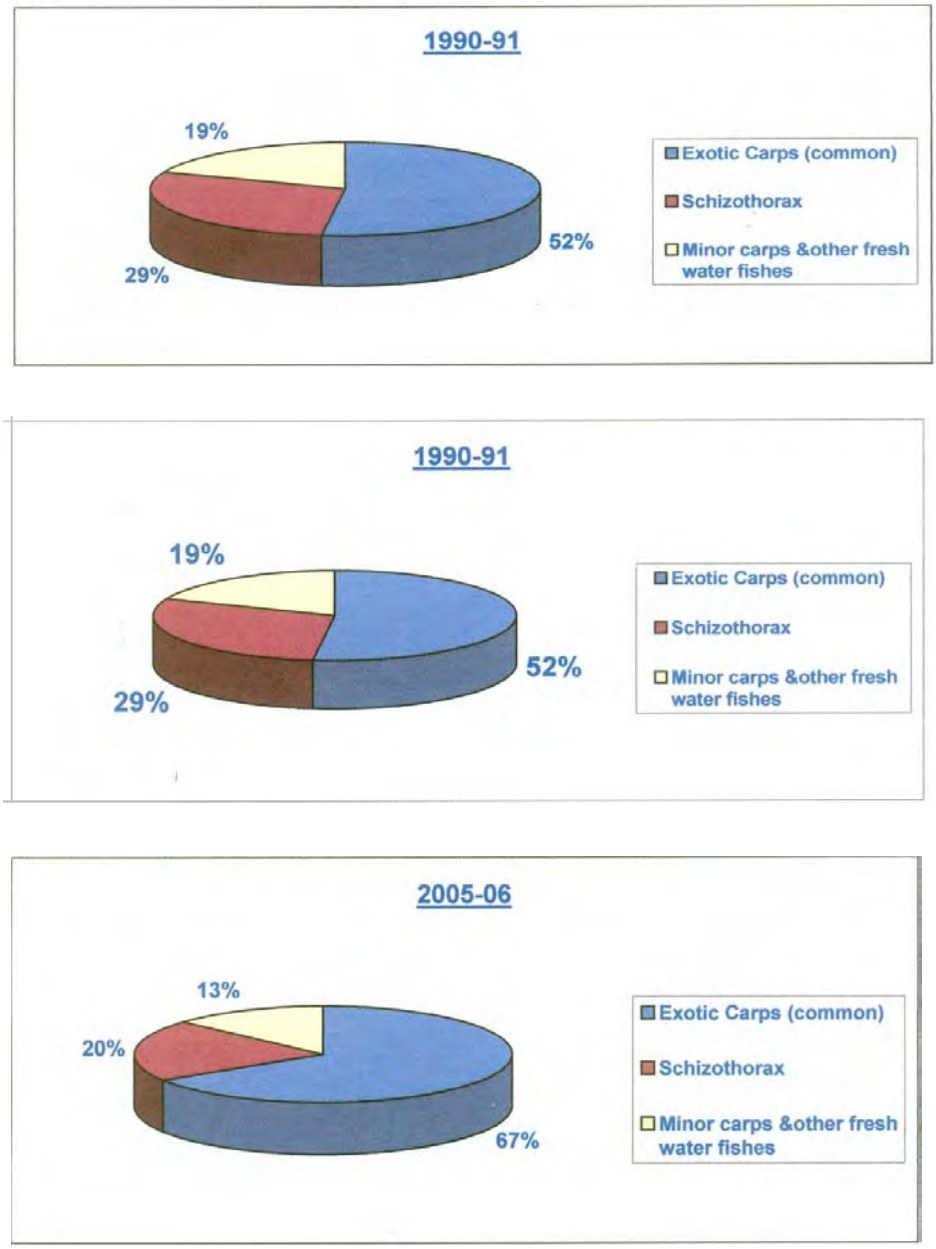


Fig. 15

A rapid survey of nine villages undertaken during December 2006 to March 2007, using PRA exercises indicated that average annual production at present is 563 kg. The annual yield of 1476 mt was calculated based on the information extrapolated to ten rural and three urban agglomerations with overall population of 17,421 located in the lake area. This clearly indicates a huge gap of approximately 20% between ground level realities and overestimates of the fisheries department. The figures need to be reconciled based on regular monitoring and developing an appropriate mechanism for monitoring and evaluation. The fish landing centres are not properly equipped with basic infrastructure for collection of fish catch from different pockets of the lake.

Crafts and Gears

Fishing Gears

Several types of fishing gears are traditionally used in Wular lake for fish harvesting, the main being cast nets, bag nets (Khurijal), dip nets, multiple head spears (Panzri), long lines (Wal raz) single / double pronged spear (Narchoo), and gill nets. However, due to decline in fish productivity, the fishermen have resorted to use of nylon nets with mesh size of 10mm and mesh bar of 0.5mm to catch fish of all sizes. The gill nets locally called *Thani* are 15 to 40m long and 1.5 to 3m wide. The use of these nets has seriously affected the regenerative capacity of the fish fauna.

During the participatory appraisals, it was highlighted that the communities themselves had imposed restrictions on the use of lower mesh size nets due to decline in fish catch. Promotion of gill nets was also undertaken by the State Government Department at select locations. Wooden primitive boats of varied dimensions of 5 - 10m length, 0.5-0.75 m width are exclusively used for fishing, transportation of fodder, trapa etc as well as navigation. Wooden boxes have been constructed in the middle of the lake to store catch. At Zurimanz village, the fishers have constructed ponds on the lake periphery to store surplus catch, and regulate fish supply for better price recovery. However, the structure of these ponds is very irregular and needs interventions for optimum us of space.

Information on Wular fisheries is highly fragmented and inadequate to support systematic management planning. There is absence of systematic inventorization and assessment of overall species richness and diversity. Limited research conducted by Kashmir University and some affiliated colleges as well as some other professional universities lack authentic information and have often published contradictory results. There is no proper monitoring mechanism to assess fish yield using appropriate methodology and long term assessment.

Based on the information available, the following key issues have been identified:

- **Decline in fish diversity and yield** due to changes in hydrological regimes and loss of critical habitats. Construction of hydraulic structures particularly hydroelectric projects has seriously impacted migration of fishes.
- **Changes in species richness:** Large quantities of sewage discharge from the Srinagar city and major towns flows into the lake thereby leading to increased eutrophication which has adverse impacts on the growth and development of the fisheries in general and sensitive species including *schizothorax* in particular. Increased pollution levels are favourable for the prolific growth of aquatic vegetation, which seems to be more favourable for hardy species thereby altering the balance of species richness.

Vegetation

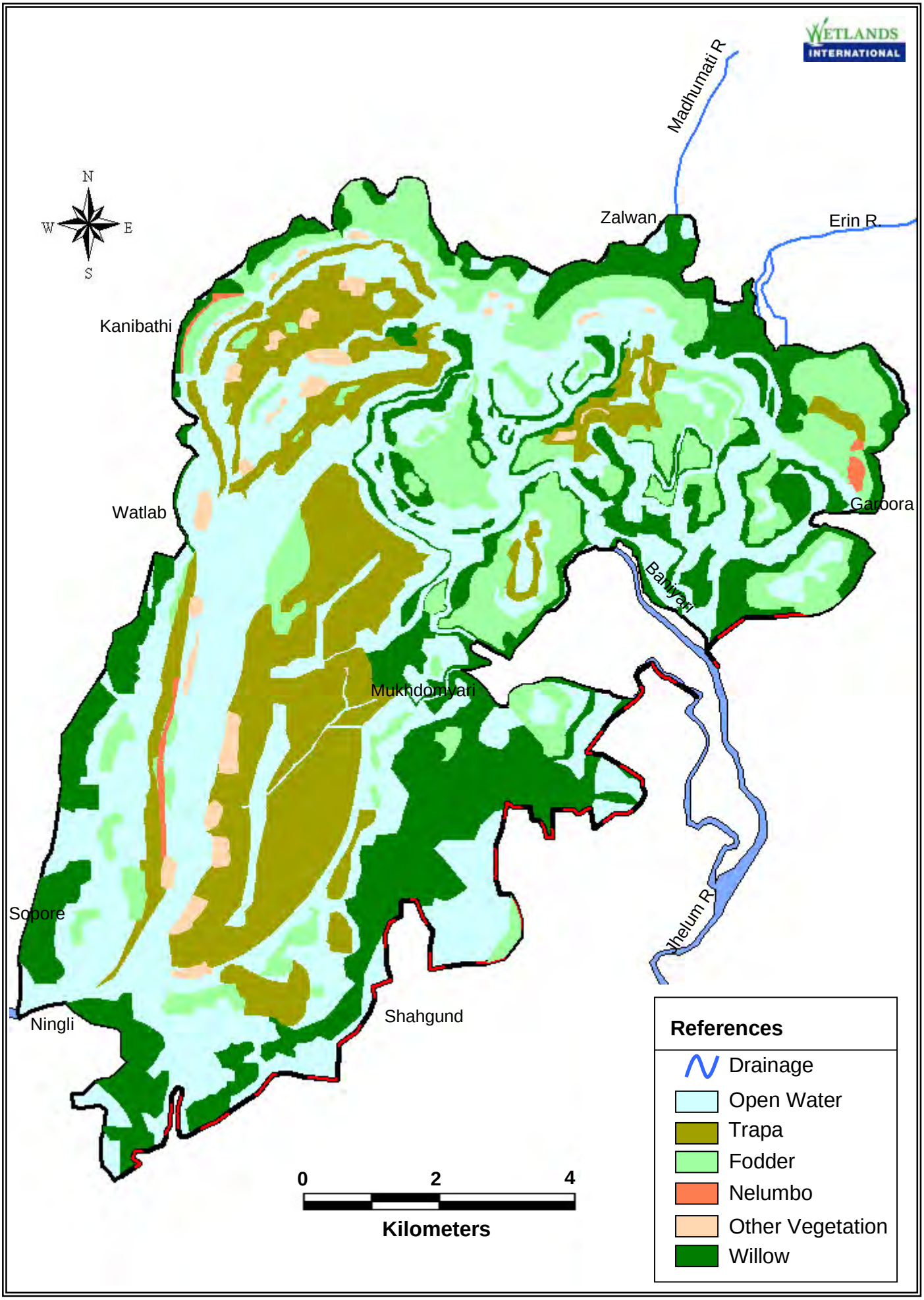
Vegetation of Wular Lake is an important component of the lake ecosystem providing both ecological and economic benefits. The communities within the lake area have been utilizing aquatic vegetation for various purposes particularly food, fodder and other purposes. However, dense growth of some species has chocked the lake area thereby reducing water flow and overall potential to provide ecological and economic benefits. Species composition, distribution, economic importance and role of vegetation in the lake ecosystem is briefly highlighted in the section.

Aquatic Vegetation

Species composition and distribution

Vegetation has not been comprehensively studied, hence the information is scanty. Overall, 13 plant species have been reported to be present in the Wular lake (Kundangar, 1993). However, 24 species have been reported in the in the associated wetlands (Kaul & Trisal, 1985). Species richness is higher in associated wetlands compared to the lake itself, thereby indicating the importance of associated wetlands in maintenance of aquatic plant diversity. A list of species recorded from Wular and associated wetlands are given in Annex IV.

In general, vegetation forms well defined zones distinguishing emergents, rooted floating leaf, free floating and submerged belts which are essentially adapted to water level fluctuations of the lake besides other environmental factors. The distribution of macrophytic species within the lake is shown in the map 2.11. The general sequence of the macrophytic species indicates occurrence of submerged species towards the center followed by mixed zones of submerged and rooted floating leaf types and emergents towards the lake shore.



Map 2.11 : Aquatic Vegetation within Wular Lake (2006)

The key features of the distribution of vegetation are:

- *Trapa* is distributed throughout the lake but the maximum concentration is found on the eastern side towards right shoreline of the lake. Kanibathi on the north-west and Garoora – laharwalpora towards north east are also thickly colonized by this species
- *Nelumnbo* species is mainly found in some areas of Ashtangu to Kanusa in the southwest and Lunkershpura, Kolhama and Garoora area in northeast.
- Emergents, *Nymphoides* and *Nymphaea* species form large belts in the Garoora- Laharwalpora portion of the lake

Invasive Species

Among the emergent macrophytes *Phragmites communis* and *Typha aungstata* are the dominant species while *Trapa s*p*., Nymphoides* sp. dominate among rooted-floating leaf type. The submerged vegetation comprising associations *of Ceratophyllum-Myriophyllum-Potamogeton* species occur in deeper portions of the lake. Overall submerged vegetation is greatly reduced due to enhanced turbidity. Exotic species such as *Salvinia natans*, *Lemna* sp. and *Azolla* sp. have profusely grown in the lake area and have assumed invasive character reaching to nuisance proportions. Proliferation of *Azolla* in the lake is a recent phenomenon and has been also reported profusely growing in the upstream lakes and the river channel. River Jhelum contributes significantly to the explosion of these species besides various channels draining into the lake.

A key feature of the vegetation around Wular is the presence of extensive willow plantations on its periphery. These plantations were raised by the various government departments to meet the fuelwood requirements of the state. Raising of willow plantation within the lake has severely altered the hydrological regimes, enhanced lake siltation and led to deterioration of its water quality (Box 2).

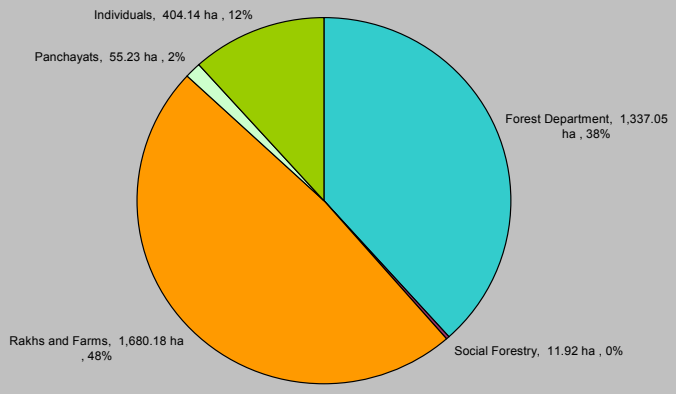
Restoration of hydrological regimes by enhancing inflows and outflows would help in drifting of these floating species downstream of Wular Lake. However, long term strategy needs to be developed to control the invasive species using biological control measures and treatment at the basin level. This could be attempted by developing an action plan for River Jhelum integrating all the connected lakes, marshes and other wetlands

Box 2 : Willow Plantation in Wular Lake

Energy security within Kashmir state has been a tremendous challenge for the government. The forests of Jhelum Basin had been under pressure for firewood, due to cold climate. Measures were undertaken during early nineties to provide firewood through plantations in Kashmir valley in the available marshy and barren areas. Through a series of experimental plots, willow was found to be most suitable in the marshes and Rubinia on the drier sites. Systematic plantation within the marshes associated with Wular was initiated in 1916. By 1924, the Ningli plantations were established and transferred under the administrative control of the then Sindh Forest Division and subsequently expanded continuously under the Plantation Division of Forest Department, Government of Jammu and Kashmir. However, the local communities, anticipating an impact on the wetland resources, which were largely concentrated in the highly productive marshes, protested against their conversion into plantations.

The State Department of Rakhs and Farms, constituted to manage and administer the marshes reclaimed for agricultural purposes further undertook the willow plantation in a major way after the 1950s. The Department promoted plantations in shallower zones of the marshes and water bodies primarily to provide fuelwood and in the later stages to support match and cricket bats manufacturing industries. In the later stages, social forestry division undertook willow plantations within the Wular Lake during 1982 – 2002 under the state government funded scheme on wasteland plantations, covering an area of 0.12 square kilometres. Village Panchayats , encouraged by the immense revenue potential of the willows also undertook plantations in 0.55 square kilometre area.

Following the Jammu and Kashmir State High Court Orders dated 10 October 2006 instructing the State Government to demarcate the territorial limits of the Wular and Manasbal Lakes, an assessment of the area under willow plantation in and around the lake was made by the Revenue Department in three tehsils of Sonawari, Bandipora and Sopore. The survey indicated an area of 34.88 sq km presently under willow plantation in 30 peripheral villages. Of this, the state government departments of Forests, Rakhs and Farms and Social Forestry account for 86% (30.29 sq km) of the willow area.



Ownership of willow plantations within Wular Lake

Raising of willow plantation has severely altered the hydrological processes of the wetland. These plantations act as barriers to silt laden waters of the river Jhelum forcing it to discharge the sediment load into the lake and thereby inducing loss of water holding capacity. A spatial analysis of the sedimentation pattern within the wetland clearly indicates rapid siltation along the fringes of the plantation areas. The detritus from the plantations have also accelerated nutrient enrichment of the waterbody leading to water quality deterioration.

Economically important species

Lake vegetation includes some economically important species utilized for food, fodder and fuel by the communities. A brief account of vegetation utilized for food, fodder, fuel and small-scale enterprises is briefly highlighted below:

Food

Several plant species in the Wular lake and associated wetlands have significant food value and are used either by the local communities for their own consumption or marketed to the neighboring towns or Srinagar city. Water chestnut (*Trapa* sp.) locally called Singhara and *Nelumbium* sp. (locally called Nadru) are the two major food resources plants derived from these plant species. Two species of Water chestnut viz. *Trapa natans* and *T. bispinosa* occupy large belts in the lake area. These two species are of great economic value to the people living in the area particularly economically disadvantageous group. Lawerence (1897) has elaborately mentioned about *Trapa* cultivation in Wular Lake. He has reported that essentially there are a number of varieties of Singhara in the Wular lake, viz. Basmati, Dogru and Kangar. Basmati with small nut and a thin skin is a superior variety named in honour of variety of rice. This variety gives one third of Kernel for two thirds of shell. Attempts to propagate Basmati have generally failed as the inferior varieties often assert and provide stiff competition to the Basmati variety. Dogru has comparatively a larger nut with thicker shell. The Kangar variety has a very thick shell with long projecting horns, and gives the least Kernel of all.

Water chestnuts occupy an overall 21.2 sq km of lake area representing 49.8 % of the lake vegetation. It is distributed throughout the lake but the maximum concentration is found on the eastern side near right shoreline (13.03 sq km) which relatively deeper area. The other chunks of the species are confined to western side (1.50 sq km), north-west near Kanibathi (4.98 sq km) and towards Garoora – Laharwalpora (1.69 sq km).

The process of harvesting of *Trapa* is an interesting feature in which a boat is moored to a pole on the *Singhara* ground, and two men rake the bottom of the lake with long poles to, which are attached crescent shaped hoes. They work in a circle around the pole by which the boat is moored, and scrape up a heap of nuts and mud. The mud is then beaten with a pole called *Chokdan* and a net called *Khushabu*, put down and the nuts are dragged into the boat.

Harvesting of Trapa

It has been reported by Lawerence that in an around the Wular lake an enormous weight of the water chestnut is gathered every year. Bates (1974) reports that about 96,000 *Kharwars* or ass loads of the nuts are harvested annually for five months in the year. It forms the main support of thousands of the poor people. The harvesting of the *singhara* is usually done when the water level is low. The Kernel which is

white and mealy, is either taken roasted or fried. The kernels are also ground into flour and eaten as porridge and gruel. No attention has been paid to propagate the best varieties of water chestnut by botanists or any agriculturist till date in or around the lake.

Nelumbium nucifera, with large floating leaves and underground rhizomes is used as a vegetable and sold in the markets of surroundings villages and towns. The flowers as well as fruits of the plant are used for religious purposes. The species is spread from Ashtangu to Kanusa and a few patches confined to Lunkershpura, Kolhama and Garura covering a total area of 0.49 sq km representing 1.14% of the total vegetation. Earlier this species used to be found all along the lake from Aidipur to Baniyari. The quality of the rhizomatous portion has also deteriorated as the fragility of the stem has increased due to reduction in the fiber content. The floods during recent years have severely impacted production of the species thereby impacting livelihoods of the people.

Fodder

Phragmites-Nymphoides-Nymphaea are the main species utilized as fodder by the communities living in and around the lake. Overall, fodder plants cover an area of 18.60 sq km of the lake represent 43.69 % of the total lake vegetation. These species form large belts in the Garoora - Laharwalpora portion of the lake occupying 10.81 sq km. This portion of the lake is swampy and shallow due to heavy load of silt brought in by River Jhelum and its deposition due to thick strands of willow plantation, which choke the inlet area.

Utilization of Aquatic Weeds

Fuel

Willow plantation covering 27.30 sq km in the lake area is utilized for supply of fuel wood mainly to Srinagar besides its utilization for manufacture of cricket bats. State government departments mainly, Rakhs and farms, forest department, local panchayats and Social forestry have undertaken massive plantation of willows. Besides several plant species or their components such as shells of water chestnuts are utilized locally for fuel purposes.

Willow Plantation

The massive plantations of willows in the lake area have considerably retarded natural water flows due to enhanced siltation in many areas of the lake. This has led to loss of wetland habitat thereby reducing the benefits provided by the wetland through its natural processes and functions, reduction in biodiversity, loss of feeding areas for waterbirds.

Small scale enterprises
Several plant species are utilized for mat and basket weaving, bat manufacturing and other purposes. The yield from the cultivation of *Trapa* is further processed and transported through a chain of contractors and finally sold in the markets of Srinagar and other towns.

Ecological importance of vegetation
Vegetation acts as a main contributor of the photosynthetic carbon fixation. The physical contours are very much conducive to the build-up of organic sediments throughout the lake areas, an important factor for the recurring dense growth of plants. A decrease in total N, available P, total P, K and Ca in lake sediments from March to July corresponds to the exponential growth of vegetation. These losses from sediments do not in any way result in the increased concentration of nutrients in the lake water as vegetation provides a biological sink reducing their solution concentration in the water. Aquatic vegetation satisfy their N, P and K demands by drawing these nutrients from the sediments and play an important role in the ecological functioning of the lake in that large quantities of materials which could have otherwise caused algal blooms are being trapped by them during the growing season. Large quantities of materials are, however, returned to the lake bottom after the deposition and subsequent partial mineralization of dead plant tissues. Lake sediments serve as an important sink for these nutrients. However, continual expansion of the beds of the rooted weeds will accelerate eutrophic conditions as they have the capacity to translocate nutrients from the sediments into water, further increasing nutrients available to phytoplankton and floating plants such as the *Salvinia-Lemna-Azolla* complex.

Based on the information available from various sources it has been calculated that annually 141.77 tonnes of nitrogen, 8.30 tonnes of phosphorus and 111.59 tonnes of potassium is locked within plant tissue which otherwise would have added to nutrient pool and led to degradation of water quality. Harvesting of vegetation provides simple method of nutrient removal form the lake ecosystem. Maintaining vegetation within the lake is thus an advantage to improve water quality.

Aquatic vegetation also provides shelter for several aquatic organisms as well as habitat for breeding and spawning for fishes. Dense vegetational cover is more conducive for the spawning of carp species rather than indigenous *schizothorax*. Vegetational modifications are required for enhanced fish diversity and productivity of native species.

2.2.4 Socioeconomics

Demographic features

There are overall 127 settlements around Wular Lake and its catchments located within the district Baramulla in the Bandipore, Sopore and Sonawari tehsils. The total population of these settlements as per 2001 census is 0.46 million, which is 9% of the state's population. Of this, 18% inhabit the 31 settlements around Wular; 70% within 70 settlements within the foothills and the rest within 26 hill settlements (Fig 16). The population is largely rural, with only 22% residing within the 36 urban settlements. The average household size ranges from 6.8 in the hills to 7.48 within the foothills and 7.56 within the lakeshore communities. The location of settlements around Wular is presented in Map 2.12.

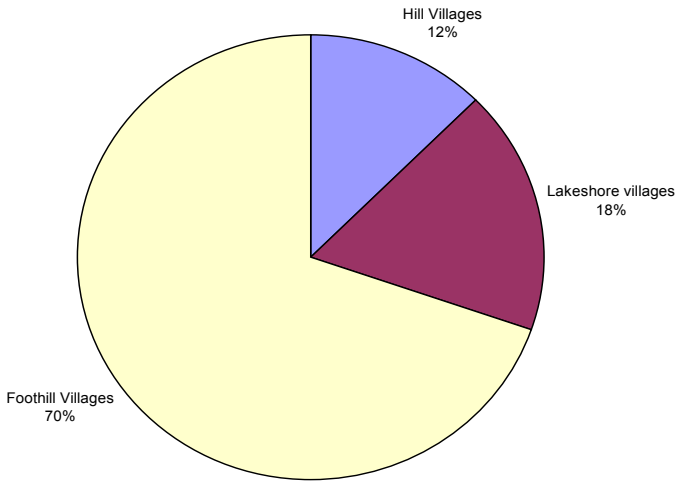
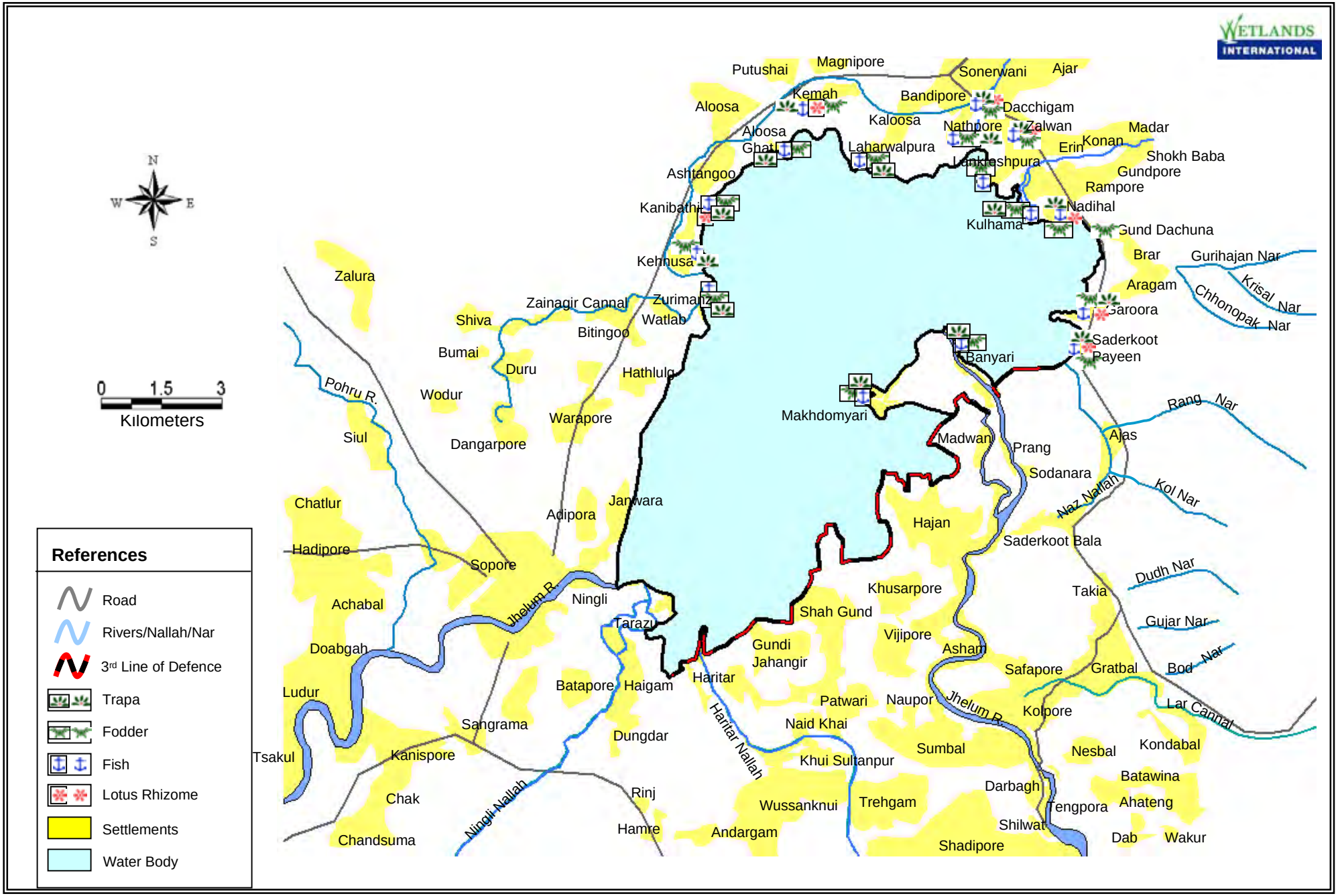


Fig 16 : Population distribution in and around Wular

Social Amenities

Social amenities vary across the region, with foothills having relatively better access to facilities as compared to the lakeshore and the hill settlements. Rapid rural appraisals carried within the area indicated that only 46% of lakeshore and 52% of hill communities have access to drinking water supply as compared to a total coverage in the foothill villages. However, owning to poor maintenance of the water treatment facilities, there are often outbreaks of water borne diseases, particularly in the lakeshore communities wherein 42% of the population was reported to use water from Nullahs / River Jhelum without proper filtration. Adequate sanitation facilities are also very limited in the entire region. Less than 2% of the households in the lakeshore and hills and 8% of the population within the foothills have access to flush toilets, leading to high amount of dumping of untreated sewage in the waterbodies draining the area. Similarly, the access to healthcare is also wanting in the region, 36 - 60% of the settlements have no health care facilities in the village. Fair weather roads are only accessible in the foothill villages, road connectivity becomes severely limited in the high rainfall / snowfall periods.

A comparison of the status of access to social amenities in the region around Wular with the state indicates high levels of under development within these areas. The average access to sanitation for the whole state at 9% compares with the foothill villages, but is higher than the lakeshore and hill village avareges. Similarly, access to road communication for the state ranges from 60.63% to 82.64% which is much higher than the connectivity within areas adjoining Wular. In particular, the lakeshore villages have been completely left out of the development process in terms of access to social amenities.



Map 2.12 : Lakeshore Communities Resource Linkages

Economic Activities

Economic activities of the communities are directly linked with access to natural resources. Detailed resource trend and access analysis were carried out in 23 representative villages for livelihood assessment and are presented below:

Lakeshore villages

Livelihoods of lakeshore communities are primarily dependent on lake resources, including fish and aquatic vegetation. While all the lakeshore villages harvest vegetation to varying proportions, 13 of the 31 villages engage in capture fisheries within the lake. The following are the main findings of the trend analysis:

Fisheries: Capture fishing in Wular is main occupation of 2,331 households. There are an estimated 2,621 active fishers in Wular, the rest engaged in trade and / or limited value addition processes including salting and drying. Fishing in the lake is done for 6 months during March – June and then from October – December. Higher catches are realized in the peak summer months of May – June, which corresponds with higher water levels and consequently greater lake spread. While the male members are engaged in fishing, women of the family undertake marketing and related operations. Fish licenses need to be obtained from the Fisheries Department for fishing into the lake. A license for one year is provided for Rs. 100.

Analysis of the resource mapping trends indicates a steep decline in the fish catch over the last fifty years. The total catch as extrapolated from the catch records from the surveyed villages has declined from 10,544 MT to 1,476 MT. With a three-fold increase in population of households dependant on fisheries, and decline in overall catch, the per capita catch has gone down by 20 times (Fig 17). The average annual household income from fisheries is therefore only Rs. 22,528, which is hardly sufficient to sustain an average family of seven.

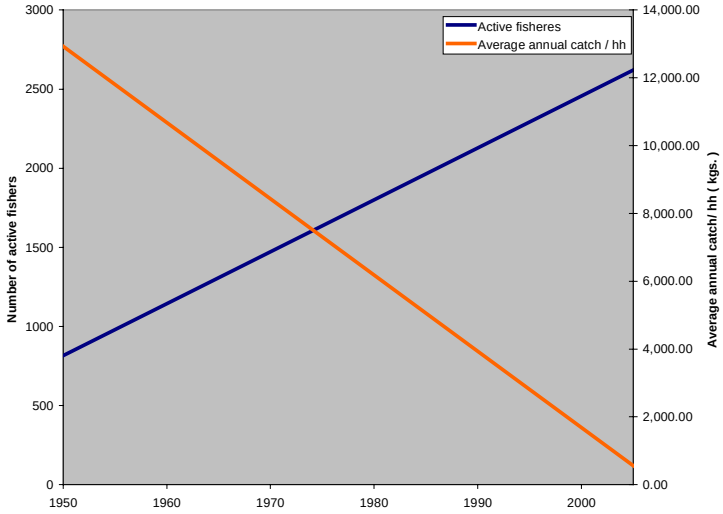


Fig 17: Trends in number of fishers and annual household catch

Economic status of the fisher households is further constrained by lack of access to formal credit mechanism. This has therefore provided an opportunity for a middlemen system, which provide credit on easy terms to the fishermen but undertake a contractual obligation for selling the fish directly to them at prices lower than the market and also pilfering the weighing system.

Lake Vegetation: Lake vegetation provides a significant means for augmenting livelihood base of the lakeshore communities. The key species harvested from the lake for economic purposes are *nelumbo* (nadru) and *trapa* (singhara) as food and *nymphoids* (khur and nar) as fodder. Lake vegetation sustains livelihoods of an

estimated 24,150 households forming 29% of the total lakeshore population. *Trapa* presently is the key commercial crop harvested from the lake.

Analysis of trend data on availability and dependence indicates drastic changes in vegetational resources over the last fifty years. Data collated from the rural appraisal indicated an abundance of vegetation, particularly *nelumbo* during 1950s, which provided income base to 75 – 80% of the population. However, the availability of *nelumbo* has decreased by 56% during the last fifty years owing to reduction in lake area, siltation and decline in water quality. On the other hand, the total collection of *trapa* and fodder has increased by five and three times respectively. Therefore, the communities have gradually switched over from *nelumbo* to *trapa* collection, thereby leading to a two fold increase in annual household collection of *trapa*. (Fig 18)

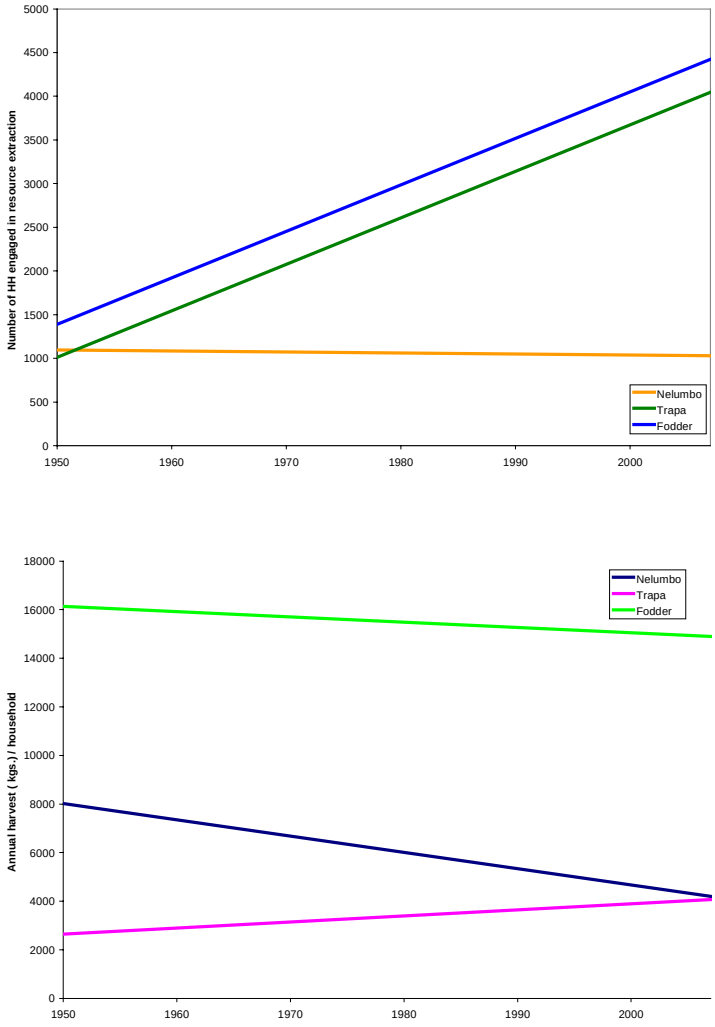


Fig 18: Trends in population dependant and quantity of aquatic vegetation harvested from Wular

Collection of vegetation is primarily regulated by the Revenue Department. Areas for *nelumbo* are auctioned annually by the Revenue Department. *Trapa* collection is managed by a separate office of Revenue Department titled Nayab Tahsildar (Malsinghara), Sonawari. Licenses are issued for trapa collection in two phases, a fee of Rs. 25 is charged for three months, i.e. August – October (for immature fruits, locally called *milech gair*) and Rs. 100 for a five months license during November – March (for mature seeds called *kamai gair*). While trapa and fodder collection is carried in 32 lakeshore villages, the activity is concentrated in the northern periphery villages (Kulhama nadihal, Lankrishipora, Zalwan, Laharwalpora, Aloosa Ghat, Kanibathi, Zurimanz) and within settlements where Jhelum enters Wular (Banyari, Mukhdomyari). The total revenue generated from vegetation of Wular Lake is presented in Table 2.10 :

Table 2.10: Revenue accrued to Government through vegetation of Wular Lake

Vegetation	2002-03	2003-04	2004-05	2005-06	2006-07
Nelumbo	655,000	1,851,000	2,425,000	1,060,000	-Nil (Crop lost due to heavy floods)
Fodder	110,000	181,000	81,000	301,000	280,000
Trapa	80,056	128,320	104,240	125,532	29,508

Based on the annual harvest, it is estimated that incomes from vegetation from Wular contributes annually an average income of Rs. 10 – 13,000, which is critical for livelihood support of the community.

Foothill villages

The foothill communities have a diversified livelihood portfolio. While agriculture and horticulture remain the basic source of income for 43% of the households, business and artisinal crafts are also undertaken by 27% of the population. The rest draws sustenance on dairying and other activities. Several farmers have also raised plantations in the private lands for fuel wood, timber and wood based industries as bats and matchsticks. Availability of irrigation water through canals ensures high productivity. The region also has better road and infrastructural connectivity, and therefore markets are concentrated in this region.

Hill Villages

Communities living in the hills are based on catchment resources and sheep rearing. The primary occupation of the hill communities is collection of firewood and charcoal, which is the main source of energy for the entire valley. Illegal timber felling also provides a rich source of income to the communities. Degradation of the forest resources has led to shrinkage in the resource base of the communities. Several minor forest produce of high economic value [Guchh – used as medicines; Manchren and Ringrish – local tea,; Wupal Hakh, Vulket – used as vegetables] are no longer available within the catchments. Decline in area under certain economically important tree species as Pohu has adversely affected communities engaged in related microenterpise, eg Kangri manufacturing. Availability of firewood and charcoal has also declined by over 10% and 30% respectively in the last five decades. Forests which were the main source of livelihood of 80% of the communities 50 years back can at present support no more than one fourth of the population. Therefore, several households migrate to the valley region to work as agricultural labour in the fields.

Institutional Arrangements

Village Panchayats are the key local self government institutions entrusted with the task of local level planning and management. However, activities of these institutions have been largely limited to political concerns, with little role in development planning within the region. Development projects implemented under Integrated Watershed Development Programme have resorted to formulation of alternate institutions, called 'Village Development Committees' in the World Bank funded Integrated Watershed Development Programmes within the hill villages. In several villages, user groups (as District Union of Mahigeer wa Singarkash, Dehat Sudhar Committees, Weavers Association) have been formed to cater to the needs of specific groups. Baraderi, or informal elders' group play important role in day to day management of village

resources and resolution of conflicts. Aukaaf committees are key religious institutions at the local level having significant influence on the village activities.

Impacts of wetland degradation on livelihoods

Poverty

High dependence on natural resources, declining resource base and limited opportunities for occupational diversification have led to high levels of poverty within the communities. Population falling below poverty line around Wular ranges between 41 – 52% as compared to state average of 3.91% (Fig 19).

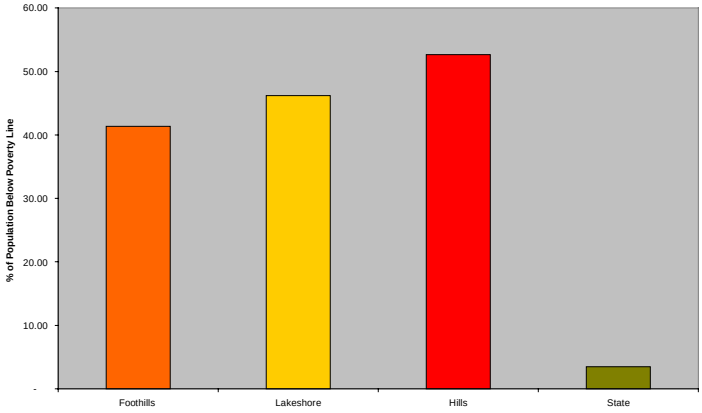


Fig 19: Percentage population living below poverty line in and around Wular

Changes in resource harvesting methods

Declining resources have forced the communities to adopt more exploitative forms of harvesting. This has particularly taken place in the case of fisheries, wherein fishers have resorted to use of nylon nets with lower mesh sizes and long gill nets which drastically affects the regeneration of resources. This has also created conflicts amongst various fisher groups within the lake.

Health hazards

Absence of adequate sanitation and safe drinking water facilities have led to severe health hazards particularly for the lakeshore communities. There is a high incidence of water borne diseases as gastroenteritis, jaundice and diarrhoea. Presently, less than 2% of the households living in the lakeshore villages have access to safe sanitation facilities and 42% use untreated water from Jhelum / Wular for domestic purposes rendering them highly vulnerable to water borne diseases and infections.

Problems in lake transportation

Wular has traditionally been an important mode of communication within villages. However, silting up of large areas and reduction in waterspread has reduced access to and increased travel time for several lakeshore settlements, particularly those living in the eastern periphery of the lake.

The following key issues emerged through the assessment of community profile and resource linkages:

- **Absence of community participation in resource management**
  Livelihoods of the communities living around Wular is dependant on natural resources. However, they have little participation in management of resources. The government departments have largely focused on revenue generation through enhancement of resource extraction. The current resource management system is therefore untenable and therefore calls for institutional reorganization with active participation of user groups.

- **Poverty due to declining resource base and limited opportunities for livelihood diversification**
  There has been a drastic decline in resources both within the lake as well as its catchments leading to decline in incomes and poverty within the communities. There is also limited emphasis on value addition and post harvest management, which present significant opportunities for enhancement of economic returns. Absence of access to economic infrastructure as banking and credit facilities has rendered the communities vulnerable to moneylenders, which lead to lower price recovery pushing the communities into debt trap.

- **Declining quality of life due to limited access to social infrastructure**
  Lakeshore communities in particular have limited access to social infrastructure, particularly adequate drinking water and sanitation facilities. High incidence of water borne diseases also leads to more frequent loss of working days and morbidity within the communities. This significantly reduces the opportunity for ensuring safer living and better quality of life.

2.3 Developmental Activities and Their Impacts

Wetlands of Jhelum basin are the lifeline of Kashmir. They provide ecological and economic security to the entire Kashmir Valley through their natural functioning. The wetlands form the base of food security of the valley by providing fish and aquatic vegetation. Set within the picturesque setting of Himalayan mountain ranges, several of these wetlands are centers of touristic attraction thereby supporting economic growth through revenue generation to the local economy. By regulating hydrological regimes, these ecosystems provide flood protection as well as water security to the entire basin.

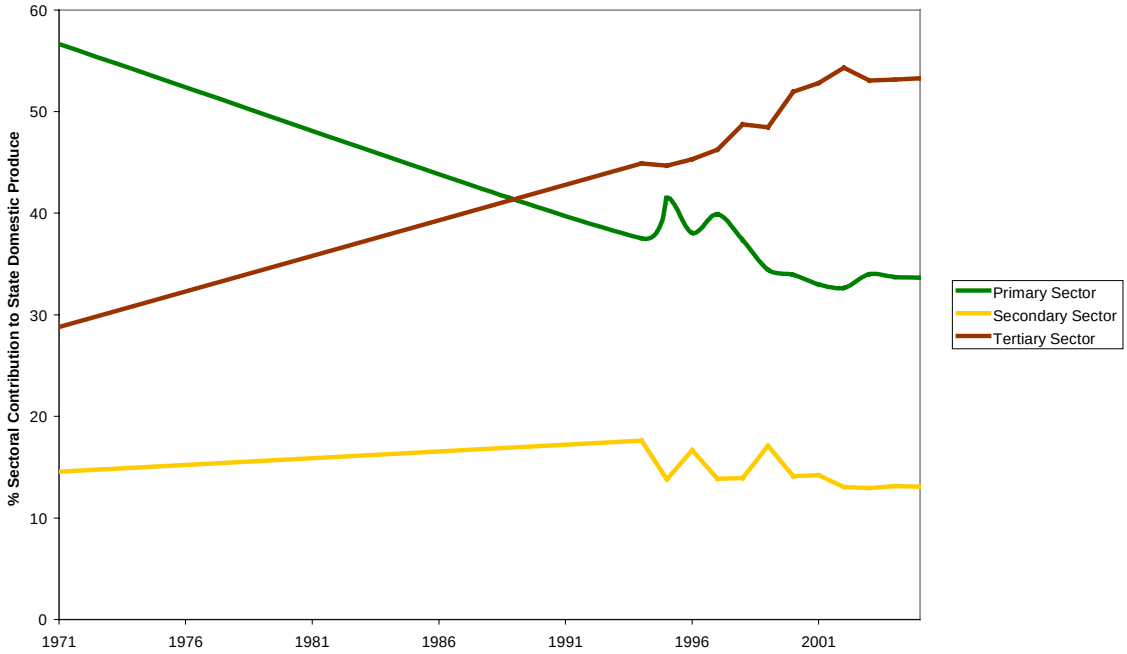


Fig. 20: Trends in sectoral composition of state Gross Domestic Product

The Kashmir economy has undergone large scale changes in the last few decades. The primary sector was the largest contributor to the state Gross Domestic Product till 70s. However, agricultural growth has been constrained due to limited availability

of land and irrigation facilities. Nature based tourism today dominates the economy contributing more than 50% of the state income (Fig 20).

Developmental activities however completely failed to recognize the immense role of the wetlands within the basin, and thereby led to their large scale conversion, and degradation. Expansion of agriculture during 1900 – 1970s was the primary reason for conversion of wetlands and associated marshy areas in and around Wular. The first major plan for reclamation of marshes for agriculture development was formulated in 1949 identifying 13,540 ha of area for reclamation through construction of embankments. A detailed historical perspective on Wular reclamation is presented in Box 3. The need to provide energy security to Kashmir led to introduction of willows in the peripheral areas of Wular, which led to fragmentation of overall wetland regimes, rapid siltation, water quality deterioration and social conflicts.

The following are the impacts of developmental activities on Wular and associated wetlands:

- **Shrinkage of wetland area:** Several wetland of the basin have been converted for alternate purposes. Wetlands complex of Batmaloo – Bemina have been reclaimed for development of housing complexes. A large chunk of marshes along Bad Nambal, Rakh Ajas, Malgom, Haigam, and Nawgam have been reclaimed for agricultural purposes. Within Wular Lake alone, 71.55 sq km has been converted for willow plantation and agriculture development.

- **Fragmentation of wetland regimes:** The connectivity of wetland complexes within the basin is being progressively reduced primarily due to construction of embankments and other structures, siltation of channels and other factors. This has accelerated the process of shrinkage of wetlands. For example, the large wetland marshes complex adjoining Wular extending to more than 60 sq km in 1911 has been reduced to less than 14 sq km due to construction of flood protection embankments and conversion for agriculture.

- **Changes in hydrological regimes**: The hydrological regimes of the wetlands have been severely altered due to interventions to enhance the outflows and reduce water levels of River Jhelum for flood protection, and loss of natural water holding capacity in the upstream reaches of the basin through conversion of marshes and degradation of catchments. Hydrological assessments for Wular Lake indicate shifts in water storage period from peak summer months to lean seasons, thereby reduced capacity to regulate flow regimes. This has affected the overall water availability within the basin, leading to more frequent occurrence of droughts and floods.

- **Decline in water quality:** The water quality of the wetlands has significantly deteriorated due to uncontrolled dumping of sewage and solid waste by the adjoining settlements. The situation is most glaringly reflected in Wular Lake , which due to its physiographic settling becomes recipient of all wastes dumped into the river upstream, and turns into a cesspool of wastewater leading to high incidence of water borne diseases in the peripheral communities and reduction in biodiversity.

- **Loss of biodiversity:** Alteration of hydrological regimes has severely altered biodiversity of the wetlands. Several native fish species have been reported to be declining due to deteriorating water quality. The waterbird population has also declined due to declining food availability and shrinkage in water spread area.

- **Poverty in wetland dependant communities:** Wetland resources, particularly fish and economically important food and fodder species form the base of livelihoods of the 31 villages located around Wular. While the peripheral settlements have undergone a rapid growth in population, there has also been a simultaneous decline in resources. Based on the rapid appraisals carried in 8 villages, the most affected resources are the fish and nadroo, which have recorded 87% and 46% decline over the last fifty years. With little opportunities for occupational diversification, this loss of resources has induced high levels of poverty within these communities. With rapid degradation of lake water quality and absence of adequate sanitation and safe drinking water facilities, the quality of life of the communities has rapidly eroded.

Box 3 Reclamation of Wular: A Historical Perspective

Kashmir valley is essentially a floodplain of River Jhelum and its tributaries located in its upstream areas, a large part of the basin being in Pakistan. Wular and its associated vast swamps played a critical role in maintaining the uniformity of lows in River Jhelum. During the peak summer months with high flows, the swamps would provided storage to the excess flows and thereby prevented lager valley areas from flooding. During lean flow seasons, particularly in the dry months of November to March, the marshes released the stored water, thereby maintaining uniformity of flows and moisture regimes within the valley. The role of wetlands in best described by Lieutenant Colonel A. J. de Lotbiniere, State Engineer, Kashmir Darbar, in a memo dated 6th May 1912 in the following words:

" Kashmir acted as a great sponge at the head of Jhelum which held up the floodwaters and gradually oozed dry during the winter months"

Wular and its associated marshes were identified as important capital assets during the kinship of Maharaja of Kashmir. Their importance was significantly recognized as a) flood reservoir providing protection to life and property in upstream reaches of Srinagar; b) revenue generation through sale of water to downstream Punjab and c) revenue generation through creation of additional acreage through conversion of marshes for agriculture development.

The first early intervention into hydrological regimes of River Jhelum took place in December 1902 with the primary objective of:

- Mitigation of floods in Srinagar and downstream settlements through improving drainage options leading to reduced retention of flood flows in the valley
- Increasing area under agriculture through reclamation of marshes, which were considered to be unproductive wastelands
- Augmenting water availability for irrigation to Punjab State of undivided India for triple canal project contemplated to irrigate Jech, Rechna, and Bari Doab areas. The third objective was envisaged to be achieved by storing of water in Wular Lake through construction of a barrage.

Manipulation of water levels in river and wetland system was therefore identified as central means to achieve the aforementioned objectives. The following activities were envisaged under the Maharaja's Action Plan:

- Dredging of river bed from Srinagar to Wular Lake and thereafter from Sopore to below Baramulla enabling lowering of water levels by 8 – 10 feet leading to flood mitigation in upstream areas
- Providing of narrow and deep drainage cuts from Baranagara Swamp into River Jhelum above Baramulla to drain the pestilential marshes leading to availability of 1,00,000 acres of agricultural land at southern shores of Wular

- Construction of light wooden barrages wherever necessary to ensure river navigation
- Construction of a barrage at the Lake outfall channel for enhancing lake storage for winter irrigation needs of Punjab

The aforementioned activities were expected to significantly enhance the revenue base of the kinship. A review of the proposed plans indicates conflicting objectives of creating storages in Wular for irrigation development on one hand, and decreasing river and wetland levels on the other hand to mitigate floods and drain marshes. This contradiction, as would be expected, resulted in protracted correspondence and deliberation on the scheme of things in which the joint venture economics of the project also became controversial. The matter, therefore, was referred to Government of India which categorically ruled out the propositions of construction of Wular Barrage. The final decision of Government of India was conveyed to Darbar in Residency letter no. 3899 dated 15.12.1905 stating that the Darbar might consider:

"storage scheme as definitely abandoned and may therefore proceed with their over scheme of reclaiming marsh and waterlogged lands in the Kashmir Valley"

Accordingly, dredging works were commenced by the Darbar in the reach from Sopore to Baramulla. During these operations, it was also realized that lowering water levels in Jhelum would require cutting through the rocky boulder below and boulder obstructions below Baramulla. Dredging works led to decline in lake levels at Sopore by atleast three feet. This was accomplished along with the dredging operations, and the results of the change in the river regime started showing in 1912 – 13 onwards when the drainability started increasing with lowering of the lake levels. The lean seasons flows were reportedly declined by 1,000 – 1,500 cusecs.

Reduction of lean flows of river Jhelum also led to decrease in winter water availability in Punjab, and therefore a reconsideration of the above project was warranted by the Inspector General of Irrigation in India, Mr. M. Nathersole, as reflected in the inspection note of the Kashmir Drainage Works of later dated 10 July 1912. The said note recommended the need of artificially regulating Wular Lake at its outfall through a barrage. To be constructed below Sopore and above Pohru River with its sill level at elevation 5150 feet and top up gates at 5161 feet to afford storage of 1500 cusecs for 105 days. This was to compensate the natural storage of the lake lost due to dredging.

The changes in river Jhelum flows , i.e. more flows in Summer and less in winter was also noted with concern as an impact of dredging operations by the Darbar engineers. Measures were therefore sought to regulate the flow regimes to make irrigation water available to Punjab state during the winter seasons. However, construction of barrage also implied inundation of the areas which were reclaimed for agriculture by drainage of the marshes. Therefore construction of embankments around the reclaimed land to a specific height less than the maximum flood levels ever recorded was proposed along with sluice gates which would be operated commensurate with storage of water in Wular during summer months. It was envisaged that the sluice gates would be opened after harvest to enable flooding of the reclaimed lands and thereby an increase in the storage area during high flows of summer months. Winter crop of mustard on the reclaimed land was thereby assumed to be sacrificed for this flood mitigation benefits. A cost sharing formula was worked out for the project keeping all the aspects in view, which was again controversial and deterred the reconsideration of barrage.

After reconsideration, the Durbar realized that revenue maximization through draining of marshes and achieving flood mitigation could not be achieved simultaneously. A revenue sharing formula was therefore worked out for compensation for hydrological regulation. The debate on revenue sharing an mutual interests of Darbar authorities threw up data regarding the benefits and losses of the project which throws a lot of information upon the aspects of values of Wular from the considerations of pasturage, gathering of water nuts and reclamation of culturable areas for agriculture. The debate conclusively stated that in 1919 that completion of dredging works in 1912 and maintained since have *"considerably helped to keep the lands on the left banks of River Jhelum and are now surrounded by embankments dry. These areas used to be flooded at time of fairly high flood and so helped to keep the level of the lake*

down. But at present, with raised embankments to keep out moderate floods, the water which used to find its way onto these lands now passes direct into the lake and so tends to thereby neutralize the effect of dredging. The greater the area of land reclaimed, the greater will be this tendency. The effect of reclaiming the whole of Baranagra swamps area on the height of water in the lake has never been calculated but this must be great." (Remarks contained in the note on Wular Lake storage by the Pubic Works Minister, 25 June 1919).

A structural shift in approach to reclamation of marshes is reflected in the above note. The note recommends reclamation through natural siltation by the flood waters, in moderately bunded areas in segmetized compartmetalization, rather than through embankments and drainage. Physically draining out the waters through nullahs whenever lake levels would permit same. This opinion was reported to be based on experiences in Italy and Egypt.A model of distribution of reclaimed land and lease of same to the beneficiaries was also worked out where considerations were given to resource dependence and lake linkages.

After much deliberation, and apprehensions of loss of reclaimed agricultural areas, assets and socioeconomic implications, the Wular Barrage project was disapproved by Maharaja Inder Mahinder in 1921. However, in the time decision making and beyond the time of this decision , the natural tendency of local farmers to protect their agricultural land from floods resulted in raising up of the moderate level bunds over a period of time and the prospects of reclamation through holding up of silt laden waters in encompassed areas kept on fading.

Water resources development in the post independence period was influenced largely by the Grow More Food campaign. In July 1949, reclamation of lands in Kashmir by bund making, drainage of marshy lands, irrigation and levelling was envisaged under the Grow More Food Campaign, which was duly considered by the state government. Marshes, locally called rakhs / nambals , came under a fresh introspection as potential areas for reclamation. The areas identified for reclamation were as under:

a) southern fringe of Wular Lake below Baniyari, Maqdoomyaari and Shahgund and the islands formed by river Jhelum at its delta
b) part of Anchar lake known as Koojar Rakh
c) areas as Sultanporich Rakh in which water Sukhnag, Ferozepur Nallh and floodflow of sill channel is received
d) Part of Hokarsar NAmbal and Rakhe Harath
e) Gund Akhsa forming part of Batmaloo Nambal

The engineering authorities after exhaustive survey and study of revenue records gave the extent of land that could be reclaimed in the above areas and the money that would be required subject to the following general observation:

- Nambals play an important role in hydrodynamics of the Kashmir valley by acting as storages of flood waters. This was critical to security of life and property of the entire valley as the river channel above as well as below Srinagar did not have sufficient capacity to carry big flood discharges.
- Nambals besides acting as flood storages, regulated the flow regimes by discharging in the lean flow seasons. This function of the Nambals *was reported to be far higher than it could be as arable land.*

However, striking a compromise between the need to support additional food production, the committee recommended reclamation of the nambals around Wular , with the following precondition:

- Regulation of height of the embankments. It was suggested the top levels of the embankments would be such so as to permit inundation by high floods, which could revitalize the soil through deposition of fertile soil as well as contain floods of high magnitude.

- Providing control inlets and outlets within the embankments for proper and quick drainage.

Of the areas recommended for reclamation, certain portions within the periphery of Wular waterline (adjoining Gurura) were included. , specially on periphery of Wular Lake included part of the areas which were within the waterline of the lake , especially near Gurura. Further implementation of recommendation made the state Government to adopt different alignments of flood protection levies towards the southern shore of Wular Lake. The first came to be adopted in mid fifties which is now known was first line of defence, in which the moderate bunds were raised and strengthened. The floods of 1957 – 59 led to construction of second line of defence in mid sixties. The third line of defence was constructed in 1975 – 76, which marks the present lake boundary. Subsequently the embankment heights were also increased to above 1580 meters, in contravention to the recommendations made by the committee. This therefore led to fragmentation and hydraulic isolation of the marshes from the wetlands. Later 14 pumping stations were also constructed to drain the nambals.

2.4 Institutional Arrangements

The State Department of Wildlife Protection is the nodal agency responsible for conservation and management of the Wular Lake. Several state government departments viz. forests, horticulture, soil conservation, social forestry, ecology environment and remote sensing, science and technology, command area development, agriculture, fisheries, public health engineering, rural development, khadi and village industries, tourism, and revenue are involved in regulation and developmental activities influencing Wular and its adjoining areas. The main activities of these organizations relate to implementation of various programmes for land and water management, socio-economic development and conservation of natural resources.

Wular Lake management has historically been revenue centric based on its rich resource base, particularly water chestnuts. Realizing the scale of harvest of aquatic vegetation, Mahla Singhara was established under Revenue Department for regulation and sale of water chestnut, and fodder by auctioning to the contractors. Forest Department, Social Forestry, and Panchayats were mainly involved in supply fuel wood by plantation of willow trees in the lake area. The fisheries department is responsible for management of lake fisheries which is a major resource of the state. Irrigation and flood control Department is involved in implementation of water supply schemes for irrigation and other human uses. Rural Development department has several schemes for livelihood improvement of communities in and around the lake area.

Lately, there has been concern about environmental improvement and overall sustainable management of lake ecosystem. Department of Forests and Remote Sensing has undertaken several activities for lake conservation which included catchment conservation and some limited environmental management in the lake area. However, there has been little coordination among the various departments for conservation and management of the wetland. Realizing this the state government has recently constituted Manasbal and Wular Development Authority (MWDA) under the aegis of Tourism Department. The MWDA has identified 21 action points for development of Wular and Manasbal Lakes for which no rationale has been provided and at present all these activities seem to be disjointed and lacking long term objectives and vision.

2.5 Current Management Practices and Gaps

Wular Lake was identified as a Wetland of National Importance in 1986 under the National Wetland Programme of Ministry of Environment and Forests, Government of India for intensive conservation and management purposes. A committee was constituted under the chairmanship of the Chief Secretary for formulation of management action plan, with representatives of the concerned state government department including a member for the Ministry of Environment and Forests.

Catchment conservation was identified as priority activity by the committee and therefore an ecological restoration plan for Erin watershed was prepared in 1988 by the Directorate of Ecology and Environment. Activities for treatment of degraded micro watersheds of Erin catchment was supported through the MoEF, which included afforestation , aided regeneration, pasture development and limited soil conservation works , viz contour bunding, bench terracing, stream bank protection and vegetative contour bunding. Limited activities for education and awareness generation were also supported under this action plan. Subsequently, limited funding was provided to continue the various activities, mostly focused on catchment conservation. The focus of all the activities has been on conservation of direct catchments with limited activities in the lake including manual deweeding, desilting in the peripheral areas and monitoring of lake water quality.

The State Department of Environment and Remote Sensing formulated an eco restoration plan for Wular Lake for the period covering 2005 – 15 at an overall cost of Rs. 201.97 crore. The plan envisaged six objectives, including lake protection, land use management, flood control, provision of water for hydropower projects and navigation, control of pollution, and socio economic development of communities living in and around the wetland. However, detailed analysis was provided only for the catchment conservation component, with allocation of 53% of the implementation budget. Remote sensing based delineation of the catchment at sub watershed level, and identification of erosion prone areas based on assessment of land use, aspect and slope were used as basis for planning.

Besides the Department of Environment and Remote Sensing, different schemes are also being implemented, which directly or indirectly influence various features of Wular Lake. The following schemes are outlined in the District Annual Plan for Baramulla for 2006 – 2007:

- **Catchment Conservation:** Rehabilitation of 163 ha of degraded forests through plantation and small scale engineering works. An additional area of 50 ha is proposed to be undertaken through the social forestry division at Bandipora. The department also aims to reduce pressure on forests through development of village woodlots in 29 ha at Pehlipora and plantation within marshes in 17 ha area at Shahgund
- **Irrigation development** through implementation and maintenance of lift Irrigation schemes and upgradation of Tarzoo Weir. Within the Sonawari area, it is envisaged to support lift irrigation schemes at Churthangoo, Veerkhan, Purnibal, Sadarkote, Babdud, Paribal, Garikhan and Baniyari. Dewatering scheme at Wasikhan and Gund Boon have also been planned to support agriculture within the reclaimed marshes. The schemes are being implemented through the Irrigation and Flood Control Department

- **Maintenance of water supply schemes** for 17 villages in Bandipora and urban drainage schemes for Bandipora, Sopore, Baramulla and Hajin through the Urban Development and Public Health Engineering Department
- **Conservation of Protected Area Networks** (Ajas, Hokersar, Shalbug, Haigam, Meergund) through maintenance of species composition, enhancing food availability for flagship species, and protection by the State Wildlife Department
- **Fisheries development** construction of Mahseer fish farm at Boniyar Uri; trout hatcheries at Wanpora (Gurez) and Shokbaba (Bandipora) and restocking of trout streams with 1 lakh seeds.

An analysis of the current management practices reveals the following gaps:

- **Sectoral approaches to development planning:** Presently the schemes in and around Wular Lake are being implemented on an ad hoc basis, without assessment of interlinkages within a definite planning framework. Thus, one hand, the state government is investing into conservation of Wular Lake, schemes for its conversion into plantation and agricultural land is also being proposed through the social forestry and irrigation and flood control divisions.
- **Revenue centric approaches to resource management:** There is an absence of any plan for regeneration of lake resources which sustain livelihoods of local communities. The government on the other hand charges revenue for harvest of all of these resources. The revenue centric approaches are bound to lead to eventual decline of resources.
- **Inadequate targets:** The schemes are mere financial allocation, without any baseline assessment of issues. For example, mere construction of a hatchery is envisaged to lead to enhancement of fisheries. Targets for forestry similarly are not based on achieving a time bound regeneration of forest areas. This sub critical investment is not expected to yield any tangible results in terms of conservation and / or development outcomes.
- **Ineffective institutional arrangements:** No road map has been laid out for participation of local communities in the planning and management of action programmes. In absence of this , any realistic targeting and ownership of the interventions is difficult to achieve , thereby jeopardizing the overall purpose of implementation.

2.6 Key Issues

Based on assessment of hydrological regimes, developmental activities and their impacts on wetlands and assessment of review of management practices under implementation through various agencies, the following management issues have been identified to address conservation and management of Wular Lake:

- **Absence of policies and strategies to guide coordinated actions within River Jhelum Basin**

  The functions and processes of Wular Lake are inextricably linked with the hydrological regimes of River Jhelum, which accounts for over 80% of the overall inflows into the system. Maintenance of natural flow regimes, both in terms of quantity and quality is critical to conservation and management of Wular Lake. However, there is a marked absence of polices and strategies to guide coordinated action at river basin level. Adoption of sectoral strategies without assessing the overall impacts on the wetlands has led to upstream downstream conflicts thereby threatening ecological and economic security of the whole

region. Loss of water absorption capacity due to degradation of catchments, destruction of marshes and changes in land use (creation of plantations and expansion of agriculture) has enhanced the risk of flooding as well droughts in the entire basin. Absence of effective waste management in the upstream areas of the basin has converted entire Wular Lake into a cess pool of wastes creating severe health hazards for the communities living in and around the wetland. Regulation of river in the downstream reaches has effected migration of several economically important fish species, particularly mahaseer. Changes in hydrological regimes have reduced the overall capacity of hydropower generation to support economic development, a large proportion of which is supported through the concentration of population and economic opportunities in the upstream reaches of the basin. In the current context, effective conservation and management of Wular Lake is implausible unless measures are undertaken to coordinate actions at the river basin level.

- **Values and functions of Wular and associated wetlands not integrated into developmental planning**

  Wular and its associated wetlands through their natural functioning form the basis of various developmental activities. However, developmental planning has failed to take into cognizance the role played by these systems and therefore adopted measures for short term developmental gain at the cost of sustainability of the developmental process. Wular has long been viewed as a commodity supporting revenue generation, and has therefore been the focus of conversion and degradation, without any concomitant measures for its conservation. The grow more food programme under which conversion of large area under marshes into agricultural land were undertaken led to impairment of the hydrological regimes regulation capacity of marshes , contributing to increase in frequency of droughts and floods. Similarly expansion of settlements in the basin without adequate sewerage management systems have led to the wetlands being used as sink for wastewater leading to water quality deterioration and loss of resources.

  The lack of basic understanding of the nature of wetland ecosystem has led to overall loss of benefits accrued from the wetland through its natural processes and functions. As a consequence of this problems of water quality deterioration, decline in fish productivity and overall loss of aesthetic appeal are quite apparent. An innovative approach needs to be adopted for developmental planning integrating values and functions of the wetland. Such an approach would help to mitigate floods, regenerate water quality, enhance resource base and improve overall quality of life of the marginalized communities.

- **Water allocation biased towards human uses ignoring ecological aspects**

  The entire focus of water management in the Jhelum basin is on human uses, particularly irrigation and hydropower development, ignoring water allocation for maintenance of biodiversity and overall integrity of the wetlands. Water is critical to the maintenance of biodiversity and overall wetland ecosystem processes and functions. Though the Indus water treaty has prevented creation of any large water storage structures on the upstream reaches of the River Jhelum, expansion of developmental activities, would gradually crowd out the water availability for maintenance of ecosystem functions. A balanced approach to allocate water for human uses and ecological requirements is critical to sustainable management of wetland.

- **Lack of baseline information for planning and decision making**

  The current information on Wular Lake is fragmentary and of little use for the practical management of the ecosystem. A few scientific studies carried out are more of academic interests and no attempt has been made to systematically analyze the data for practical implementation. The data collected by various organizations has been for short term objectives and with limited scope. Overall the information collected is grossly inadequate and has not been critically assessed and linked with the defined objectives. There is an urgent need to build up the strong database on ecological, economic and social aspects to develop basis for sustainable resource management.

- **Marginalization of wetland dependant communities**

  The communities depending upon wetland resources have been seriously effected by the degradation of Wular Lake. These communities entirely dependent upon the lake resources such as fish, fodder, fuel and other products of the lake which has drastically declined thereby effecting the livelihoods. The developmental processes adopting structural approaches to poverty reduction has not benefited these communities in absence of resource recovery policy, the wetland dependent communities have been economically marginalized and live under abject poverty.

- **Absence of effective institutional mechanism for coordination and implementation**

  Lack of effective institutional mechanism to coordinate the activities of various state government departments for conservation and development of Wular Lake and its catchments is the major factor for degradation of the lake environment. Although several agencies are involved in implementation of sectoral activities for socio-economic development but often they lead to impacts on regenerating capacity of the lake ecosystem. Further conflicting interests of the stakeholders departments and lack of involvement of local communities in the planning and implementation have lead to intersectoral conflicts and loss of lake resources supporting livelihoods.

3. Management Planning Framework

3. MANAGEMENT PLANNING FRAMEWORK

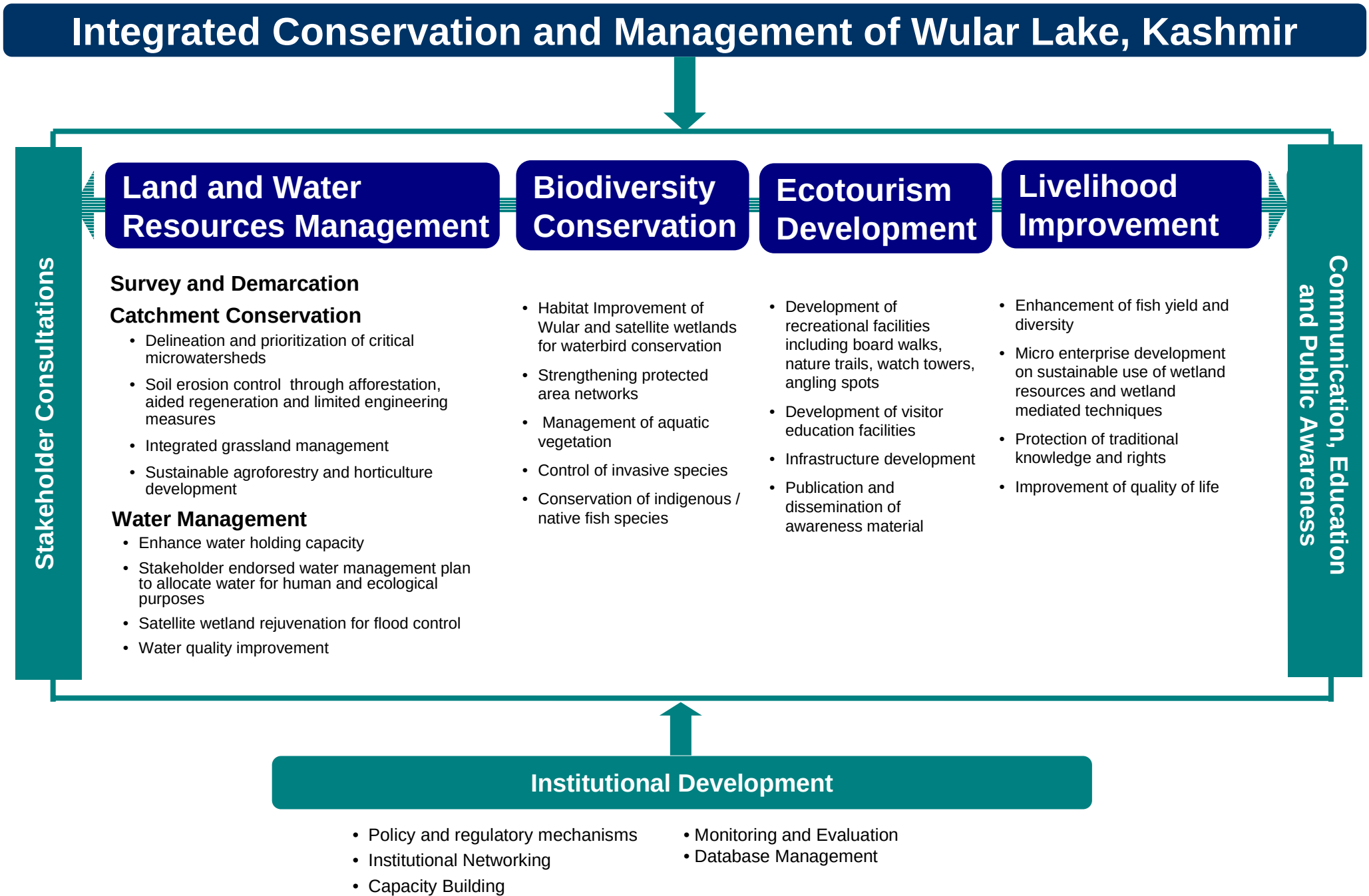
Conservation and sustainable development of Wular Lake requires integrated planning and resource management at the Jhelum River basin level recognizing the interconnectedness of wetlands with their catchments. River basin level planning requires understanding of the carrying capacity of the river basin with a view to produce desired goods and services from limited resource base and achieve equitable quality of life while maintaining desired environmental quality in the region. The planning for sustainable development calls for trades off between desired production and consumption levels. It also emphasizes on development of supportive mechanisms within the generative capacity while maintaining the environmental quality. The challenge, therefore, is to conserve wetland ecosystems along with their rich biodiversity while providing sustained economic benefits to the communities dependent upon these resources for their sustenance.

River basin approach has been adopted to address the management problems of Wular Lake taking into account the external, natural and induced factors and their influence on the ecosystems. Wular Lake and its resources are essentially adapted to the hydrological regimes and vulnerable to changes due to anthropogenic pressures. The emphasis for successful management of the lake, therefore, is on maintenance of ecosystem characteristics and sustainable utilization of its resources for the benefits of stakeholders, particularly local communities. Integrated management planning therefore aims at bringing together stakeholders at all levels and to consider their needs and aspirations while ensuring sustainability of wetland ecosystems within the Jhelum River Basin.

The 'New Guidelines for Management Planning for Ramsar Sites and other wetlands' as adopted in the meeting of 8th Conference of Parties to the Ramsar Convention have been applied to develop the management planning framework. These guidelines emphasize on evaluation of ecological and socioeconomic and cultural features to identify factors, objectives and operational limits for effective restoration and management of the lake ecosystem. Application of these guidelines involved a comprehensive understanding of ecological and socioeconomic features based on elaborate social processes. WISA carried out rapid assessments and extensive Participatory Rural Appraisal (PRA) exercises and socioeconomic surveys in selected villages within the valley as well as in the hill areas to identify the critical ecological issues, socioeconomic conditions of the communities, resource linkages and their needs and aspirations. The evaluation of the features led to the identification of the management objectives. The critical problems confronting the lake were thoroughly analysed to develop rationale for the management objectives. The targets under each management objective were quantitatively defined wherever possible.

The management planning framework seeks a balance between ecosystem conservation for ensuring ecological integrity of Wular Lake and ensuring livelihood security to the communities. It also seeks to ensure an effective institutional mechanism that harmonizes planning at various levels with participation of all concerned stakeholders to achieve the objectives of integrated conservation and livelihoods. In order to achieve the above, management planning has been organized along five subcomponents, viz land and water resources management, biodiversity conservation, ecotourism development, livelihood improvement and institutional development. Schematic presentation of the planning framework is presented in Fig 3.1. Specific projects have been defined for each of the five components. Project implementation mechanisms have been defined to achieve the management

Fig. 3.1 Management Planning Framework



objectives identified under the action plan, with special emphasis on gender equity and upliftment of weaker sections of the society. Cost-benefit analysis of the action plan was carried out to assess the feasibility of the interventions and sustainability of the activities. The local and global benefits accrued to the stakeholders through implementation of the action plan have been assessed using the techniques of economic evaluation.

The details of the management planning framework are discussed in the present section.

3.1 Goal and Purpose

Goal
The goal of the CMAP is conservation and sustainable development of Wular Lake within River Jhelum Basin for ecological security and livelihood improvement of local communities

Purpose
The purpose is to establish effective management practices for restoration of Wular Lake within River Jhelum Basin for ecological and economic security of the people dependent upon the lake resources for their livelihoods.

3.2 Management Zoning

The CMAP is based on the principles of management zoning which provide a basis for targeting interventions for achieving conservation and wise use of the wetlands. The Ramsar framework for 'Wetland Inventory, Assessment and Monitoring', which is a multi scalar approach to wetland inventorisation has been adopted for the purpose (Fig 3.2). This hierarchical approach comprises a progression in scale from river basin to individual wetland site, and is consistent with the river basin approach adopted for management of Wular Lake. Interconnectivity in management planning at different hierarchical scales ensures maintenance of ecological character of the wetland system. The Indus river Basin and Jhelum sub basin form the first and the second management levels. Wular wetland complex, which include Wular Lake and associated marshes ,form the third management level.

Wular Lake, which forms the fourth inventory level, can be delineated based on its hydrological regimes. The extent of Wular Lake was reported to be 217.88 sq km in 1911, which included an 58.67 sq km of marshes forming a contiguous system. However, owing to various hydrological interventions, the wetland system has been highly fragmented, disconnecting the marshes from the main lake. Though the entire system remains a single ecological entity, the area can be delineated into lake proper and associated marshes for effective management. The third line of defence, which extends from Haigam Rakh and till Sadarkoot Payeen has been constructed at a minimum elevation of 1580 m amsl and hydrologically isolates the marshes located on the south eastern periphery from the main lake. Flood routing studies carried out under the Tulbul Navigation Lock Project have revealed that a even a flood of frequency 1:500 years cannot overtop this embankment, and therefore can be safely taken as the south eastern boundary of the lake. The lake boundary from Sadarkoot Payeen till Watlab is defined by mountain ridge, wherein the elevation increases from the 1580 m amsl rapidly to more than 1600 m amsl within a distance of 200 meters. The flat zone between Watlab till Jhelum outlet bears continuous inundation till the Baramulla – Sopore Road, which defines the western boundary of the lake.

Delineation of the lake boundary is proposed to manage the land use for maintenance of ecological character of the wetland system. Hence, the land use within the proposed boundary needs to be regulated on the principles of wise use of wetland, which is defined by Ramsar Convention as *"maintenance of their ecological character, achieved through the implementation of ecosystem approaches within the context of sustainable development."* This would therefore imply permitting activities within the wetland consistent with its wise use, and regulating the detrimental developmental activities. The approach underlines communities as an integral part of ecosystem, and proposes to regulate wetland use to maintain its ecological character.

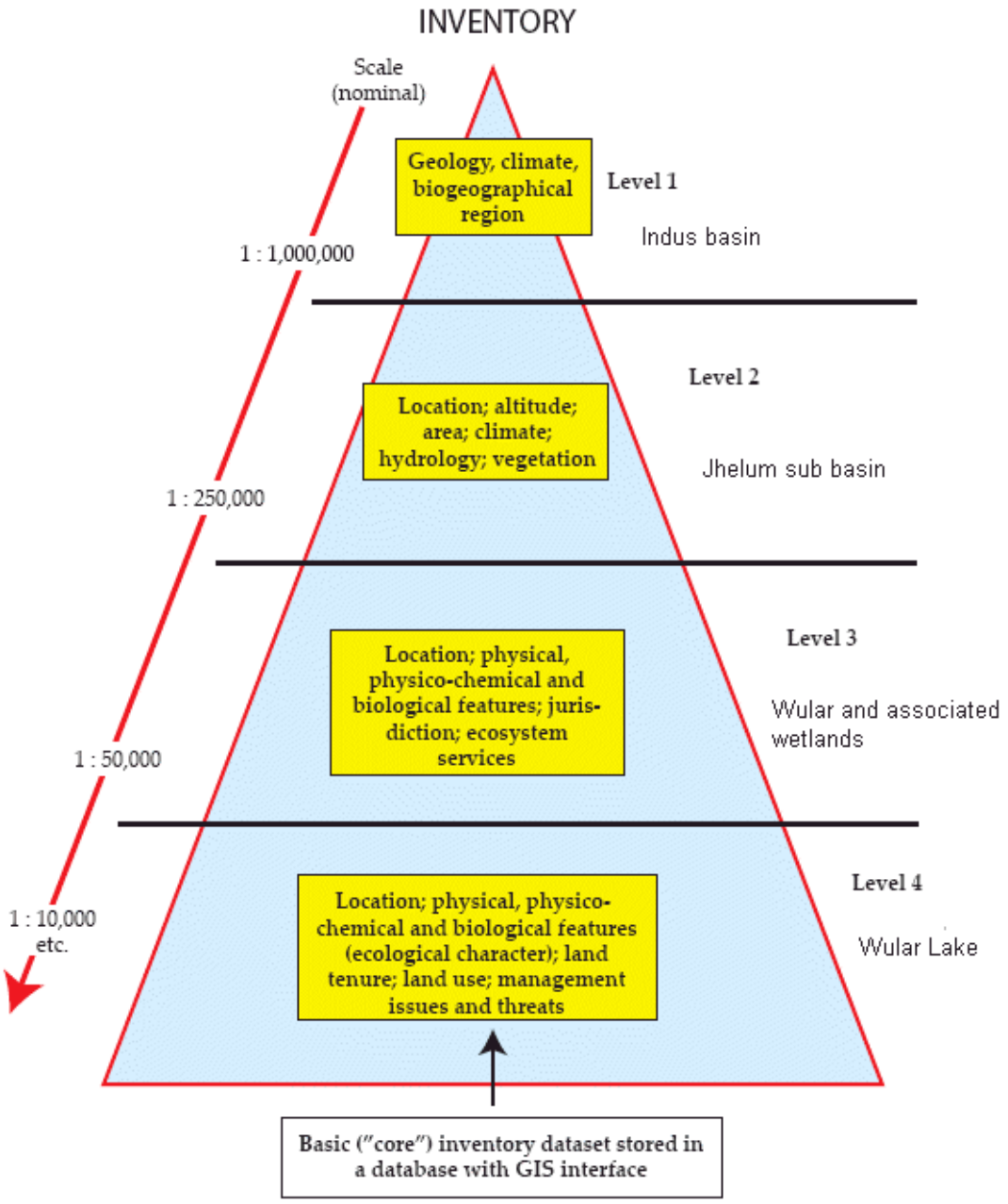


Fig 3.2: Hierarchical approach to inventorization of Wular Lake

3.3 Objectives, Targets, Indicators and Strategy

Objective 1: Wetland survey and demarcation

Target

- Demarcate the wetland area based on hydrological regimes using Integrated Wetland Inventory and Assessment Approach

Indicators

- Mapping of wetland extent at 1: 10000 scale based on hydrological regimes, using remote sensing imageries and hydrological assessments
- Establishment of boundary indicators, eg pillars in consultation with local communities

Strategies

- Multi scalar hierarchical inventorisation and assessment
- Community consultations for boundary demarcation
- Establishment of management zones for regulating developmental activities in various parts of wetlands and its periphery to maintain its ecological character

Objective 2: Control of soil erosion from degraded watersheds

a) Enhancing vegetative cover in degraded watersheds through biological and small scale engineering measures

Target

- Enhance dense forest cover from 29% to 40% of the direct catchment area

Indicators

- Formulation of village level planning and implementation committees as per National Afforestation and Eco development Guidelines of Ministry of Environment and Forests for 6 watersheds of Wular Lake
- Afforestation and aided regeneration in 3,718 ha and 2,789 ha of catchment area supported by small scale engineering measures in 815 ha

Strategies

- Formation of Joint Forest Management Committees (JFMCs) and Forest Development Authority (FDA) as per NAEB Guidelines
- Afforestation of degraded forests area using native species. Robinia could be used for planting on the refractory hill sides; other species that could be integrated are Hari, Ailanthus, Cethis, Pines and Walnuts
- Aided regeneration through gap filling (patch sowing in small enclosures) and protection of young saplings to assist natural regeneration
- Development of contour hedging to check soil erosion using local species as *Indigofera hithrantha* (Keitch), *Partiposis jacquamontaus* (Pohu), *Crotoncaster oxycantha* (Reing), *Salix*

tetresperma (Veer), *Onobrachys vicifolia* (Sanfine), *Vibernum foeteus* (Kilmach) , *Prunus foetens* (Zoumb) and *Morus alba* (mulberry). The choice of species could be optimized to enhance the biomass availability as well as support micro enterprise , as Knagri manufacturing using wicker shoots.

- Control stream bank erosion through drainage line treatment, particularly of the first order streams. Check dams, gully plugging, gabion structures are some of the techniques that could be used for the purpose.
- Small scale engineering measures including construction of check dams, landslide control structures, stream bank protection spurs would be used for augmenting soil conservation measures in highly degraded areas.

b) Management of high altitude pastures

Target

- Reduce area under degraded pastures from 4% of the total catchment area to less than 1%

Indicators

- Regeneration of 4,100 ha of degraded pastures,
- Introduction of sustainable grazing management practices in 80% of grazing lands

Strategies

- Regeneration of degraded pastures through a system of rotational closed grazing and plantation of grass seeds, augmented with limited small scale engineering measures. Plantation of herbs including *Rannenculus lutem, Gernium spp, Plantego mager, Caltha palusris, Sibbaldia caneta, Senecio chryanthenoids, Gemeelatum spp, Euphorbia wallichi* etc. in the higher reaches.
- Promoting of on farm fodder production systems for enhancing on farm fodder availability and decline pressure on forests. Suitble fodder crops that could be used for the purpose include cultivable kale and fodder turnip after paddy or cropping Berseem and Oats within paddy cultivation system
- Promotion of silvipasture, integrating fodder species within tree plantation
- Integrated cattle management, including veterinary care, stall feeding, and breed improvement

c) Promoting sustainable agro practices for dryland agriculture / horticulture

Target

- Reduce degraded area agriculture/ horticulture from 16% to 1% of the catchment area

Indicators

- Agro forestry undertaken in 1,000 ha
- Practices for improved management of homesteads adopted by 2,500 hill households

Strategies

- Promotion of agro forestry models based on integration of tree, fruits and agricultural crops. Poplar, Robinia and Ailanthus are suitable crops that may be used for the purposes.
- Promotion of organic horticulture through establishment of demonstration plots
- Improved management of homesteads through promoting growing of multiple storeyed vegetation, with tubers, shaped loving creepers and tree crops.

d) Reducing pressure on forests through provision of alternate sources of energy

Target

- Reduce harvest of fuelwood from forests by 60%

Indicators

- Village woodlots created in 1,500 ha area, covering 75% settlements
- Smokeless hearths used by 75% of the households living in the Wular catchment
- Hydel power constructed and operationalized in Erin catchment to augment power availability

Strategies

- Creation of village woodlots on commons, kahcharais and group lands. Management of these lands should be under the village development committees, which will set up rules and guidelines for management of woodlots. As the CMAP proposes removal of Ningli plantation extending to 27.30 sq km, the area should be compensated by creating village woodlots in 1500 ha
- Promotion of use of smokeless hearths which reduce overall fuelwood consumption by atleast 30 – 50% and also improve the domestic cooking environment
- Construction of mini hydel in Erin catchment

Objective 3: Improve water regimes of Wular and associated wetlands to restore ecological services and economic benefits

a) Enhancing water holding capacity of Wular Lake

Target

- Enhance present water storage capacity by 54% , proving an opportunity to accommodate the high flows, which in absence of adequate storage is forced to drain out of the system

Indicators

- Willow plantations removed from 27.30 sq km
- Removal of 35.33 MCM of silt through selective dredging in of lake and channels

Strategies

- Enhance lake water holding capacity through selective dredging and removal of willows. The capacity thus created equals 73% of the peak excess flows recorded for a flood year (1991). Enhanced water holding capacity will help rejuvenate the hydrological functions of the wetland, and thereby improve biodiversity and resource base for supporting livelihoods of local communities. Changes in area and capacity due to intervention is presented in Fig 21. The dredged material will be used for filling the area proposed for construction of wetland interpretation center at Hajan, and strengthening of the existing third line of defence.

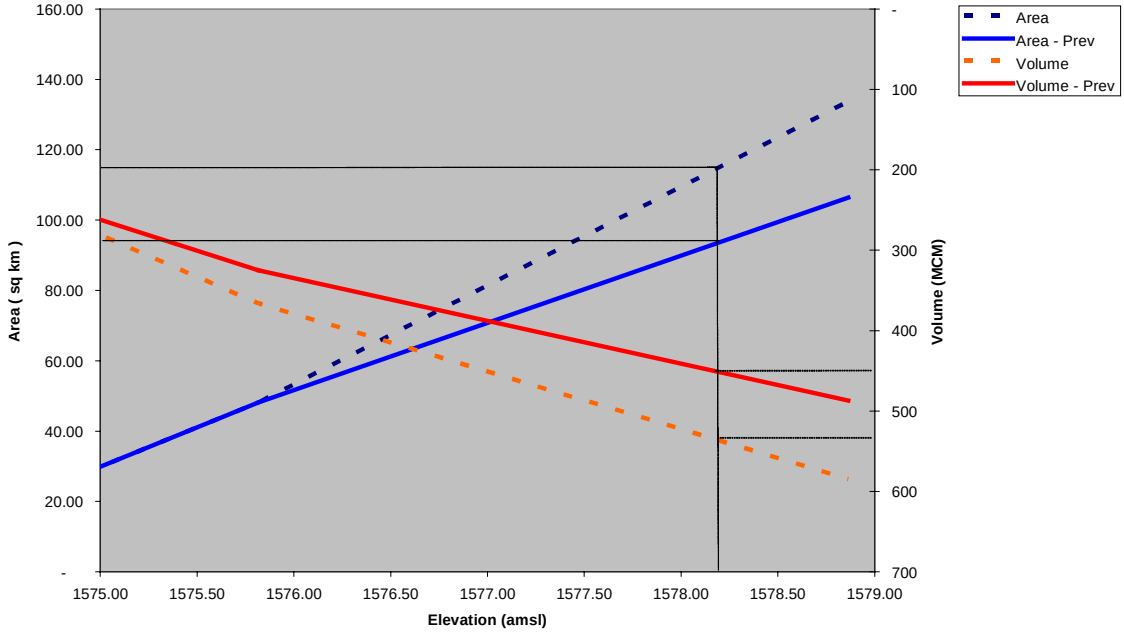


Fig. 21: Changes in area capacity due to hydrological intervention

- Regulating activities in downstream reaches which tend to enhance outflows, (eg river channel dredging for sand).

b) Rejuvenation of marshes associated with Wular Lake

Target

- Ensuring hydrological connectivity of the existing marshes adjoining Wular Lake

Indicator

- Dredging of critically silted portions of Naz Nallah and Haritar Nallah carried out for enhancing surface connectivity of existing marshes

Strategies

- Assessment of water exchange patterns of the marshes adjoining Wular Lake
- Rejuvenation through mechanical dredging. This is expected to provide an additional capacity of 22 – 25 MCM which will

augment the capacity of wetlands to regulate hydrological regimes.

c) Water quality improvement

Targets

- Provision of access to safe sanitation in 31 settlements in and around Wular
- Control of pollution from Bandipore and other adjacent villages contributing to pollution loading of Wular Lake

Indicator

- Lake water quality within B category as per CPCB's designated best use criteria

Strategies

- Sewage interception and treatment of Bandipora town and adjoining villages using activated sludge process
- Treatment of sewage entering from southern side of Wular using wetland mediated technologies
- Construction of 18,200 low cost sanitation units as per WHO design for improvement of sanitation facilities
- Water quality improvement by enhancing flushing rate

d) Allocation of water for human and ecological purposes

Target

- Allocation of water for human and ecological purposes

Indicators

- Stakeholder endorsed water management plan formulated and implemented
- Allocation of water for Wular and associated wetlands for supporting aquatic diversity and maintenance of ecological functioning

Strategies

- Environmental Flow Assessment of River Jhelum for identification of optimal water allocation scenarios for human needs (agriculture, domestic use, hydropower etc.) considering ecological needs (maintenance of biodiversity, ecosystem health). Based on the flow recommendations, optimal water allocation strategies should be formulated and implemented

Objective 4: Biodiversity Conservation

a) Enhancement of fish diversity

Targets

- Achieving self sustaining native and endemic fish populations through targeted restocking.
- Enhancement of diversity and abundance of Schizothoracins and Mahseer
- Improving knowledge of diversity of native and endemic non-commercial species

Indicators

- Inventory on distribution, seasonal abundance and management needs of non-commercial, native and endemic fish species developed.
- Population of Schizothoracins and Mahseer species is increased through protection of breeding and spawning grounds to levels where auto recruitment is phased out within 5 years.

Strategies

- Undertaking detailed baseline studies of the distribution, abundance and conservation needs of little known non commercial, native and endemic fish species.
- Extensive stocking of Mahseer through fish seeds available from the state government hatchery at Boniyari Uri
- Stocking of lake with Schizothoracine fingerlings
  Enhancing auto recruitment through protection of breeding and spawning grounds and clearing pathways channels

b) Enhancement of wetland bird populations

Targets

- Improved knowledge of year-round habitat requirements of birds, especially migratory and breeding waterbirds in the Wular Lake and associated wetlands and conservation priorities.
- Increased carrying capability of the Wular Lake and associated wetlands for birds, especially migratory and breeding waterbirds
- Improved knowledge of migration strategies, precise international and national migration routes (including breeding, staging and non-breeding sites) and linkages of waterbirds using the Wular Lake.
- Control of poaching through strengthening existing network of protected areas
- Establishment of two new bird sanctuaries in unprotected areas
- Involvement of local communities through formation of bird protection committees
- Improved understanding of the health of birds (particularly of zoonotic diseases, which have the potential for transmission to people).

Indicators

- Waterbird diversity and abundance is enhanced
- Populations of threatened and vulnerable waterbird species are enhanced
- Populations of all breeding waterbird species is increased through improvement of breeding habitats and conditions
- Hunting of waterbirds is controlled
- Information on migration strategies and precise routes of major long-distance migrant and local migrant waterbird species is available
- Long term waterbird population monitoring information is available

- Long term surveillance information on the health of birds (particularly zoonotic diseases) is available.

Strategies

- Strengthening of existing network protected areas
- Establishment of new bird sanctuaries
- Networking with state and national government and non-government agencies and institutions to implement cooperative and collaborative actions for waterbird management and conservation.
- Involvement in activities to implement priorities of international treaties (including CAF Action Plan, CMS, Ramsar, CBD).
- Involvement of local communities in waterbird and habitat conservation activities
- Involvement of government agencies, academic institutions and NGOs in inventory and monitoring of waterbirds and their habitats
- Establish a long-term intensive monitoring programme for wetland bird species.
- Establish a bird migration study programme for breeding and migratory waterbirds, in collaboration with local and international expertise.
- Establish a bird health surveillance and monitoring programme for breeding and migratory waterbirds, in collaboration with local and international expertise.

c) Habitat improvements of bird areas through water level modifications and vegetation management

Targets

- Enhancement of native food and cover plants as a resource base for waterbirds
- Maintenance of open water areas and proportionate emergent vegetational belts to respond to the wide diversity of feeding and nesting habitats required by different waterbird species.

Indicators

- Abundance of food and shelter plants
- Increase in density and population of benthic fauna
- Enhancement of fish dependent waterbird populations

Strategies

- Maintaining connectivity of existing bird sanctuaries and other wetlands in the Valley with the Wular lake
- Dredging and deweeding in some lake sections to maintain optimal water levels and enhance open water areas.

Restoration of encroached land to enhance area of waterbird habitats.

d) Wildlife Conservation

Targets

- Enhanced wildlife population and diversity within Wular catchments

Indicators

- Enhancement of wildlife population and diversity within protected areas
- Reduction in man-animal conflict
- Breeding centre for rare and endangered species established

Strategies

- Demarcation of new wildlife sanctuary
- Strengthening conservation measures in existing protected area network
- Construction of rescue and rehabilitation centres
- Improving land transport and patrolling

e) Optimization of production of economically important plant species through water level enhancement

Targets

- Optimizing production of food and fodder plants
- Increase in coverage of plants utilized for small scale enterprises

Indicators

- Reestablishment of food, fodder and other plant species in response to enhanced water regimes in the lake area
- Shift in Trapa communities from currently deeper regions towards littoral areas
- Open water area of the lake enhanced

Strategies

- Removal of willow plantation to provide additional water holding capacity and enhancement water depth and water spread area
- Dredging of silted up areas in some pockets to provide additional space for plant colonization
- Water quality and quantity improvement through enhanced flushing conducive for reestablishment of *Nelumbo*

f) Control of invasive plant species through effective flushing of the lake

Target

- Reduce the prolific growth of exotic aquatic plant species

Indicators

- Coverage of *Lemna, Salvinia* and *Azolla* species is reduced

Strategy

- Removal of willow plantation and desiltation of inlets and some stagnated pockets to enhance lake flushing

g) Maintenance and regeneration of marshes to enhance their ecological role

Target

- Delineation and protection of marshes while maintaining agriculture and other human uses

Indicators

- Inclusion of 17 sq km area under sanctuaries to be notified
- At least 50% of 41 sq km of marshes restored

Strategies

- Notification of Malgam-Saderkout Bala- Ajas as protected area for bird conservation to ensure protection of 17 sq km of marshy areas
- Rejuvenation of Naz nallah and its connectivity with the Wular Lake to promote regeneration of marshes

Objective 5: Ecotourism Development

Target

- Development of ecotourism in and around Wular Lake for awareness generation and providing economic benefits to the local communities

Indicators

- Development of a comprehensive ecotourism plan with a detailed zoning plan of the lake, associated marshes and catchment areas.
- More visitors are attracted by Wular Lake for bird watching, water sports, fish angling to enjoy its natural beauty
- The sites of attraction in and around Wular are enhanced and equipped with facilities for the visitors to stay for longer duration
- Communities are involved in organizing field trips and providing clean and safe accommodation
- Communities involved in ecotourism related activities are earning from these activities.
- Trained field guides available to interact with tourists for awareness generation
- Interpretation centers developed at key spots for generating awareness about biodiversity and ecological significance of the Lake
- The environment, biodiversity of the Wular Lake and its associated marshes and local people are not negatively impacted by the ecotourism activities.

Strategies

- Development of a comprehensive ecotourism plan with a detailed zoning plan of the lake, associated marshes and catchment areas that takes into consideration the annual changes of water level and climate and biological requirements of plants, animals and birds.
- Development of key sites for bird watching and provide facilities to observe birds at different spots
- Developing board walks to have closer look at marshes and nature
- Construction of bird hides at key points
- Watch towers built strategically to have close view of Wular Lake and its marshes

- Development of interpretation centres at key spots for awareness generation
- Provision of facilities for developing low impact boat cruises in selected areas of low bird abundance.

Objective 6: Sustainable Resource Development and Livelihood Improvement

6.1 Sustainable Fisheries Development

(a) Enhancement of fish yield through development of capture and culture fisheries

Target

- Enhancement of annual capture fish yield by 840 MT/ annum and culture fish yield by 1300 MT/annum

Indicators

- Fish seed production of Schizothorax species enhanced by 4.8 millions per annum, of which 50% available for stocking in the lake
- 50 ha of village ponds brought under integrated farming with support through community owned hatcheries cum rearing facilities
- Community imposed fisheries regulation during breeding season

Strategies

- Construction and operationalization of three fish seed farms exclusively for culture of Schizothoracid fingerlings within Madhumati and Erin catchment areas to revive the indigenous fish fauna and to augment fish diversity in Wular.
- Extensive stocking of Mahseer (*Tor pitutora*) through the fish seeds available from the Mahseer fish farm of State Fisheries Department being established at Bela (Uri).
- Enhancing auto recruitment through protection of breeding and spawning areas
- Construction and operationalization of 5 community owned hatcheries cur rearing facilities and introduction of integrated fish farming techniques (e.g. fish cum duck farming) to promote effective use of village ponds and reduce pressure on lake fisheries.
- Increasing water levels to enhance capture fisheries. Removal of willow plantations from the lake area is expected to increase the open water area by atleast 20 sq km, and increase in water levels by 1 meter, which will greatly assist in rejuvenation of lake fisheries.
- Observing closed season for fishing during the months of May and June which is the breeding seasons for almost all the economically important fish species
- Strict banning on use of harmful and illegal crafts and gears and fishing methods including Ambar, Ghaurun (multiple head spear (Panzri), Dharabandhi and use of fixed gill nets through endorsement and implementation of community based fisheries rules and regulations. The activities would be

supported by mass awareness and education to the fishers on sustainable fisheries management.

(b) Improvement of harvesting and post harvesting infrastructure for enhanced economic returns to the fishers

Target

- Organizing 80% of capture fisheries of Wular Lake to ensure higher economic returns to the fisheries through collectivized investment in harvesting and post harvesting infrastructure

Indicators

- 80% of the capture fish catch registered at the nine fish landing centers, and provided adequate post harvesting and marketing support
- 25% active fishermen provided with improved fishing crafts
- 15% enhancement of processed fish realized

Strategies

- Collectivizing fish landing through strengthening existing nine landing centers through creation of appropriate infrastructure and enhancing capacity
- Provision of improvised fishing crafts and gears to the fishers to optimize effort
- Enhancing stocking capacity and prevention of distress selling of fish through restructuring existing fish tanks in Zurimanz and provision of 3-4 additional tanks in 5 fisher villages.
- Enhancing shelf life of fish through provision of 2 ice plants at main landing centres in order to increase the shelf life of the fish. Provision of insulated vans to enable transportation of fish from the landing centers to the markets.
- Enabling value addition of fisheries through establishment of modern fish processing plant at Laharwalpora.

(c) Strengthening of fish cooperative societies for collective ownership and management of Wular fisheries through a community driven process

Target

- Management of lake capture fisheries through community institutions

Indicators

- 80% of active fishermen are registered under and operate as per the mandate of fisher cooperative societies

Strategy

- Formation and strengthening of Fish Farmers' Cooperatives (FFCs) to enable community ownership and management of fisheries of Wular. The FFCs would also function as the primary institution for implementation of community development programmes aimed at improvement of quality of life of fishers. The FFCs would function as the apex stakeholder body responsible for managing lake fisheries, and would therefore design a policy for sustainable management

and ensure its implementation through community participation.

6.2 Economic utilization of aquatic vegetation

Target

- Community based management of aquatic vegetation resources in a sustainable manner without negative impact on aquatic biodiversity.

Indicators

- 80% of harvest of Trapa, *Nelumbo* and fodder managed through community organizations
- Harvesting of aquatic vegetation resources does not negatively impact on the use of vegetation by feeding and nesting waterbirds.

Strategies

- Formation of user groups for *Trapa, Nelumbo* and fodder
- Organize and manage lake harvest to ensure that vegetation is harvested without a negative impact on the use of vegetation by feeding and nesting waterbirds.
- Develop financial mechanisms for investment into corpus for management of lake vegetation and support credit needs
  Promote value addition

6.3 Livelihood Improvement

Targets

- Reduce poverty within communities by 50% within 2010 (Millennium Development Goal)
- Improve quality of life through enhanced access to safe drinking water , sanitation and access to markets

Indicators

- Increase in average household incomes by 21% over the present
- Occupational diversification through alternate sources of income to 25% hill and 20% lakeshore households
- 250 Self Help Groups established to initiate micro credit operations
- Proportion of households having access to safe sanitation facilities increases from 2% to 80%
- Proportion of households having access to safe drinking water facilities increases from 36% to 80%
- 10 market centers within lakeshore villages strengthened to enable trading facilities to 75% of the population

Strategies

- Enhancing the current resource base through sustainable development of capture and culture fisheries and economic utilization of aquatic vegetation
- Promoting micro enterprise based on value addition to existing resource base
- Livelihood diversification through ecotourism development

- Providing alternate sources of income through micro enterprise based on apiculture, mushroom cultivation, food processing, natural dyes, sericulture etc.
- Promoting rural micro credit schemes to address credit needs
- Construction of pond based rural drinking water supply systems
- Strengthening existing market network through infrastructure development, storage facilities and better road connectivity
- Dovetailing existing rural development programmes of the state government in and around Wular Lake

Objective 7: Institutional Development for effective management of Wular and associated wetlands

Targets

- Establishment of Wular Development Authority with the mandate of coordination, regulation and financial management for conservation and wise use of Wular and associated wetlands
- Capacity building of WDA, government agencies and community organizations for sustainable management
- Monitoring and evaluation of management action plan implementation

Indicators

- WDA coordinating implementation of CMAP for conservation and wise use of Wular in consultation with line departments, NGOs and other stakeholders particularly local communities
- Harmonization of inter-agency policies and practices in support of the CMAP
- Increased managerial capacity within WDA to manage the CMAP programme
- Database on hydrological, ecological and socio-economic features developed
- Key factors identified for monitoring the changes in processes and functions
- Results based monitoring of MAP implementation at activity, output and outcome levels using SMART (specific, measurable, achievable, repeatable and transparent) indicators.

Strategies

- Developing a detailed Terms of Reference for establishment of WDA
- Assessment of technical and infrastructural capacity building needs of WDA, concerned line agencies and local communities
- Training through involvement of expert agencies and experience sharing
- Developing a 3 tier results based framework for monitoring of MAP implementation with well defined performance indicators at activity, output and outcome levels
- Establishment of Hydrobiological and GIS laboratory which shall carry out research and developmental activities under

proper scientific guidelines and shall monitor the efficacy of the management activities on short and long term basis
- NGO-CBO exchanges of project experiences and technical skills; farmer to farmer learning
- Improved opportunity of WDA environmental and community development staff for professional development and advancement
- Involvement of stakeholders particularly local communities in monitoring and evaluation of MAP implementation
- Use of economic evaluation to assess impacts of MAP implementation in ecological and concrete economic terms
- Use of GIS and remote sensing for mapping land use and changes due to developmental activities
- PRAs and rapid socioeconomic surveys to assess community structure, needs and aspirations and resource linkages

3.4 Project Outcomes

The project is expected to ensure conservation of Wular Lake ecosystem and enhance its resources through contributing to the following outcomes:

Catchment Conservation
- Reduction in overall soil loss from degraded watersheds through enhancement of dense forest cover to 40% of direct catchment area, reduction in area under degraded pastures and erosion enhancing agro practices to less than 1% of the catchment area and reducing harvest of fuel wood by 50%

Water Management
- Rejuvenation of hydrological functions of Wular lake through 54% enhancement to present water holding capacity and restoration of hydrological connectivity to the marshes
- Reduce flooding by 70% in the flood prone areas in and around Wular Lake by enhancing water holding capacity and establishing linkages with satellite wetlands through hydrological intervention
- Water quality of Wular improved to B category as per CPCB designated best use criteria through management of sewage and sewerage from adjoining settlements and water quality regulations
- Allocation of water for human and ecological purposes through formulation and operationalization of stakeholder endorsed water management plan

Biodiversity Conservation
- Enhancement of diversity of Schizothoracine and Mahseer fish species
- Enhancement of water bird population through control of poaching, strengthening existing protected area network and habitat improvement
- Optimization of economically important plant species through water level enhancement
- Control of invasive species through effective flushing of lake

Ecotourism Development
- Development of ecotourism in and around Wular Lake for awareness generation and diversification of livelihoods of wetland dependant communities

Sustainable Resource Development and livelihoods Improvement

- Poverty within communities living around wetland and its catchments reduced by 50% through regeneration of resources and additional livelihood options
- Enhanced quality of life of communities through access to safe drnking water, sanitation and rural markets

Institutional Development

- Establishment of an integrated policy framework for conservation and development of Wular and associated wetland
- Establishment of separate and accountable funding mechanism for conservation and management of Wular
- Enhanced awareness of decision makers and stakeholders on values, functions and attributes of Wular
- Enhanced technical and managerial capacity of WDA, government agencies and communities to implement wetland conservation and management initiatives
- Establishment of monitoring mechanisms for implementation of Action Plan
- Establishment of Hydrobiological and GIS laboratory

3.5 Risks and Assumptions

Project Goal level

- Commitment of Government of J&K to establish Wular Development Authority with sufficient legal and financial powers to implement management action plan
- Local communities have continued participation in the conservation and management of the Wular Lake and its catchments
- Government is willing to reconsider the current water management policy
- Sustainable yield of resources from the Lake

Project Objectives level

- Trained manpower are available for management of the Lake
- Communities are sufficiently organized to engage in and take ownership of the project activities
- The local community requests WDA and other institutions to offer advice on improved shifting cultivation packages/ appropriate regulatory mechanisms for sustainable management of resources
- Legislature supports a new statute to govern WDA operations
- A long-term financial framework can be established for maintaining the expanded WDA programme

Project Output level

- Qualified trainers and experts are available
- Strategies offer flexibility for adaptation
- Fool proof monitoring mechanisms and application of scientific approach for resolving conflicting issues
- Capable NGOs are available to assist community-based activities

3.6 Implementation Arrangements

Organizational Structure

The project has been organized to ensure that responsibility and accountability for delivery of the project outputs and results are clearly defined. Figure 3.3 presents the project organization.

The **Wular Development Authority Governing Body** will serve as the executive board, chaired by the CM and responsible for overall direction and performance. **Wular Steering Committee**, a 'High Level Empowered Committee' will be responsible for inter-agency cooperation and overall achievement of the project aims.

A **Project Implementation Committee (PIC)** consisting of senior staff from WDA, NHPC, the Department of Environment and Remote Sensing, Forests, Wildlife Protection, Agriculture, Fisheries, Irrigation and Flood Control, Tourism , Revenue and other concerned agencies will be established with administrative and other support provided by WDA. The Director WDA will be the convenor of the team

The **Project Management Unit (PMU)** will be small project management group within WDA responsible for assisting the completion and approval of operational plans, undertaking progress and financial monitoring and reporting, and providing technical data and coordination support where required The terms of reference for this unit are:

- assisting the completion and approval of operational plans,
- undertaking progress and financial monitoring
- output verification and reporting,
- providing technical data and coordination support where required

A **Catchment Area Conservation Team** is proposed within WDA (with staff deputed from Forests, Ecology and Environment Agriculture and Wildlife Protection) responsible for plantation and soil conservation activities, and water engineering staff from WDA responsible for stream engineering works and water detention structures. Implementation of the catchment conservation and development programmes shall be done using a two-tier community centred mechanism comprising of the Joint Forest Management Committees (JFMCs) and the Forest Development Agencies (FDA). The broad structure and functions of the JFMCs and FDA shall be as under:

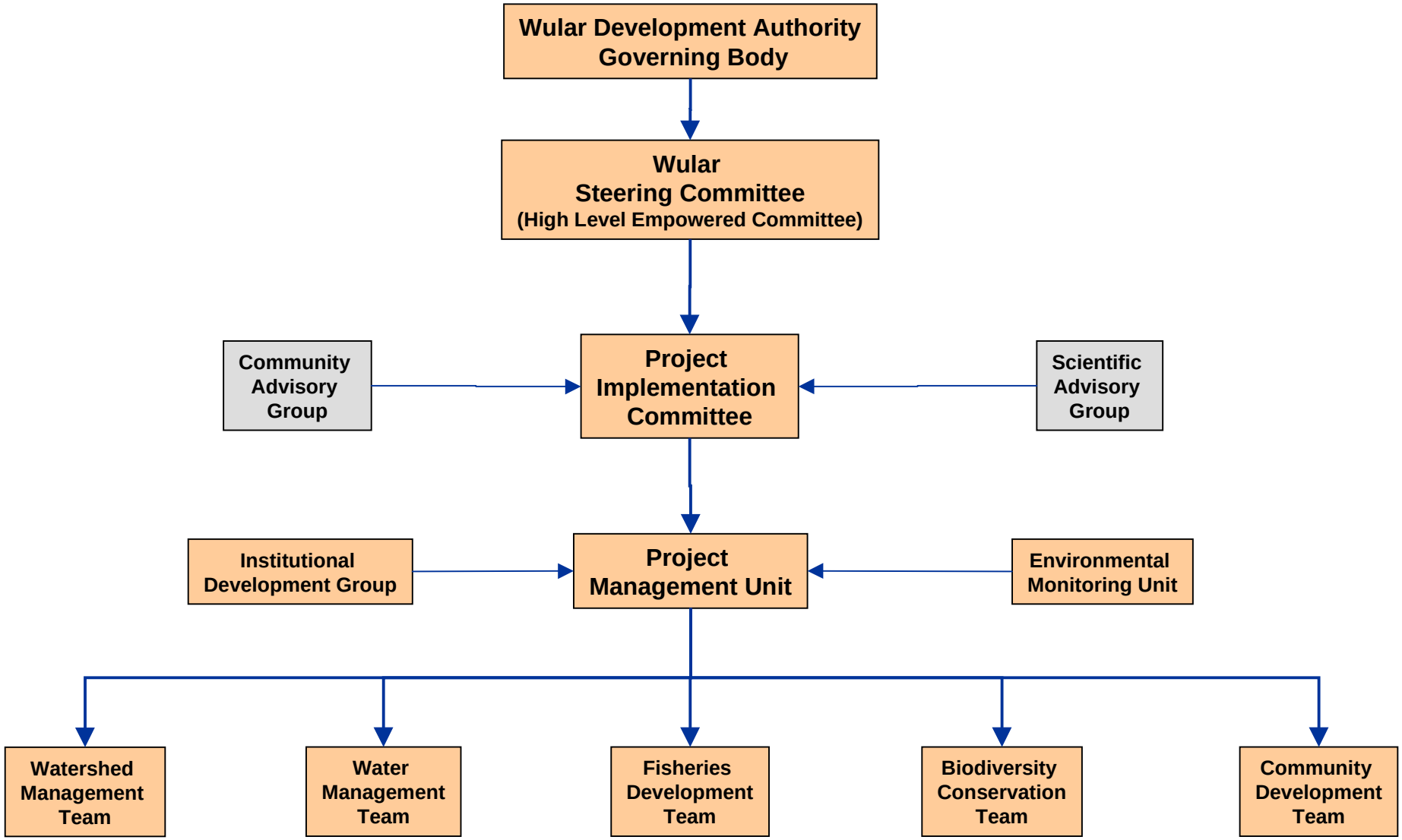
(a) Joint Forest Management Committees (JFMCs)

The JFMC will be the implementing agency at the grass root level and will be registered with the respective territorial / wildlife Conservator of Forest. The broad structure of the JFMCs shall be as follows:

General Body: comprised of all the adult members of the village chaired by the Village Authority/ Chief. The President shall be elected for a period of one year, with a women member elected at least once in three years.

Executive Body: comprised of six nominated members of General Body, with the Chairman, General Body as ex officio Chairman of the Executive Body and respective forester / block forest officer as the Member Secretary. A treasurer shall also be appointed from the General Body by the Member Secretary in consultation with the President.

Fig. 3.3 : Project Organization Structure



The primary functions of the JFMC shall be:

- To assist the general body in preparation of microplans
- Identify choice of species to be planted
- Suggest physical and financial targets
- Propose entry point activities
- Develop usufruct sharing mechanisms
- Awareness generation

(b) Forest Development Agency (FDA)

FDA will be constituted at the territorial / forest division level and will be registered as a Federation of JFMCs under the Societies' Registration Act. The composition of the FDAs shall be as under:

General Body: comprising of Presidents of JFMC General Bodies, not more than 20 at any time of which 7 shall be women members, appointed on rotational basis for two years; ACFs and Range Forest Officers. The Conservator of Forest shall be the Chairperson of the General Body.

Executive Body: comprising of 8 nominees of JFMCs with a minimum 3 women, District level officers of Agriculture, Rural Development, Animal Husbandry, Soil Conservation, Tribal Welfare, Sericulture, Industries, Public Health and Engineering and Education Department; and ADM / ADC to be nominated by the DC. The Conservator of Forests shall function as the Chairperson and the Divisional Forest Officer shall act as the Chief Executive Officer of the executive body. The General Body will meet at least once in a year, while the executive body will meet once in three months. The FDA will sign a Memorandum of Understanding (MoU) with the JFMCs indicating the mutual obligations, rights and roles. This shall, *inter-alea* also include the right of FDA to stop and / or withdraw funding form JFMCs in situations of poor performance of the latter. In the initial stages, FDA shall strengthen the existing JFMCs and create new ones in villages where these committees do not exist. The FDA shall make linkages with the communities through the JFMCs to explain the objectives and scope of the project, mutual obligations and usufructuary rights.

The primary functions of the FDA shall be:

- Approving plans of all afforestation related activities including microplans prepared by the JFMCs
- Provide support and assistance to JFMCs for microplanning
- Organize training and awareness generation programmes in the hill villages
- Implementation of water harvesting and soil conservation measures with appropriate approvals
- Prioritize scheme wise and activity wise financial outlays
- Decide livelihood interventions for the micro-watersheds
- Formulate guidelines for utilization and sharing of the usufruct
- Evolve rules for use of funds created
- Establish and maintain decentralized nurseries
- Coordinate and monitor the constituent JFMCs

The funds released to FDA for implementation of the workplan shall be deposited in an exclusive and separate current account to be operated jointly

by the Chairperson and Member Secretary. The FDA shall in turn release the amount earmarked to the JFMC within 15 days into the exclusive and separate account of JFMC in a nationalized bank/ cooperative bank or Post Office. The account of the JFMC would be jointly operated by the Member Secretary of the JFMC and the Treasurer concerned.

A **Water Management Team** is proposed within WDA composing of experts and engineers from WDA, NHPC, IFCD and Department of Revenue staff, responsible for establishing the optimum flow regime, demarcation of the lake boundary, water quality improvement and flood mitigation strategies. The terms of reference for this team are:

- Development and implementation of a water management plan
- Development and implementation of flood mitigation strategies,
- Coordinating with external expert for Environmental Flow Assessment

A **Fisheries Development Team** is proposed within the WDA, to be responsible for providing technical support for community-based aquaculture, fisheries management policy development and enhancement, and post harvest technical support in fish processing and marketing. The terms of reference for this unit are:

- Development and implementation of a sustainable fisheries plan for Wular
- Facilitate community groups to develop and implement fisheries policy and regulation
- Undertake initiatives for improving post harvest management, processing and marketing

A **Biodiversity Conservation Team** is proposed within the WDA responsible for habitat management including conservation of waterfowl populations, wetland biodiversity and ecotourism development.

A **Community Development Team** is proposed within WDA and responsible for micro-planning, community organization, community activities related to watershed management and fisheries development, micro-enterprises development and public awareness and education, including ecotourism development. The terms of reference for this unit are:

- Support for community organizations involvement in the project
- PRA and community involvement inputs
- Community organizations leadership and capacity building
- Micro-planning and community review of project operational plans
- Technical assistance in micro-enterprises development and alternative livelihoods

Project Management and Implementation Strategy

The project management arrangements will meet international standards. Figure 3.4 outlines the major steps involved in managing the project. The strategy for project implementation is based on:

- Establishing the project as a distinct, mission-oriented entity and funding mechanism, separate from the regular government services;
- Further developing the project management capacity within WDA;
- Directly involving communities in the selection and implementation of project field interventions and disbursements;

- Formulating agreements between WDA and the appropriate agencies to provide technical advice in the implementation of specified components of the project;
- Formulating agreements between WDA and community organizations regarding implementation of specified components of the project; and
- Developing various project 'operational plans' which will guide the delivery of the specified project outputs.

It is proposed to establish a '*Wular Lake Conservation Fund*' within which separate accounts can be set up for specific projects funded by Government of India and international donors. The fund utilization would be directly limited to objectives and strategies within the Management Action Plan. Independent accounting and reporting procedures would be adopted for the fund under specified terms of reference.

The operational plans are intended to provide field level details of project activities necessary to achieve the outputs and outcomes specified in the Management Action Plan. They will provide the basis for agreements between WDA. Other concerned government agencies, and community organizations. The scope and boundaries of the plans will depend upon the micro-planning process supervised by WDA staff. The operational plans will be reviewed and endorsed by communities to ensure a participatory and transparent process. They will provide the guide for allocation of funds for specified activities in support of sustainable resource management.

As noted in Figure 3.4 the Steering Committee will give final approval for proceeding with implementation of operational plans. Disbursements will be administered by the Project Management Unit based on operational plans only and in accordance with internationally accepted financial management procedures. Quarterly progress reports will be submitted for evaluation by the PIC, and necessary adjustments made based on performance. Monitoring reports will be submitted to the Steering Committee, the WDA Governing Body and project funding organizations.

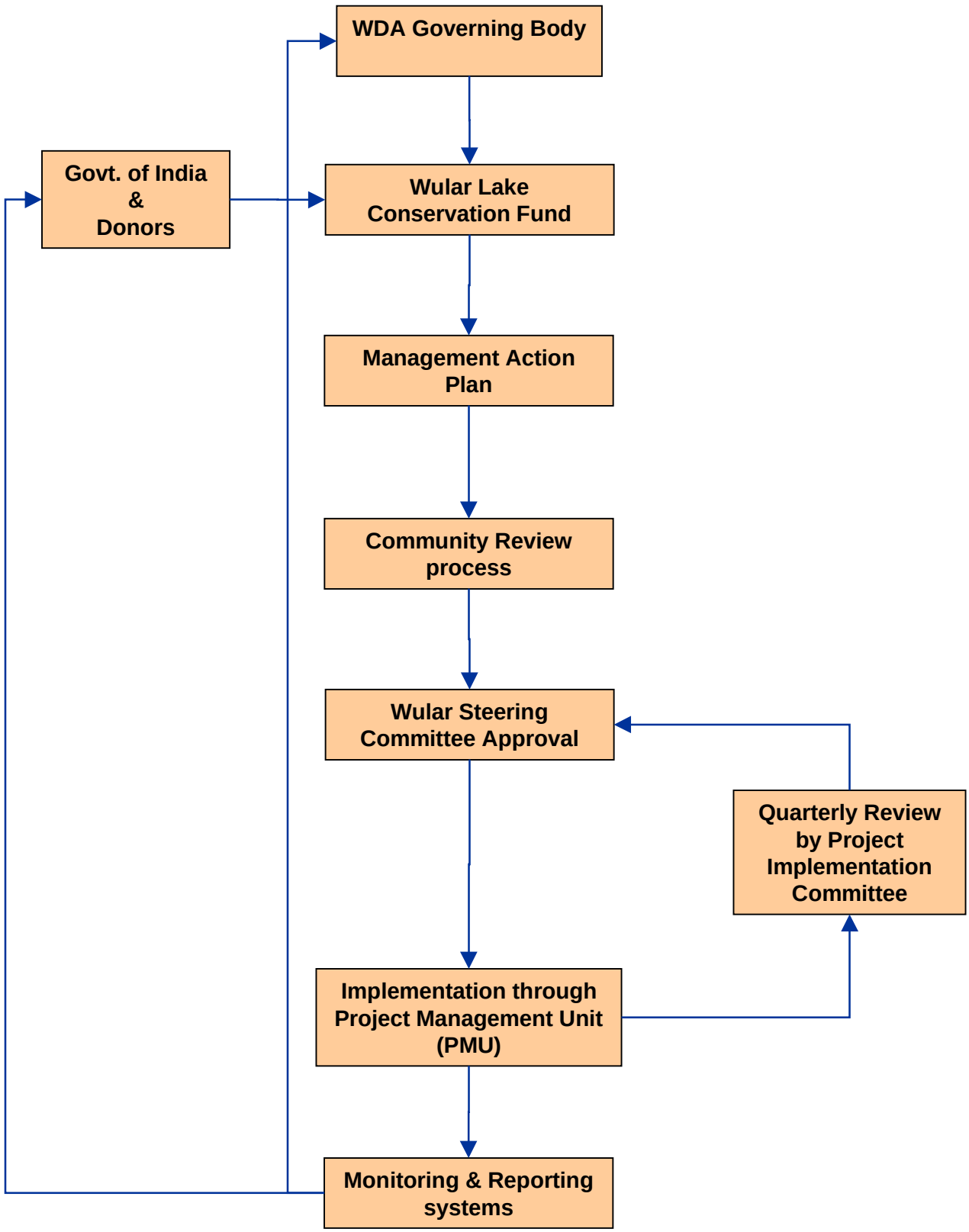
The Project Implementation Committee (PIC) and the PMU have a key role in coordinating field implementation. Figure 3.4 outlines the proposed project implementation arrangements for field implementation involving the local communities. The PMU will organize technical and organizational support from government advisors and qualified NGOs for implementation of specific activities by community organizations, principally, local panchayat or other authorities, youth associations, women associations and related self-help groups.

Financial Management

The proposed *Wular Conservation Fund* will be designed to provide the necessary transparency, verification and monitoring systems within the Project Management Unit. The funds will be guided by the following:

- A special committee of WDA governing body will be established to oversee the fund and the financial management procedures, and will include representation from the donor organizations.
- A financial management procedures manual will be prepared by a professional accounting firm and will provide the basis for fund operations.
- A project accountant will be appointed within the PMU, operating separately from the government agencies and reporting to the special committee.
- Disbursements will be linked to approve operational plans and verification procedures.

Fig. 3.4 : Project Implementation Process



- Partner organizations will be carefully selected by the PIC to ensure that they have the capacity, experience and orientation to assist with implementation of funded activities.
- Arrangements for funding field activities will involve agreements between the PMU and the contracted partner organizations, in accordance with specified terms of reference and milestones for payment.
- Communities will be directly consulted in the preparation of operational plans and the funding agreements with partner organizations.
- Training and support will be provided as required for partner organizations to conform to the financial procedures manual.
- An annual report will be produced on fund status and project disbursements
- A marketing strategy will be developed to encourage contributions to the fund.

4. Action Plan

4. ACTION PLAN

4.1 Survey and Demarcation

4.1.1 Mapping and ground truthing

A 1: 10000 scale mapping of the project using a sequence of high resolution images from IRS P6 LX4 may be used for mapping the wetlands including its hydrological regimes during various seasons. The map so obtained should be updated using extensive ground truthing and community consultations. These maps would for the basis for management zoning as well as monitoring changes in lake ecosystem. Activities to be carried out include:

- Procurement of satellite imageries from National Remote Sensing Agency
- GIS processing of the imageries and preparation of base layer series for various seasons
- Ground truthing and map validation
- Community consultation on extent of various map features

4.1.2 Boundary demarcation

Lake boundary demarcation based on survey and ground truthing will be carried out using concrete cemented pillars of 2 m length laid at a distance of 30 m apart.

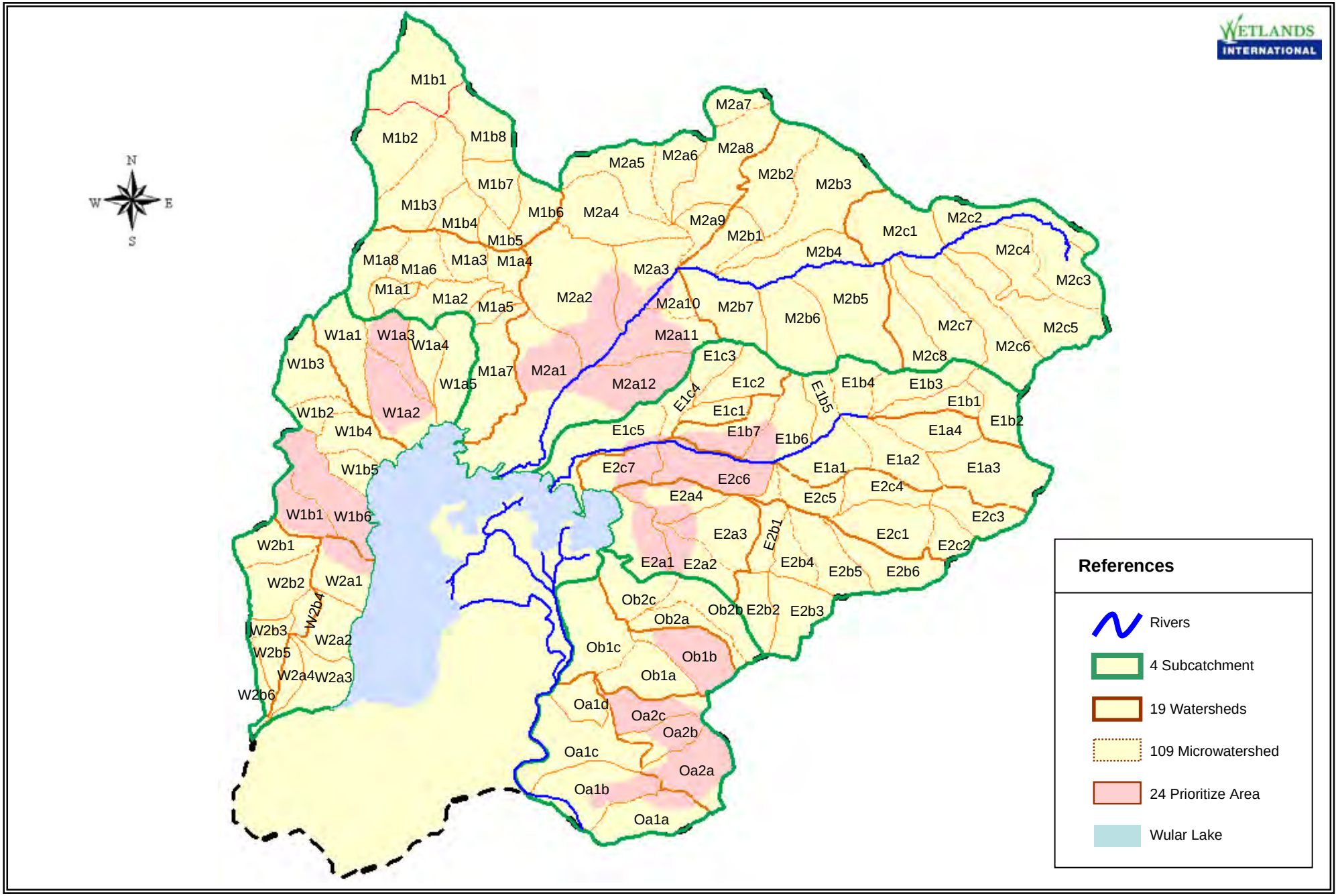
4.2 Catchment Conservation

4.2.1 Treatment of degraded forests

Based on the assessment of catchment features, 7,436 ha under 24 microwatersheds have been prioritized for treatment, of which afforestation is proposed to be carried out in 3,718 ha and aided regeneration in 2,789 ha (Map 4.1 and Table 4.1).

Table 4.1: Priority Areas for Catchment Treatment

Watershed	*Priority Microwatershed*	*Area*	*Area to be treated(ha)*	*Afforestation (ha)*	*Aided regeneration (ha)*
Erin	e2c7	548	300	150	113
	e2c6	849	210	105	79
	e1c6	958	490	245	184
	e1b7	714	267	134	100
	e2a4	828	325	163	122
	e1c4	294	150	75	56
	e1b6	897	210	105	79
	e2a1	423	150	75	56
	8	***5511***	***2102***	***1051***	***788***
Madhumati	m2a2	808	304	152	114
	m2a10	324	193	97	72
	m2a11	893	432	216	162
	m2a12	739	358	179	134
	m1a6	691	411	206	154
	5	***3455***	***1698***	***849***	***637***
Wular 1	w1a2	618	391	196	147



Map 4.1 : Priority Microwatersheds

Watershed	Priority Microwatershed	Area	Area to be treated(ha)	Afforestation (ha)	Aided regeneration (ha)
	m2b1	892	313	157	117
	m1a3	892	327	164	123
	m1b4	614	388	194	146
	w1b1	911	304	152	114
	w2a1	752	200	100	75
	w2b1	648	200	100	75
	7	***5327***	***2123***	***1062***	***796***
Wular 2	oa1b	732	417	209	156
	ob1b3	852	393	197	147
	ob2c	561	382	191	143
	oa2c	418	321	161	120
	4	***2563***	***1513***	***757***	***567***

Treatment of degraded forests would be carried through the following mix of biological and small scale engineering measures

a) Afforestation

A total of 3,718 ha of fallow land in 24 microwatersheds have been identified for treatment by afforestation. The activities involved are:

- Selection of native soil binding and economically important species in consultation with local communities through PRA exercise
- Nursery raising through community organizations
- Preparatory works, including deweeding and making pits for plantation
- Plantation of saplings into the prepared pits
- Protection measures (including watch and ward) from fire, cattle etc.

The plantation shall be maintained for three years after creation, and handed over to the respective Joint Forest Management Committee for operation as per the approved Forest Working Plan.

b) Aided regeneration

A total of 2,789 ha of degraded forest area in 24 microwatersheds have been identified for treatment by aided regeneration method. The activities to be undertaken are:

- Selection of species in consultation with local communities through PRA exercises
- Procurement of seeds of appropriate species for sowing
- Deweeding, preparation of seed beds and sowing pre-treated seeds
- Protection measures (including watch and ward) from fire, cattle etc.

Regeneration areas shall be maintained for two years creation, and handed over to the respective Joint Forest Management Committee for operation as per the approved Forest Working Plan.

c) Small scale engineering measures

Small-scale engineering measures will be taken up for immediate control of soil erosion, landslides and arrest flow of silt from critical micro watersheds. The following activities are proposed in the critical micro-watersheds:

- **Check Dams :** 470 ha of DRSM, 75 ha of gunny bag and 70 ha of crate wire dams would be constructed to arrest flow of silt and prevent bank erosion along streamlines.
- **Landlside control structures:** 762 landslide control structures are proposed to be constructed to control landslides. Areas presently under quarrying and intensive erosion shall be given a high priority under the activity.
- **Construction of streambank protection spurs:** Streambank protection spurs will be constructed in 200 ha of landslide prone areas and areas prone to severe soil erosion. This is to supplement to the Gabion works.
- **Water Harvesting Structures:** 1,500 units of water harvesting structures shall be constructed for enhancement of moisture regimes in the watersheds of Wular. These structures shall be further developed for small scale enterprise as integrated farming, fisheries etc.

4.2.2 Management of high altitude pastures

a) Regeneration of degraded pastures

Regeneration of 4,100 ha of pasture lands having moderate to high erosion is proposed to be undertaken through following measures :

- **Fodder and forage plantation** to be undertaken in 3,000 ha in a rotation of 1,000 ha of each year. This would include closure of the area and plantation with forage and fodder species (including *Poa pracense, Prestina ovina, Trifolium repense* in higher reaches and *Trifilium pretense* and *Lotus conicultaus* in the lower reaches)

- **Small scale engineering measures** to augment the soil conservation measures. The following are recommended:

  ◊ Check dams in 40 ha (20 ha each under DRSM and Crate wire dams)
  ◊ Vegetative spurs in 500 ha
  ◊ Stream bank protection spurs in 100 ha
  ◊ Gully plugging in 500 ha

b) Grazing management

Management of grazing is central to regeneration of the degraded pastures. The following interventions are proposed for management of grazing:

- **Silvipasture :** Silvipasture , based on integration of Rubinia, poplars and Ash trees within the pasture lands is proposed to be undertaken in 500 ha of pasture lands, presently with moderate erosion.

- **On farm fodder management:** Fodder crops would be introduced in crop rotation to boost fodder production, and promote stall feeding. This is proposed to be introduced in 600 ha.

- **Veterinary health support :** Veterinary health support is proposed to be undertaken to promote cattle productivity and optimize resources. Major activities to be undertaken are breed improvement and health support through mobile dispensaries.

4.2.3 Management of horticulture and dryland agriculture

a) Agroforestry

The present system of hill agriculture, which involves ploughing across contours promotes soil erosion. Annual cultivation of crops also clears all vegetation enhancing soil loss. Therefore agro forestry is proposed to be promoted in 1,000 ha.

b) Improved management of homesteads

A tremendous scope exists for enriching the homestead lands for enhanced production of useful biomass by introducing three storey vegetation above ground including useful fruit trees, shrubs, climbers and herbs (including a select having medicinal value). Packages of assorted seeds could be provided to the households along with technical inputs on raising their nurseries and maintenance of crops. The other alternative could be encouraging the households to grow native species, with adequate emphasis on utilizing the below as well as above ground products.

An area of 100 ha is proposed to be brought under this activity.

c) Promotion of sustainable horticultural practices

Horticulture within rainfed conditions in Wular catchment bears very low production as well as promotes soil erosion due to cultivation practices. It is therefore envisaged to demonstrate sustsianble horticulture practices in 600 ha, wherein in situ moisture conservation techniques would be followed by laying V shaped ditches along the contour with planting of fruit trees on the hill side of the trench.

4.2.4 Alternate sources of energy

a) Development of village woodlots

Village commons, panchayat lands and group lands are ideal for raising woodlots to meet the energy requirements of the village and to reduce dependence on the forests for firewood. Small timber, fuel wood and fodder species could be raised for the bonafide uses of the beneficiaries. The present management action plan recommends the removal of Ningli plantation on account of its deleterious impacts on the lake hydrology. Village woodlots are therefore a compensatory strategy for meeting the fuel availability gap created due to removal of these plantations.

Village woodlots are proposed to be raised in 1500 ha of catchment area.

b) Promotion of smokeless hearths

The primary objective of promotion of smokeless hearths is to reduce pressure on the forests through efficient use of fuelwood. This also helps to reduce the health hazards in cooking through reduction of smoke generated.

A total of 20,000 nos. of smokeless chullahs shall be installed in hill villages. Training will be provided to community groups for installation and maintenance of these hearths.

c) Mini hydel project – Erin Watershed

A mini hydel is proposed to set up in Erin watershed using the opportunity of high water falls for energy generation.

4.3 Water Management

4.3.1 Enhancing Water Holding Capacity

a) Removal of Ningli Plantations

Ningli (willow) plantations extending to an area 27.30 sq km, as assessed using remote sensing imageries need to be removed for enhancement of water holding capacity and overall water regimes of Wular (Map 4.2). Based on an average plantation density of 1000 trees per ha, it is estimated that 21.84 lakh trees need to uprooted using manual and mechanical means. Specific areas to be covered under the activity are:

Location from where Plantation to be removed	Area Sq. Kms
Watlab to Wular Outlet	2.75
Ningli to Maqdoomyari	9.15
Maqdoomyari to Banyari(Laharwalpora side)	3.95
Laharwalpora to Kanusa	3.23
Kanusa to Zurimanz	0.17
Total	**27.30**

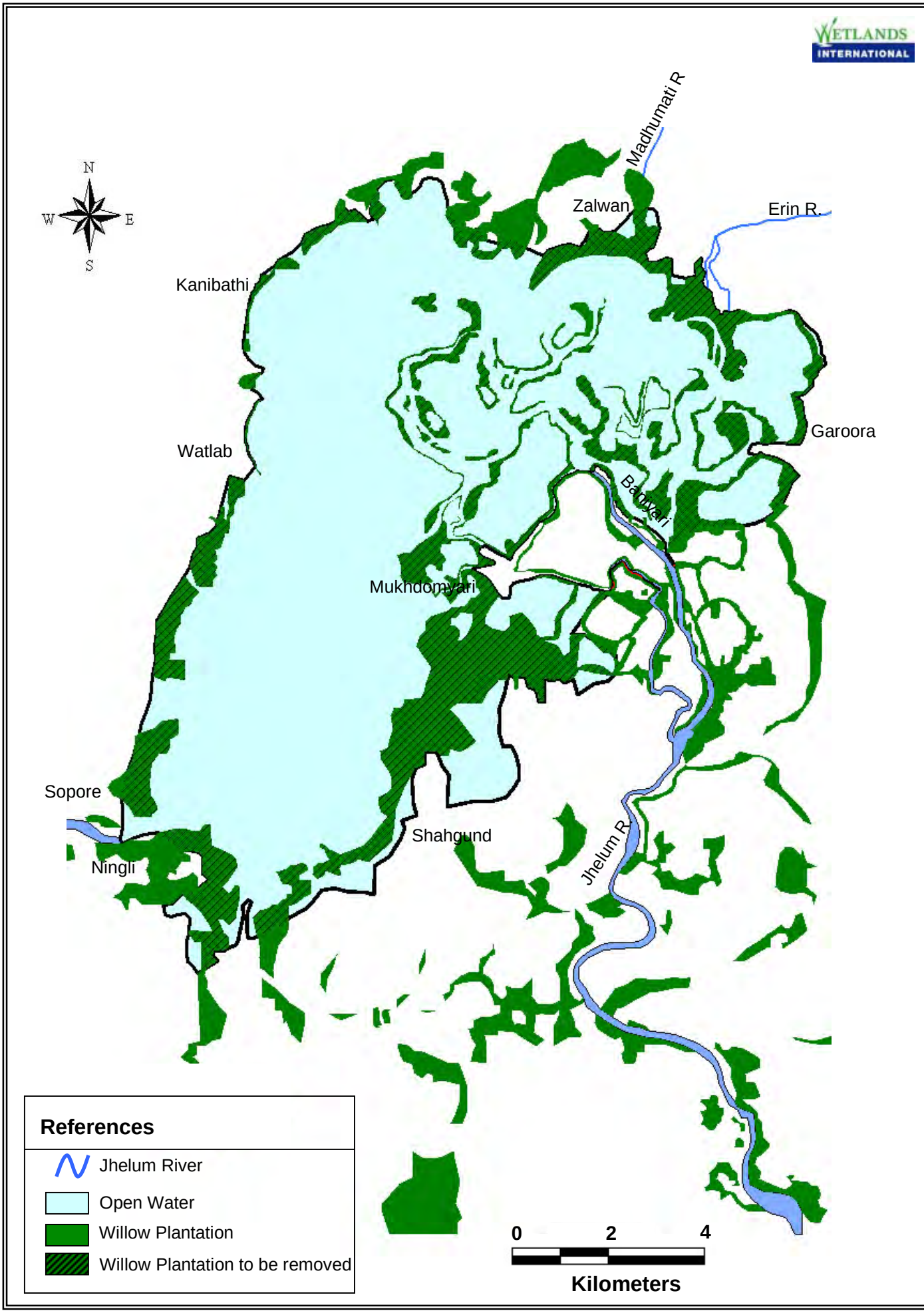
The revenue proceeds through the sale of harvested willows could be earmarked for conservation and management of Wular Lake. An amount of Rs. 31.12 crore is proposed for implementation of this activity.

b) Selective dredging of silted lake areas

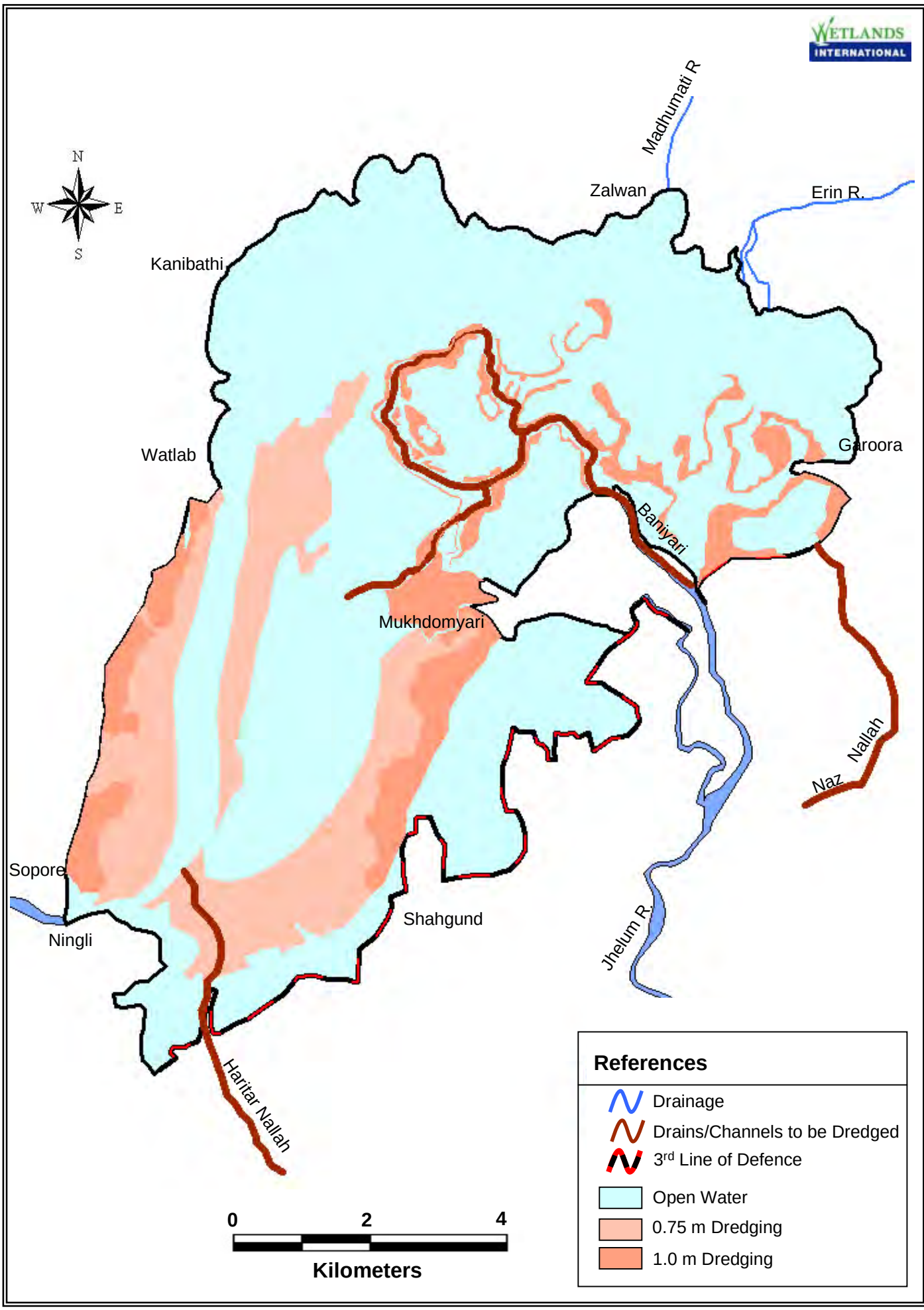
Water holding capacity of the lake has been critically affected by siltation, which has been aggravated by willow plantations within the lake periphery. Mechanical dredging is required in these areas for enhancement of lake capacity.

The areas to be dredged may be broadly classified into three; a) areas presently under willow plantation which may be dredged to an average depth of 1.5 meters, b) critically silted areas along the shorelines of Wular to be dredged to a depth of 0.75 meters, and c) Waterways and watercourses to facilitate better water circulation (Map 4.3). These actions, besides providing navigational facilitates to the adjoining settlements, will address the problem of waterlogging in the southern land side of the lake, created due to criss-crossing of earthen levies.

Location of areas to be dredged	Area	Volume
a) Willow Plantation Area	7.47 sq km	11.20 Mcum
b) Critically silted lake areas	20.25 sq km	15.19 Mcum
c) Channels		0.15 Mcum



Map 4.2 : Area for Removal of Willow Plantation in Wular Lake



Map 4.3 : Areas Proposed for Dredging within Wular Lake

c) Equipment augmentation

In order to achieve the stipulated targets in water management the following equipment may be procured which would augment the existing capacities of the state:

- Cut suction dredger including slurry piping – 5 units
- Motorized carriage tucks – 10 units
- Hydraulic Excavators – 3 units
- Multipurpose maintenance machines – 2 units
- Weed harvestors – 2 units

4.3.2 Rejuvenation of associated wetlands

a) Hydraulic connectivity of marshes with Jhelum / Wular Lake

It is envisaged to improve the hydrological connectivity of the existing marshes through improvement of major surface courses of the marshes (Haritar Nallah for Rakh Haigam and Naz Nallah for Rakh Ajas and Rakh Malgam) and catchment drainages (Bod Nar, Rang Nar, Gujjar Nar, Dud Nar) based on detailed assessment of hydrological exchange patterns.

Area to be desilted	Length
a) Naz Nallah – connecting Rakh Malgam and Ajas	5740 m
b) Haritar Nallah – connecting Rakh Haigam and Naugam	3600 m

4.3.3 Water quality improvement

a) Augmenting pollution abatement programme for River Jhelum

Implementation of River Jhelum Conservation Plan with additional scope incorporated to cover Bijbihara, Awantipora, Pampore, Sumbal and Hajan needs to be prioritized. The primary activities to be carried out include:

- **Interception and treatment of sewage** before its outfall in River Jhelum through construction of Sewage treatment Plants.
- **Solid Waste Management** in areas in immediate proximity of river, which could include collection, disposal and management of solid waste

b) Sewage management in urban peripheral towns of Wular

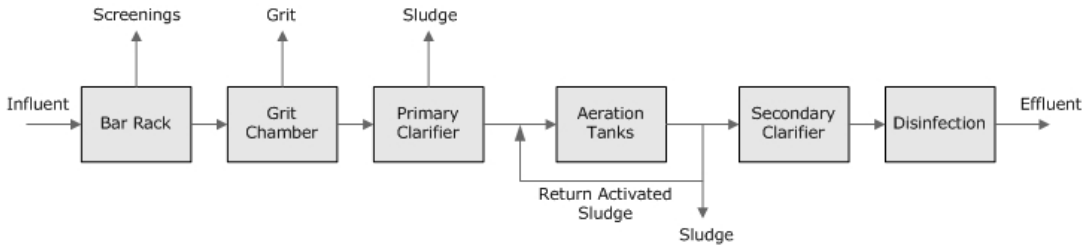
In absence of any proper sewerage system in and around Wular lake, all wastewater generated directly enters into the lake. This has resulted in the eutrophic state, seriously jeopardizing its natural assimilation. It has been estimated that population of about 2,44,821 contributes to the sewage pollution directly or indirectly through Mudhumati catchment, Erin catchment, Bandipora town and adjoining villages. A total of 8.94 MLD of wastewater is generated from these areas, out of which 53% is contributed from 44 villages which fall in Erin and Madhumati catchments with Bandipora town contributing about 25%, villages in the southern side of the lake contributing about 12.8% and villages in eastern and western side generating 7% and 3.5 % respectively. This liquid waste carry about 21.6 tonnes of inorganic nitrate and 15.6 tonnes of phosphorus, which not only enrich the lake sediments but also increase the fertility of water, resulting in accelerated growth of aquatic vegetation and proliferation of algal growth.

Area	Population (2006)	Total sewage generation (MLD)	Nitrate loading (tonnes/MLD)	Phosphorus loading (tonnes/MLD)
Bandipora Town	33926	2.17	5.25	3.82
Kulhama, Nadihal, Rampur-Gundpore and Shok baba villages on Eastern side	19360	0.62	1.5	1.0
Watlab, Zurimanz, Kenusa and kanibathi villages on western side	8678	0.30	0.67	0.48
Villages in Mudhumati, Erin, Northern and Eastern Lake peripherals	150610	4.82	11.66	8.48
Villages in Southern lake Peripherals	32247	1.03	2.50	1.82
Total	**244821**	**8.94**	**19.41**	**14.12**

It is proposed that the sewage generated from Bandipora town, villages on eastern side (Kulhama, Nadihal, Rampur- Gundpore and Shok baba) and villages on western side (Watlab, Zurimanz, Kenusa and kanibathi) shall be treated using conventional sewerage treatment plant. Waste generated from villages scattered in the Madhumati and Erin catchment area shall be intercepted using low cost sanitation units and sewage generated from the Villages situated in the southern lakeshore shall be intercepted and treated using wetland mediated technologies.

a) Wastewater treatment through Sewage Treatment Plant

Sewage interception and treatment is one of the most important activities that shall be undertaken for wastewater treatment. The objective of the sewage treatment is to stabilize the wastewater and reduce its organic content as far as possible. Flow diagram of an Activated Sludge Process is given below:



Bandipora town, the largest urban peripheral town, Villages on eastern side (Kulhama, Nadihal, Rampur- Gundpore and shok baba) and villages on western side (Watlab, Zurimanz, Kenusa and kanibathi) around Wular is proposed to be undertaken for sewage management to reduce direct / indirect discharge of wastewater. Sewage generated from these villages shall be intercepted and treated by construction of three sewage treatment plants using Activated sludge process and designed for year 2021, including allied sewerage works.

b) Community based soil waste management systems

The management of solid waste is practically non-existent in areas in and around Wular. Average generation of solid waste is about 0.35 Kg per capita per day with density of about 500 kg/m^3, which is based on the production of

domestic and commercial waste, animal waste, abattoir and construction waste etc. Since the area does not include industrial area, the industrial waste is not considered. The total domestic and commercial waste expected to be generated in year 2007 based on the present population of 82,894 individuals living in 31 settlements in and around Wular lake is about 29 tonnes.

It is therefore proposed to develop Community based Solid Waste Management Systems for 25 markets and 25 villages for systematic collection and disposal of solid waste. This would involve construction of waste collection centers at common locations, with segregated compartments for recyclable and non-recyclable wastes. Specially designed carriages would be operated through non-government organizations / community based organizations for waste collection from individual households.

c) Low cost sanitation in peripheral villages

Presently 15% of 21,516 households residing in the 44 villages situated on Wular periphery towards north and eastern sides have access to adequate sanitation facilities. It is therefore proposed that sewage generated from rest of the villages without sanitation facilities and scattered in the Madhumati and Erin catchment area shall be intercepted using low cost sanitation units as per WHO design comprising of twin leaching pits with pour flush latrine. It has been calculated that about 18,600 low cost sanitation units with leaching composting pit for managing the domestic sewage. A typical section of the pour flush type latrines is shown in fig 4.1 and brief description of the unit is given in Annex V.

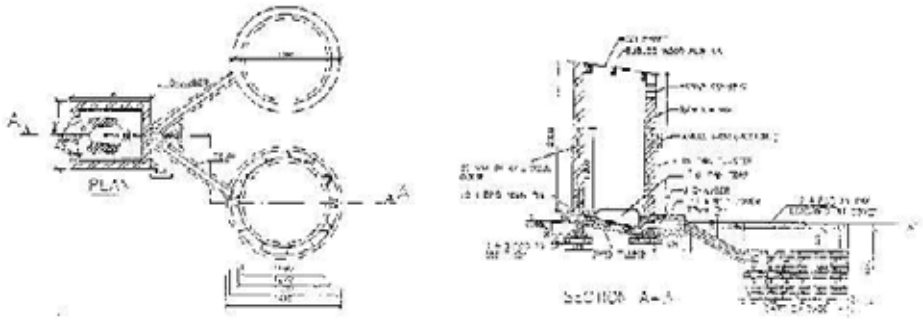


Fig. 4.1

d) Control of diffused pollution through wetland technology

Ten villages which are situated in the immediate proximity of the Wular Lake towards the southern side areas were earlier part of the lake and were reclaimed over a period of time vis-à-vis flood protection. These villages fall in Sonawari (rural) area with total number of 3142 household with a population of 32247 souls. Taking 40 liters per capita per day as per the norms of CPHEEO with 80% of the total water supplied to be taken as wastewater, these villages generate a total of 1.03 MLD of domestic sewage. Since marshes encompass these villages, the sewage generated is directly drained into the lake. Assuming that each MLD of domestic waste generated contains nitrate nitrogen, ammonical nitrogen and total phosphorus of 0.56, 1.86 and 1.76 tonnes respectively which amounts to nutrient generation to the tune of 0.5768, 1.9158 and 1.8128 tonnes/MLD from these villages, thus adding to the lake fertility. Moreover, these villages are scattered in southern sector and therefore the

wastewater generated form these habitation shall taken care of by using wetlands mediated technology.

The goal of using wastewater treatment through wetland mediated technologies is for the removal of contaminants from the water in order to decrease the possibility of detrimental impacts on humans and aquatic ecosystem. Many contaminants, including a wide variety of organic compounds and metals, are toxic to humans and other organisms. Other types of contaminants are not toxic, but nevertheless pose an indirect threat to human well-being. For example, loading of nutrients (e.g., nitrogen and phosphorus) result in water quality deterioration, excessive growth of obnoxious algae and unwanted aquatic vegetation thereby diminishing the recreational, economic and aesthetic values of aquatic ecosystems.

It is proposed to construct treatment wetlands in 10 villages in the southern lake periphery (presently discharging 1.03 MLD of sewage into the lake) to control diffused sources of pollution. Based on population, three types of models are proposed:

Design Category	Population Size	Area requirement
Category A	200 HH	1,880 sq m
Category B	350 HH	3,290 sq m
Category C	900 HH	8,460 sq m

A pre treatment tank will be constructed before allowing sewage to enter into the constructed wetland systems. Each unit will comprise three different compartments with different types of aquatic vegetation based on their nutrient uptake capacity. Cross section of Constructed wetland is given in Fig 4.2 and details are given in Annex VI.

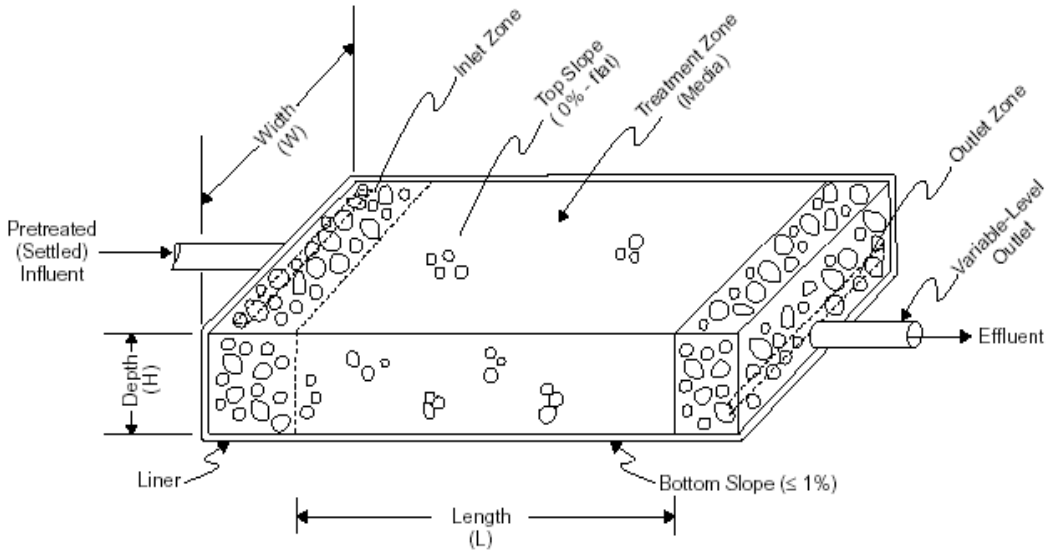


Fig. 4.2 Cross-section design of Constructed Wetland compartment

4.3.4 Water allocation for human and ecological purposes

a) Environmental Flow Assessment

Environmental Flow Assessment is proposed to be carried out define water requirement for ensuring functions and processes of the wetlands of River Jhelum Basin while optimizing allocation for other development purposes including agriculture, hydropower and domestic water supply. The Flow Assessment will focus on defining water allocation scenarios based on detailed assessment of flow regimes of River Jhelum and its tributaries, and linkage of flow regimes with various wetland functions. Water requirement for various uses will be projected based on which optimal allocation scenarios will be arrived at.

An Environmental Flows Team may be constituted for the aforementioned purpose having representation of concerned state government agencies, facilitated through an external expert. The recommendations of the Flow Team should be endorsed by a Stakeholder Executive Committee and implemented by the water resources department. The Wetland Authority can continuously monitor implementation of the flow recommendations and suggest adaptations as necessary.

Specific activities to be undertaken are:

- Constitution of a Environmental Flows Team with representation of all stakeholder departments facilitated by EF expert
- Defining flow scenarios
- Identification of optimal flow scenario based ecological and socioeconomic assessments
- Endorsement of flow recommendations by the Stakeholder Executive Committee
- Implementation of flow recommendations
- Monitoring and evaluation

4.4 Biodiversity Conservation

4.4.1 Waterbird Conservation

a) Inventorization and assessment

The following specific studies are proposed to be carried out for inventorisation and assessment of waterbird diversity:

- Species wise estimates of waterbird populations
- Water regimes assessment
- Key biodiversity assessment
- Human activities and their impacts
- Migration studies (bird banding, satellite and VHF tracking)
- Avian influenza surveillance

The studies are recommended to be undertaken by an external research agency with support and coordination by the concerned state government line agencies.

b) Strengthening existing network of protected areas

Habitat restoration

Regulation of water levels is critical to the maintenance of species diversity and abundance. Haigam, which, was originally connected with the Wular Lake through a channel has been isolated due to siltation of the channel and human encroachment. This channel needs to be restored for effective water exchange between Haigam and the Wular Lake. Following restoration of the channel, manipulation of the water level can be made within the wetland as per the requirement of different species.

Areas of open water also need to be created to cater to the requirements of some bird species, particularly diving ducks for feeding and many other species for resting. The food and feeding habits of different species need to be investigated to advice on their precise needs. Thereafter, a detailed survey of the lake is required to ensure that there is a proper proportion of open water area and surrounding vegetational belts.

Rehabilitation of threatened / rare species

Maximizing of the carrying capacity of the wetlands and associated marshes for waterbirds that use a range of preferred habitats for feeding, resting/roosting and nesting requires considerable planning and location specific knowledge. Adaptive management should be applied based on available knowledge of the management of the marsh vegetation and water depths and new information gained during the implementation of the Action Plan. Through experimentation within sample plots, different vegetation management regimes may be tested during which time continuous monitoring of waterbird diversity, abundance and habitat use as well floral species diversity, abundance and cover, aquatic faunal diversity and abundance should be undertaken. Actions to manage the aquatic vegetation (species, quality and abundance/densities) should be undertaken with a complete understanding of their importance for waterbirds, fishes and other aquatic fauna.

The specific actions required are:

- Identify potential areas of habitat that may be restored or improved to increase the carrying capacity of these sites for waterbirds. This may include deepening or shallowing of certain areas, creating of small islands, etc.
- Planting of certain native food plants (such as *Trapa natans*), or only native tree species for nesting, etc. *Trapa* and other floating species on the one hand provide nesting sites to the birds like Whiskered Tern, Little Grebe and Pheasant-tailed Jacana, while on the other hand, they also form the food for the winter visiting waterbirds and will attract and sustain larger populations of waterbirds to these areas.
- A detailed inventory should be undertaken of each wetland and habitat maps be created. The Asian Wetland Inventory approach and methodology promoted by Ramsar Convention should be applied. Such mapping work should be undertaken following a database format on a GIS platform, to enable incorporation of new data.
- Areas of current importance and concentration of waterbirds should be identified and plotted on maps, to identify high priority areas for waterbird management and conservation action. Waterbird habitats to be identified, demarcated and maintained will include:

- ◊ open water areas as feeding areas for diving species, such as pochards, grebes and coots, and as open roosting areas for other flocking waterbird species.
- ◊ reed beds and channels for migratory ducks and geese, for feeding and roosting,
- ◊ reed beds and open marsh vegetation for nesting species,
- ◊ trees along the wetland edge and on islands in the wetlands for tree nesting species,
- ◊ patches of wet grassland and open ground for grazing ducks and geese, and shorebirds.
- ◊ marking of a representative number of individuals of selected species with VHF transmitters or satellite/GPS transmitters is required to plot daily and seasonal movement patterns of resident and migratory waterbirds to understand their dependence on the network of wetlands in the Valley.

- To restore breeding waterbird populations that depend on reed beds, trees and other vegetation and on abundant food supplies, the identification of important nesting areas and potential areas is required. Thereafter management prescription actions are prescribed. These include:

  - ◊ For areas of importance for reed nesting species, grazing and harvesting of macro-vegetation will need to be completely banned, particularly during the annual breeding seasons of birds from April to August.
  - ◊ For areas of importance for tree nesting species, cutting of trees and tall bushes along the periphery of the lake and marshes and within these habitats should be banned.
  - ◊ Specific activities for restoration and improvement of wetland habitat are required. Following the recommended mapping work to identify current areas of importance for waterbirds (proposed above), it is necessary to identify potential areas of habitat that may be restored or improved to increase the carrying capacity of these sites for waterbirds. This may include deepening or shallowing of certain areas, creating of small islands, planting of certain native food plants (such as *Trapa natans)*, or only native tree species for nesting, etc. Such restoration/ improvement work should only be guided by the detailed analysis of the habitat preferences for feeding, resting and nesting and food requirements of these birds.

c) Control of poaching:

Control of poaching requires an understanding of the modus operandi, impact on species and socio-economic impacts to enable appropriate responses to be undertaken. Field investigations should be undertaken to:

- understand the scope and intensity of the activity and provide a detailed analysis of the poaching activities of waterbirds,
- type of people involved (and their reliance/dependence on this occupation for survival,
- patterns of sale and marketing and consumption, past and current prices of different species, and
- main locations of poaching, seasonality, main species taken and numbers per season be quantified.

For the resident species, an analysis of poaching of eggs, chicks and adults at nests and disturbance through cattle grazing, reed harvesting, lotus/other plant collection should be undertaken.

Activities recommended for control of poaching are:

- **Strengthening protection staff**
  Strengthening of protection staff through increased staffing, equipment and training programmes for enhancement of skill base should be taken up to ensure that poaching can be controlled.

- **Formation of bird protection committees**
  Control of poaching could be effectively controlled by sensitising communities about the importance of the waterbirds at the state, national and global level. Involvement of communities who have a long stake in the protected area could provide a lead role by formation of protection committees to whom economic incentives could be provided through habitat restoration programmes. Chilika Development Authority has developed a successful model to combat poaching by formation of bird protection committees. This model will be replicated through collaborative actions of the state govt. and the local communities. The protection communities could play an effective role in raising the awareness and shifting the attitudes of poachers. The poachers could be involved in the conservation activities and provided with economic incentives such as habitat restoration activities for which financial support is envisaged in the plan.

d) Networking with national / international treaties

- **Implementation of activities under the national wetland action plan – Ministry of Environment and Forests.**
  Haigam and Hokersar are identified bird sanctuaries and are supported under the scheme on National parks / sanctuaries for protection of birds. Wular Lake is covered under National wetland programme and the state Govt. receives financial support for restoration of the lake ecosystem.

- **Implementation of the Asian Waterbird Census**
  The Asian Waterbird Census is undertaken each January, under coordination by the Bombay Natural History Society. Census data collected during this period needs to be forwarded to the BNHS for incorporation into national reports. The national reports feed into regional and global databases and is reflected in the regional reports of Asian Waterbird Census and Waterbird Population Estimates published by Wetlands International.

- **Participation in Important Bird Areas programme**
  Initiated by BirdLife International and in India by the Bombay Natural History Society, the Important Bird Areas in India, published in 2005 has identified, Wular, Hokersar, Haigam, Shallabugh and Mirgund as five internationally important bird areas. The Wildlife Department can use the programme to raise awareness of the importance of sites through a range of local activities, including through support to implementation of the Site Support Group programme.

  Due to their strategic location, the valley wetlands can play critical role in maintaining flyway populations of migratory waterbirds in the Central Asian Flyway (CAF). The conservation of these migratory waterbirds requires an international framework for cooperation. As a Contracting Party of the

Convention on Migratory Species, the Indian Government with support of Wetlands International have been involved in the finalisation of the *Central Asian Flyway Action Plan For The Conservation Of Migratory Waterbirds And Their Habitats* (CMS 2006) to serve as a regional framework for cooperation and conservation action.

The Action Plan covers five main areas:

- Species Conservation (Cooperation, Legal Measures, Development of Single Species Action Plans for Globally Threatened Species, Emergency Measures, Species Re-establishments and Introductions)
- Habitat Conservation and Management (Habitat Inventories, Conservation and Management of Habitats, Establishment of CAF Site Network, Rehabilitation and Restoration, addressing effects of Climate Change)
- Management of Human Activities (Harvesting/Hunting, Livelihood Support Activities, Assessing Impacts of Development Activities, Other Human Activities)
- Research and Monitoring.
- Training, Education and Public Awareness

    ◊ The establishment of the Central Asian Flyway Site Network under the Action Plan is to serve as a mechanism for linking national networks of waterbird sites of international importance across the Flyway. Based on the principle of establishing an ecological network of internationally important sites through promotion of conservation and sustainable management of wetlands and other habitats, it will also provide a mechanism to target actions to improve the well being of local people dependent on the sites. The Network will encourage implementation of a range of actions including, (a) information sharing for conservation and management of waterbird populations with focus on increasing awareness, (b) training to improve monitoring and management, (c) research and monitoring of habitats and waterbirds, and (d) study tours for site managers.

e) Establishment of new bird sanctuaries

Hokersar and Haigam are protected areas within Jhelum basin and have been declared as bird sanctuaries by the state govt. of Jammu & Kashmir. Wular Lake as such is not covered under a protected area network. Similarly, the huge marsh area associated with Wular lake is also unprotected and has been converted for agriculture, settlements and other purposes. Large flocks of birds which used to visit these areas are heavily poached and need to be brought under the protected area network. A rapid survey carried out highlights the importance of Malgam – Saderkoot Bala-Ajas as bird sanctuary / community reserve. For designation of this area as a bird sanctuary / community reserve following activities be undertaken:

- Confirmation of current status of the proposed sanctuary and land tenure ownerships
- Survey and demarcation of Malgam –Saderkoot Bala-Ajas marshes
- Delineation of various zones for management planning
- Inventorization of biodiversity with emphasis on waterbird composition and population estimates
- Identification of critical species for protection
- Measures for rehabilitation of biodiversity adopting zonation concept

- Sustainable utilization of resources and species
- Community consultations for mobilising and finalizing compensation issues

Based on detailed Inventorization and assessment of the proposed areas the state govt. would declare the stretch encompassing Malgam-Saderkoot Bala- Ajas as bird sanctuary / ies under State Wildlife Protection Act. This would provide legal status to these important bird sites for protection and combating poaching and to allow for the local people to access these marshes in a regulated manner to continue grazing, fishing and harvest of water plants.

f) Monitoring and research

Information on waterbirds and their habitats is collected mainly by the State Wildlife Department, and University of Kashmir. The Wildlife Department has undertaken various waterbird monitoring programmes at Haigam, Hokersar and other sites over the last decades. The information on waterbirds though patchy, is useful to provide some information on species diversity, seasonality and abundance. The University of Kashmir has undertaken studies of the breeding and feeding habits of different resident and seasonal migrant waterbird species.

A detailed assessment of current waterbird species composition and abundance and their relationship to the different wetlands should be undertaken over the next 3-5 years.

- **Waterbird population monitoring**

An intensive programme of regular counts (at fortnightly intervals) be undertaken at all important sites utilising international standards and protocols at all the major wetlands in a coordinated manner covering the full year to get a comprehensive understanding of the current importance of these wetlands for migratory waterbirds and to plan and monitor habitat management strategies and actions. Data collected during this monitoring work will include collection of detailed information on habitat structure and seasonal abundance and changes in different prey items (aquatic flora and fauna).

Information collected should enable realistic population estimates of the different waterbirds and trends to be developed and provide guidance for management activities.

The development of such a programme will require the constitution of a multi-skilled team, that can collect information on habitat condition, identify and census waterbirds, quantify aquatic flora and fauna using standard techniques and high quality field equipment. A cadre of properly trained staff of the Wildlife Department, University of Kashmir and interested volunteers should be developed with the support of the Bombay Natural History Society and other organizations.

Results of the annual monitoring programme should be analysed to asses the trends in population changes and change in species composition as well as identification of endangered / critically endangered species along with the historical data.

An assessment of current waterbird species composition may be undertaken over 3-5 years along with habitat changes.

Regular counts (at fortnightly intervals) be undertaken at all important sites in a coordinated manner covering the September-May period for a 3-5 period to get a comprehensive understanding of the current importance of these wetlands for migratory waterbirds and to plan and monitor habitat management strategies and actions. Such studies should focus on seasonal abundance and food availability.

Collection of baseline information on the population estimates, precise habitat requirements, breeding success of these waterbirds and determination of current threats to the birds and their nesting habitats be collected to provide management input.

A long term comprehensive colour marking and ringing/banding programme of long –distance and seasonal migratory species be established. The work of such a programme may be enhanced by marking of selected species with satellite transmitters to study their precise movements within the valley and across the country and the flyway.

Management of the waterbirds needs to be based on regular and enhanced field-based population monitoring programme utilising international standards and protocols at all the major wetlands around the year. This work needs to be undertaken by a team of well trained and equipped staff.

The results of the annual monitoring programme should be regularly published and integrated with national and international monitoring programmes to ensure that the work being undertaken in the Valley is integrated with international flyway programmes.

- **Breeding waterbird investigations**

An intensive programme to determine the distribution and breeding concentrations of all waterbird species (reed bed, marsh and tree nesting) should be undertaken to determine the current baseline population of breeding birds. Studies of the habitat preferences, precise requirements, ecology of key waterbird species and determination of current threats will be required to enable planning and execution of measures to manage and improve existing habitats, to identify potential breeding areas and restore degraded areas to increase breeding habitats and address increased prey requirements.

- **Migratory flyways**

A long term comprehensive waterbird migration study should be established for long –distance and seasonal migratory species.

To understand local, national and international movements of birds, the application of metal leg rings/bands, colour bands, flags and neck collars should be undertaken on selected waterbird species.

To ascertain precise movements within the valley wetlands and across the country and the flyway work, marking of selected species with VHF and satellite transmitters should be undertaken.

As the application of such techniques requires proper training and continuous practice, a cadre of properly trained staff of the Wildlife Department, University of Kashmir should be developed with the support of the Bombay Natural History Society and Wetlands International. Applications of colour marks on any bird

should be undertaken in proper coordination and permissions of international coordinators.

The outputs of this research should be regularly communicated and publicised to increase awareness and international value of the Valley wetlands for migratory waterbirds.

- **Studies on habitat improvement**

Maintenance of viable populations of resident and migratory species depends upon the health of the wetland habitat, which in turn is governed by a host of factors related to water regimes, vegetational characteristics for feeding, breeding and shelter and human pressures. The critical relationships between habitat characteristics and waterbird populations have not received much attention. Specific research studies need to be undertaken to establish key factors determining health of the wetland habitat in relation with waterbid populations. These studies should help determining species diversity, optimum populations and food requirements for various species. These findings need to be integrated into management planning. Meanwhile an adaptive approach for management should emphasize on :

◊ Reclamation of encroached land to enhance wetland area and connectivity with water resources
◊ Banning grazing and harvesting of vegetation to avoid destruction of nesting of breeding bird from May to August every year
◊ *Trapa natans* that forms the food of winter visiting waterfowl may be grown in the lake every year to attract more and more waterfowl to the lake during winter
◊ Tree felling in the periphery of the lake must be discouraged as it results in the habitat destruction of many upland birds.
◊ Macrophytes clearing operations may be allowed on those areas which have dense stands of vegetation so that the decomposed plants can be excavated which otherwise increase the nutrient quantity.
◊ Participation of ornithologists, fisheries biologists, Limnologist, hydrologists, agronomists, economists and GIS expert to develop strategies for habitat improvement
◊ Eco-development of the peripheral areas for reducing pressures on protected areas

- **Waterbird health**

Knowledge of the health of resident and migratory species that inhabit the wetlands is critical to understanding the risk and potential of transmission of avian diseases to other birds and animals, domestic poultry and people. Specific studies need to be undertaken to establish a baseline of the common and potentially harmful avian diseases, including the highly pathogenic strains of avian influenza, that have a zoonotic potential.

Establishment of a wild bird disease unit capable of undertaking year round and long-term surveillance and monitoring of breeding and migratory waterbirds is required. Such surveillance activities need to be conducted in collaboration with local and international expertise.

g) Capacity building

Capacity building is critical to the successful management of waterbirds and their habitats. This can be achieved through conducting periodic training programmes and infrastructure development for monitoring.

- **Training**

  Expertise and opportunities for training in waterbird assessment, monitoring, research and migration study exist within the country, with institutions such as Bombay Natural History Society (BNHS) - Mumbai, Salim Ali Centre for Ornithology and Natural History (SACON) - Coimbatore, Wetlands International - New Delhi, and Wildlife Institute of India (WII) - Dehra Dun.

  Periodic training programmes should be held for various target groups including field staff managers and decision makers, local NGOs and community groups. The training should be provided on methods to collect information on approaches to bird census, analysis of information developing monitoring protocols and interpretation of data for use at various levels. A cadre of trained technical staff should be developed for trend analysis of waterbird populations in relation to habitat features. Specific training programmes should be developed in collaboration with BNHS for assessment of bird migration and understanding the constraints in the pathways. A protocol for waterbird census should employ the scientific methodology emphasizing on visual census, line transect method, counting nests in colonies and block methods. Surveillance of waterbirds for avian influenza and other zoonotic diseases should employ scientific methodology and techniques as promoted by FAO.

- **Infrastructure development**

  The effective monitoring involves developing infrastructure for quick and efficient patrolling mechanisms such as mobile vans and boats etc. the equipment for bird watching need to be procured

4.4.2 Wildlife conservation

Biodiversity conservation would also focus on conservation of wildlife within and outside the protected area network within the Wular catchments, through the following activities:

- Demarcation of a new wildlife sanctuary within Erin catchment at Harmukh
- Fencing existing sanctuaries
- Construction of 10 rescue and rehabilitation centers at strategic locations
- Construction of 1 breeding center for Hangul, Musk Deer and pheasants at Chatternar, Bandipore within the existing Forestry School Complex
- Improvisation of infrastructure for land transport and patrolling
- Provision of compensation of man animal conflict

4.4.3 Management of aquatic vegetation

a) Optimization of economically important plant species through water level enhancement

Aquatic vegetation is very sensitive to changes in water levels. Plant communities stabilize in accordance to water depth profiles. Currently large belts of *Trapa* are localized in limited available water areas. Fodder plant communities adjust to the relatively shallower areas. Increasing the water level by 1 m will have profound effect on reestablishment of vegetational belts in different areas. It is expected that the plant communities will shift in accordance to the gradient of water depths. The plant communities with longer shoots will colonize deeper areas and *Trapa* which forms a large belts at present will move towards littoral areas leaving a large open water area almost devoid of aquatic vegetation due to high turbidity in the lake water a large portion would be left open which can be used for aquatic sports as proposed under ecotourism development. Water level manipulation as proposed in the project would be ecologically and economically feasible rather than options for deweeding considering their ecological role communities play in maintaining the ecological functions they play.

b) Control of invasive plant species through effective lake flushing

Hydrological interventions as proposed in the plan would enhance the water circulation in the lake. However, the problem of invasive species is linked to upstream areas, which needs treatment at the basin level. *Salvinia*, *Lemna* and *Azolla* which have profusely proliferated within River Jhelum and associated wetlands needs innovative approach to combat the problem. However, in case of Wular lake the only solution at present is enhance the flushing rate and prevent stagnation of water which are ideal conditions for growth and production of these invasive species. Water management is a critical component to control growth of noxious aquatic weeds

c) Maintenance and regeneration of marshes to enhance their ecological role

Realizing the importance of marshes in ecological functioning of Wular lake particularly in regard to water quality improvement it is proposed to rejuvenate and protect 17 sq km of marshes based on environmental flow assessment study. The environment flow assessment will provide the basis for protection of minimum area of marshes while maintaining agriculture productivity and other human uses. The trade offs between ecological aspects and human uses have to be clearly understood and shared by the communities who depend upon these resources for their livelihoods.

4.5 Ecotourism Development

Development of sound ecotourism infrastructure need to be carefully established to ensure minimal impacts on the environment while at the same time maximizing opportunities for the visitors to enjoy the wetland and their biodiversity.

4.5.1 Development of recreational facilities

At present there are no facilities and these need to be developed taking into consideration he environmental factors and tourist carrying capacity of different areas.

a) Board Walk and Nature Trails

The Boardwalks and nature trails will give the visitors a good chance to breathe in the fresh air and enjoy the peaceful environment of Wular Lake and its adjoining wetlands. The walking trail along the wetland has to be constructed well above the highest flood level of the wetland. Gates at the entry points will control these boardwalks and only serious nature lovers and birdwatchers will be allowed to access.

Guided tours can be arranged across the boardwalks in the forest and wetland areas. Well-trained guides shall escort the visitors who shall be adequately briefed about the dos and don'ts while in an ecologically sensitive area.

Two nature trails are proposed to be developed within the Ajas – Malgom Rakh area and adjoining Haigam marshes.

b) Guided boat rides

Guided boat rides shall be arranged for nature lovers to help them explore the various aspects of Wular Lake and associated wetlands. Local community groups shall be trained to take up interpretation activities. Overall two-boat ride routes are proposed, one between Nadihal and Kanibathi and second between Hajan Interpretation Center (proposed) and Zurimanz village. Ten boats are proposed to be used for these purposes.

c) Watch Towers

For the benefit of day visitors as well as organized groups, school/college students, two watchtowers are proposed. The locations of the watchtowers are located at the start of bund road on western side and almost in the middle of towards eastern side.

Entry to these facilities will be charged nominally and the group sizes regulated. Construction of these towers could be taken up during the low water season. Provision of equipment such as binoculars and telescopes for use of school/college groups and serious bird watchers could be made through the local administration on payment of nominal security deposits.

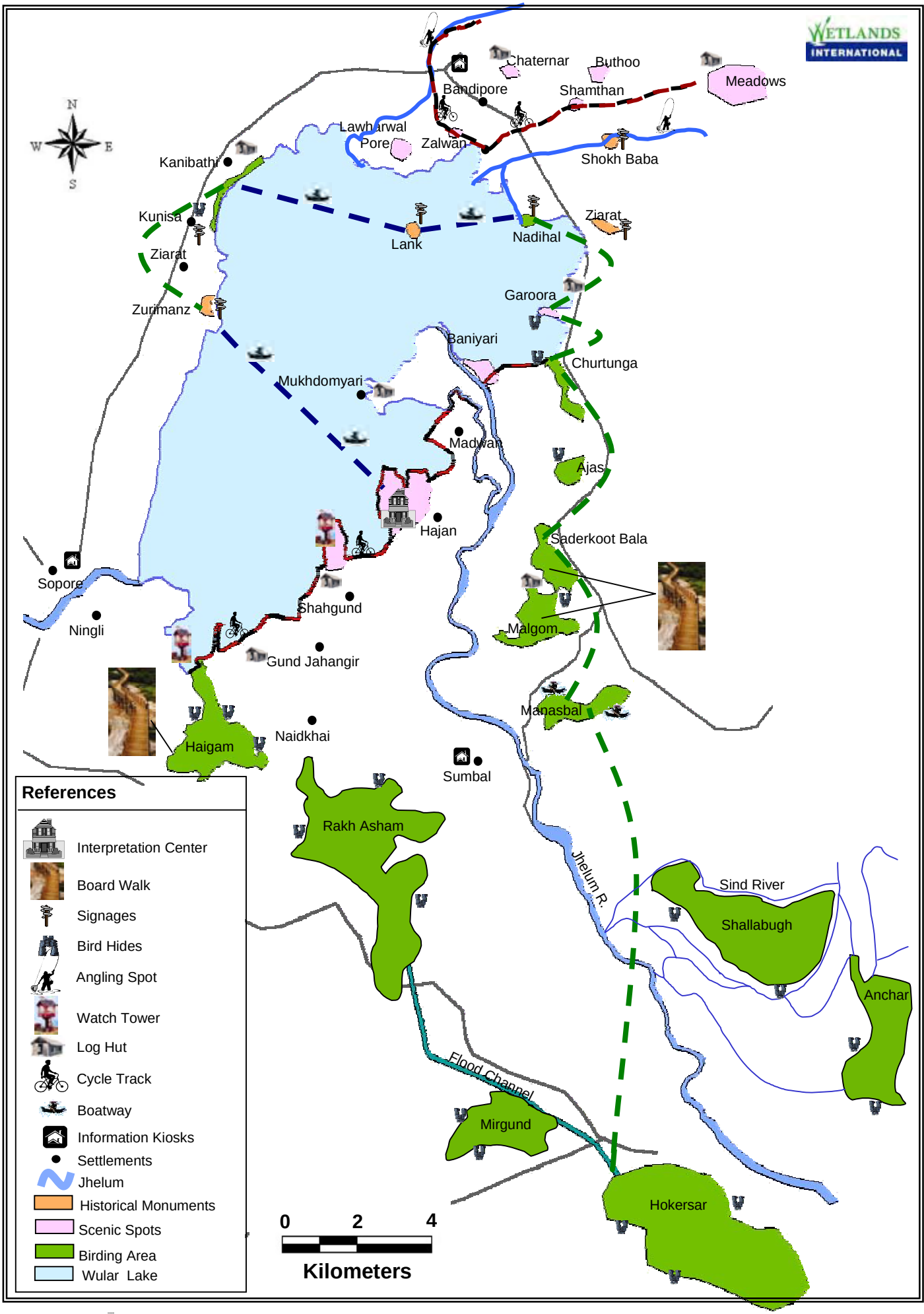
Overall 10 units of watchtowers are proposed at location described at Map 4.4.

d) Angling Spots

Overall 25 angling units are proposed to be installed including 18 along the hill streams and 7 around Manasbal Lake. The angling units shall comprise wooden raised platform with capacity of 3 - 4 persons. A minimum distance of 20 – 25 ft is proposed to be maintained between the two angling spots. Anglers should be involved and competitions held periodically by the managers to promote the initiative. Locations of angling units are provided at Map 4.4.

e) Landscape Gardens

Four landscape gardens are proposed to be developed two each adjoining the interpretation center at Hajan and Ningli.



Map 4.4 : Proposed Sites for Ecotourism Development

f) Improving the sports facilities

The sport facilities at Manasbal Lake and within Wular Lake area are proposed to be developed for pedal boating, para sailing and wind sailing. The equipment for the benefit of adventure sport lovers would be developed.

4.5.2 Development of visitor education facilities

Education and interpretation services are a fundamental component of a visitor's experience in a natural area. Plans for visitor awareness generation on the functions and values of Wular and associated wetlands and conservation needs should be designed keeping in mind different target groups like tourists, school children, local youth, fisher communities, decision makers and policy planners. Educating tourists and the agencies promoting tourism should be a major thrust of ecotourism with precaution taken to minimize environmental impacts and sensitizing about sustainability of ecosystem.

It is proposed to construct two visitor interpretation centers, one at Hajan and other at Haigam. The center shall be developed with multi-objectives catering to the need of stakeholders, tourists, local public, and school children.

The following facilities are proposed to be developed in the interpretation complex:

- **Exhibits** including posters, models, flying patterns hanging from ceiling, wetland birds interactive panel and ecosystem food chain
- **Viewing Gallery** comprising panels highlighting the ecological, socioeconomic and cultural aspects. Desks fitted with adequate displays, bird identifications books and wooden benches should be constructed along the gallery.
- **Hydrological model of Wular Lake and its associated wetlands** indicating the various hydrological influences and wetland conservation
- **Children's Play area** consisting of open dioramas and floorings with underwater paintings should be developed as a special section to cater to the young visitors. The area should have several innovative environment oriented games and interactive food chain, fish trap games, jigsaw puzzles etc.
- **Auditorium** having audiovisual facilities for screening documentaries and arranging talks / workshops / meetings.
- **Souvenir Shop** for visitors having wetland products, wetland biodiversity replicas, reading materials, photographs, maps for the visitors to take away on payment basis as memorabilia from the visit

4.5.3 Infrastructure Development

Infrastructure development is the backbone of the tourism industry. The provision of easy access, clean accommodation, convenient local travel, and opportunities for relaxation and entertainment determine the popularity of a tourist destination. Ecotourism implies the creation of ecologically friendly facilities emphasizing the utilization of resources on a sustainable basis, biodiversity conservation, waste minimization and local community involvement in planning, development and the maintenance of infrastructural facilities.

The following suggestions are made for infrastructure development for promoting ecotourism in Wular and also to ensure ecologically friendly tourism:

a) Communication and transport infrastructure

It is necessary to ensure good communication facilities including telephone, fax and internet facilities to enable people to stay connected while on the visit. Buildings, roads, and service systems should be designed to minimize environmental impacts using locally available building materials, techniques, native technologies and architectural shapes

Only pathways as designed in national parks and sanctuaries should be constructed to avoid disturbance to wildlife, and no roads should be constructed in proximity and parallel to the shoreline of the lake

b) Accommodation

Present accommodation facilities in and around Wular Lake are few. There is a need to construct rest houses at main points around the Lake. Accommodation for nature oriented tourists must be comfortable, clean and simple. These may be constructed along the lines of loghuts or as tent accommodation instead of permanent multistoried buildings. Sample of loghuts are given is Annexure VII. It is proposed to construct 25 loghuts including 5 in Manasbal, 11 in Erin and Madumati, and 5 in Watlab and 4 in Haigam. Adequate care should be taken to ensure proper disposal of sewerage and garbage generated of the habitations.

c) Signages

Signage boards are an important means of conveying messages and / or instructions to the tourists. Major emphasis should be given on developing good signage boards at important locations (viz., entry gate, sites of high biodiversity, sites of historical importance, dangerous places etc.) with clear cut messages.

d) Boating

The boating club at Zuramanz and Hajan with country boats and a few mechanized boats for recreation purposes. The facility needs to be further augmented by introducing water sports. Minimizing use of mechanized boats and reducing the noise and water pollution should be the guiding principles.

4.5.4 Publication of posters, brochures and booklets

It is proposed to develop a range of communication material and tools highlighting various values and functions of Wular Lake. The material would be developed in English and local languages to promote greater use by local tourists and visitors.

4.6 Sustainable resources development and livelihood improvement

4.6.1 Sustainable fisheries development

a) Enhancement of fish yield through development of capture and culture fisheries

- **Establishment of *Schizothorax* fish seed farms**
  Culture of commercially important Schizothoracids species is proposed to be taken up for revival of this fast dwindling indigenous fish fauna. Three

Schizothorax fish seed farms are proposed farms to be constructed within Madhumati and Erin catchments to undertake culture of Schizoththoracid species like *Schizothorax niger, S.micropogon, S.esocinus, S.curvifrons, S.richardsonii.* The hatchery will comprise of a brood tank, rearing tank, ova hatchery, feed store and mill and a generator shed and will be constructed in 1 ha area. The hatchery will have an overall production capacity of 3,000,000 fingerlings per operation.

Management of hatcheries would be through a Hatchery Management Committee comprising members drawn from fisher community and assisted through the State Fisheries Department. Fifty percent of the fingerlings produced shall be used for restocking of the lake and the rest sold to private farms at subsidized prices. The revenue generated shall be used for sustaining the hatchery operations including investment into raw material and upgradation of the infrastructure. The hatchery will also serve as state of the art center for providing training and information dissemination to the local fishers on the fish farming.

Activities to be undertaken include:

- Establishment of Hatchery Management Committees and defining rules for management of the infrastructure and sharing of usufruct
- Construction of hatchery including brood tank, rearing tank, ova hatchery, feed store and mill and a generator shed
- Maintenance/ operationalization of hatchery including
    - ◊ Cleaning and deweeding, including painting and repairing of pipes at the beginning of the breeding operation
    - ◊ Monitoring of water quality specially pH and dissolved oxygen of supply pond
    - ◊ Artificial breeding operation involves mainly inducing breeding by injecting pituitary gland extract to mature male and female fish. One operation is completed in 4 days with following activities:
        - ✓ *Collection of pituitary glands* :
        - ✓ *Selection of matured brood fish :*
        - ✓ *Injection to the brooders*
        - ✓ *Monitoring of breeding operations*
        - ✓ *Collection of spawn*
        - ✓ *Release spawn in nursery ponds*

Collection of spawns from spawn collection tank after induced breeding operations and their release in nursery pond to grow up to fingerling stage and their further growth for six month for better market price.
Restocking of lake using 50% of the fingerlings , rest being sold to private fish farms at subsidized prices

- **Enhancing auto recruitment**
  Anthropogenic disturbances along the breeding and spawning groups of fish species and obstructions to their pathways are major factors impeding auto recruitment of species into Wular. It is therefore proposed to enhance auto recruitment through protection of the breeding and spawning grounds and clearance of channels used as pathways by the fish species. Activities to be undertaken include:

- ◊ Participatory mapping and delineation of the fish breeding and spawning grounds and the pathways
- ◊ Clearing channels using manual / mechanical methods
- ◊ Stakeholder workshops for community endorsed regulation for protection of breeding and spawning grounds

- **Fish restocking**
  Restocking of the open water area, presently estimated to be 3266 ha which is expected to increase to 5300 ha after hydrological intervention would be carried out through the fish seeds available from the Mahseer fish farm of State Fisheries Department. Restocking would be done at the rate of 2000 fingerlings / ha.

- **Enhancement of culture fisheries**
  The village ponds in and around Wular Lake provide an opportunity to augment culture fisheries production. Apart from providing economic incentives to the fisheries, regulated augmentation of culture fishing capacity would reduce pressure on lake fisheries. Activities to be undertaken include:

  - ◊ *Construction of community owned hatcheries:* 5 community owned hatcheries are proposed to be constructed in the lakeshore villages. The hatcheries would be small scale, with an average production capacity of 50,000 fingerlings per operation. Village wise hatchery management committees would be formed to manage these units.
  - ◊ *Integrated farming:* It is proposed to introduce integrated farming systems , viz duck cum fish in 50 ha to enhance incomes of marginal fishers.

b) Improvement of fish harvesting and post harvesting infrastructure

- **Strengthening of landing centres**
  Infrastructure of the existing nine landing centers (Lankrishipora, Kulhama, Ashtangoo, Kenusa, Watlab, SK Colony and Ningli Balla) would be strengthened for collectivization and provision of post harvest and transport facilities to the capture fishers. Activities to be undertaken include:

  - ◊ Construction of boat jetties
  - ◊ Construction of landing sheds for storing equipment and fish catch
  - ◊ Provision of motorized boat and insulated vans for faster transport of catch to the markets

- **Provision of improvised crafts and gears**
  It is proposed to provide improvised FRP boats to 25% of the active fishers through the Fisher Cooperatives.

- **Enhancing live fish storage capacity**
  There is an immediate need to enhance live fish storage capacity, in order to regulate fish supplies and ensure higher economic returns to the fishers. The following interventions are therefore proposed:

- ◊ Reshaping the existing fish tanks adjoining Zurimanz Village to enhance their capacity
- ◊ Providing atleast 3-4 holding tanks with dimensions of atleast 100'×50′×4′ in the 8 fisher villages (Sheer colony (Sopore), Watlab, Ashtangu, Laharwalpora, Lankreshipore, Kulhama, Kanyari and Kunus).

- **Post harvest management**

Post harvest management would focus on enhancing infrastructure for fish storage, transport and fish processing for enhancing economic returns to the fisher communities. Activities to be undertaken include:

- ◊ Construction of 4 ice plants at Watlab and Kenyari
- ◊ Establishment of fish processing unit: It is proposed to establish a fish processes plant at Laharwalpora to utilize the surplus fish harvest. The processing plant will have following in built sections:
  - ➢ Processing Unit: Refrigeration with Ammonia freezing plant, canning plant, drying plant and cold storage curing etc.
  - ➢ Marketing Unit: To manage marketing of processed product by having retail outlets in the main cities and towns of the state.
  - ➢ Training Unit: In order to educate the fishermen community about the post harvesting technology, handling, storage etc. Short term training courses shall be organized. Besides training to self help groups from the community to develop fishing skills and hygienic handling of fish

  The value addition techniques proposed to be used are:

  - ✓ *Canning:* Thematically sealing in containers which need neither chemical preservation nor any special storage, maintains nutritive value and have prolonged shelf life.
  - ✓ *Fish curing:* Almost 7% of the Wular fish production is preserved by fish curing especially the salting & sun drying, and this still remains widely followed methods as capital outlay is small as compared with other processing methods. The product is relatively cheap and hence it is within the means of the economically weaker fishers. Training and subsidy on construction of drying sheds are envisaged under the scheme. It is proposed to provide solar dryers for efficient and hygienic drying and curing.
  - ✓ *Pickling, Smoking , Chips and making of fish meatballs*

c) Strengthening of fish cooperative societies for collective ownership and management of Wular fisheries through a community driven process

- **Establishment of Fish Farmer Cooperatives (FFC)**

FFCs are proposed to be set up to promote coordinated efforts to achieve all round progress in fisheries sector. FFCs shall function as the core stakeholder group for design and implementation of sustainable development fisheries programmes. This would involve, inter alea , the following:

- ◊ Preparation and implementation of Stakeholder Endorsed Fisheries Policy for Wular Fisheries
- ◊ Development and operation of corpus fund to ensure equitable and timely delivery of credit facilities
- ◊ Management of landing centers , including maintenance of infrastructure
- ◊ Monitoring fish landing and other related parameters to support fisheries planning and management

Based on the present assessment of the number of active fishers, it is proposed to establish 4 Fish Farmer Cooperatives to be registered under the Societies Registration Act of the Jammu and Kashmir State.

- **Development of fisheries policy**

  There is a need for development of a state fisheries policy for ensuring management of fisheries at basin level. The policy needs to outline the

  A Policy for managing Wular fisheries needs to be developed in consultation with all the concerned stakeholders. The policy shall include specific recommendations for:

  - ◊ Regulating effort including crafts and gears
  - ◊ Promoting best practices for

  To prevent indiscriminant fishing specially in breeding seasons a community endorsed fishery policy is required. Review of the existed Fishery Rules and framed a fishery policy for the state is urgently required. A national level involvement is also ensured under this program. The following activities will be undertaken:

  - ◊ Formation of draft fisheries policy and regulation
  - ◊ Community endorsement
  - ◊ State level committee
  - ◊ National level steering committee
  - ◊ Finalization of fisheries policy

d) Capacity Building

There is a need for undertaking capacity building across all levels for sustainable development of fisheries in Wular. The following measures are therefore proposed for capacity building:

- Need based training programmes / workshops
- Infrastructure development for monitoring and evaluation
- Exchange visits for sharing of expertise
- Farmer field schools
- Training programme for community leaders

4.6.2 Economic utilization of Aquatic vegetation

Several plant species are utilized for mat manufacturing, basket weaving and other products. The yield from trapa cultivation is further processes and transported through a chain of contractors and finally sold in the markets of Srinagar and other towns.

It is proposed to organize 10 micro enterprise units in lakeshore villages based on aquatic vegetation. Each of the micro enterprise unit shall be registered as a society and invest a part of the proceeds into group capital, to be used for credit – savings operations. The units shall be federated and linked with the established marketing channels viz State Craft Emporiums, Cottage Industries Exposition etc.

4.6.3 Livelihood Improvement

Additional and alternate income generation sources of income are important means for diversifying livelihoods and reduce vulnerability to natural changes, presently in the form of reduction of lake resources. These ventures are proposed to be operated as community micro enterprise, with inbuilt mechanisms for supporting credit needs as well as achieving financial and technical self reliance through investment into infrastructure and skill base.

a) Micro enterprise for hill communities

- **Mushroom cultivation:** There is a vast scope for commercial cultivation of mushrooms in the hill villages, which offers ideal weather conditions for mushroom cultivation. Gucchi (Morchella) is highly valued mushroom varieties cultivated in the hill areas. It is proposed to undertake mushroom farming in 50 villages through 100 self-help groups.

- **Medicinal Plants:** Cultivation of Lavendar has been undertaken on demonstration scale in some hill villages (Bothu). Scope exists for upscaling cultivation of medicinal plants with technical support of Regional Research Laboratory, Jammu / Kashmir and Sher-e-Kashmir Agriculture technology University. The medicial plants could be grown in homesteads, which could be subsequently networked for a sizeable and commercially viable harvest. It is proposed to establish medicinal plants based enterprise in 25 hill villages through 50 self help groups.

- **Sericulture :** Mulberry based silk worm rearing could be introduced in lower altitudes. There is already a highly recognized craftsmanship within the Kashmiri households, which could support sericulture within these communities. It is proposed to take up sericulture in 25 hill villages through 50 organized networks.

- **Apiculture:** The flower bearing trees in the homesteads as well as within the forests can support apiculture, which can be used to augment incomes of the hill households. It is proposed to support 100 apiculture units in 25 hill villages to reduce dependence on forests.

- **Minor Forest Produce:** The hill communities traditionally collect several minor forest produce for livelihoods (for example , Manchren and Ringrish are highly relished wild tea varieties). Enterprise based on sustainable

harvest and value addition of MFPs could be promoted within 20 villages with 35 groups on a demonstration scale.

b) Micro enterprise for lakeshore communities

Micro enterprise for lakeshore communities linked with fisheries and aquatic vegetation are proposed under Section 2.1 and 2.2. Additionally the following activities could be taken up for livelihood improvement of the lakeshore communities:

- **Poultry Development:** Poultry development program is proposed to be undertaken for 100 groups in 10 villages. The groups would be linked with the State Veterinary Department for technical support on management of poultry units.

- **Apiculture:** Homestead level apiculture is proposed to be undertaken through 100 groups in 25 lakeshore villages.

- **Natural dyes:** Production of natural dyes based on the existing plant species could be undertaken in conjunction with promotion of organized weaving units. Natural dyes based enterprise are proposed to be established through 50 groups in 10 villages.

- **Floriculture:** The Kashmir Valley has suitable agro climatic condition for cultivation of various types of flowers , for consumption of domestic as well as international markets. It is proposed to set up floriculture units through 50 groups in 10 lakeshore villages.

c) Improvement of quality of life

- **Safe drinking water**
  Provision of 100 units of pond based safe drinking water is proposed for enhancing availability of safe drinking water in the lakeshore villages. The units shall contain a three chambered structure with varying grade of gravel and alum for cleansing water. The units shall be maintained by the resource user groups through maintenance a nominal charge for cleansing, repair and maintenance.

- **Strengthening rural markets**
  In order to enhance economic returns of the agroforestry / micro enterprise produce to the hill communities, it is proposed to strengthen 10 rural markets through better communication and infrastructure facilities. These facilities shall be developed through the existing market / trader associations. The activities to be taken up are:

  ◊ Development of approach roads

  ◊ Construction of zero energy cooling chambers for storage of agri / horti produce

  ◊ Construction of market sheds and auction halls

4.7 Institutional Development

4.7.1 Establishment of Wular Development Authority

It is proposed to set up Wular Development Authority (WDA) within the administrative control of Department of Forests and Wildlife. Besides, Department of Forest and wildlife has a broader mandate for coordination and implementation of conservation programmes of natural resources and wildlife conservation would be the major beneficiaries of the conservation programs. Moreover such arrangement would be in line with similar structure in the Central Govt.

The WDA should be a semi-autonomous organization registered under Society Registration Act. The main objective of the WDA should be to undertake improvement of the lake along with development in the fields of fisheries, agriculture, tourism and rural development with the concerned state government agencies. The overall goal of the WDA should be conservation of Wular lake ecosystem integrating catchments at river basin level while providing social and economic benefits to the communities dependent upon the Wular lake area for their social and economic development. This involves multidimensional and multi-disciplinary developmental activities to promote sustainable management of the lake. The overall functions of the WDA should be aimed at establishment of policy, planning, coordination and monitoring for long-term management of the lake which could be integrated within overall sustainable development of natural resources of the state.

Terms of Reference

The following terms of reference are proposed for setting up of WDA :

- WDA has a distinct identity and is the lead agency for Wular Lake development and a having neutral role in balancing competing interests
- Representation from all of key resource management agencies having stake for Wular Lake conservation and management
- Formulate an operational programme (planning, study, project, review, action etc.) which will establish interagency working relationships so that management objectives are coordinated and mutually supportive
- Formulate an overall strategy which provides a long term vision for the future use, conservation and development of the lake
- Execute multi-dimensional and multi-disciplinary activities in collaboration with stakeholder government departments and communities living in and around the lake.
- Sustainable fisheries development to maintain / restore fish diversity and yield
- Control of siltation through catchment management in participatory manner
- Maintain / restore hydrological regimes by catchment conservation and appropriate allocation of water for ecosystem conservation and food security involving concerned stake holder agencies and communities
- Improve water quality through control of pollution and maintaining / restoration of hydrological regimes
- Biodiversity conservation of Wular Lake at genetic, species and at ecosystem levels.
- Control of invasive species and enhancing biodiversity

- Sustainable resource development within lake area and its catchments by promoting alternate / additional income generation programmes
- Promote eco-tourism development with the objective of lake conservation and providing benefits to the local community
- Collaboration with relevant institutions at state, national or international levels for all round development of the lake.
- Establishment of management information system for conservation and sustainable development of the lake.
- Carry out environmental impact assessment periodically to ensure lake conservation and sustainable use of lake resources
- Carry out hydrobiological monitoring of lake on scientific guidelines
- Upgrade the management and professional skills of the agencies associated with conservation and development of the lake.
- Acquire by gift, purchase, exchange, lease, hire or otherwise any property movable or immovable and to construct, improve, alter, demolish or repair and work as may be necessary or convenient for carrying on the activities of the authority
- Draw, accept, make and endorse for the purpose of the authority, discount and negotiate Government of India and other promissory notes, bills of exchange, cheques or other negotiable instruments.

Governing Body

The Governing Body for WDA should be set up under the chairmanship of Chief Minister / Chief Secretary. The members of the Authority may include the following:

- Secretaries - Departments of Forests and Wildlife, Revenue, Fisheries, Agriculture, Rural Development, Irrigation, and Science & Technology
- Chief Conservator of Forests & Wildlife
- Directors- Department of Fisheries and Tourism
- Chief Engineer, Irrigation
- Directors- Department of Science, Technology Environment and remote sensing
- Experts (2 / 3) drawn from universities / research institutions
- Local level MLAs
- Representative of Communities
- District Collector
- Member Convener – Head of the proposed Wular Development Authority
- Conservation NGO representative.

4.7.2 Capacity Building

Capacity building of WDA, concerned state government authorities and local communities is proposed to be undertaken through professional training in integrated lake management and managerial skills; water management, and community-based development programmes. Critical infrastructure for Lake Management including communication equipment and networking of offices should also be supported for effective functioning of the authority.

4.7.3 Communication, education and public awareness (CEPA)

CEPA will focus on mainstreaming of sustainable development of Wular Lake in awareness generation programmes. The main activities to be carried out are development of resource material, and organizing of nature camps.

Ecotourism development and CEPA will go hand in hand to generate awareness about the activities carried out under the programme and sensitize the people a various levels about the need for conservation and management of Wular Lake. Local clubs, and youth centers will be employed in organizing padyatras, rallies, and nature camps. The resource material such as posters, brochures, pamphlets, education kits, will be developed highlighting the sustainable development of Wular Lake and needs for its conservation. A newsletter will be periodically published to highlight the implementation of various activities under the present action plan. The specific activities to be undertaken are:

- Rallies, Padyatras seminars and workshops involving the local organizations, NGOs, CBOs and other stakeholders
- Nature Camps for school children

◊ Observation of World Wetlands Day and other special occasions

◊ Development of resource materials

- ➢ Posters
- ➢ Brochures
- ➢ Pamphlets
- ➢ Web site
- ➢ Education Kits

◊ Film on Wular Lake

◊ Publication of newsletter

4.7.4 Monitoring and Evaluation

a) Establishment of Lake Monitoring Laboratory

A state of the art lake monitoring laboratory is proposed to be established at Bandipore for monitoring of the ecological, hydrological and socio economic features of the lake ecosystem, and changes resulting through implementation of developmental activities. The monitoring laboratory shall be supported through a network of field stations established within the lake and its catchments. A list of necessary equipment to be procured for the monitoring center is at Annex VIII. A detailed monitoring schedule for hydrological and ecological features is presented at Annex IX.

Management of the lake monitoring center shall be done by a team of scientists under the supervision of a Senior Wetland Ecologist assisted by a team of limnologists/ aquatic ecologists, biologists, chemist, remote sensing and GIS specialists, hydrologists, ornithologists, micro biologists and wildlife specialists. A schematic organizational structure for the laboratory is presented at Annex X.

b) Management Action Plan Monitoring

Monitoring the effectiveness of management plan implementation is essential to assess the effectiveness of implementation and suggest mid term corrections to the plan, as and when necessary. A result based framework for assess the results of the action plan implementation at activity, output, outcome and impact level is proposed to be used for the purpose. Management plan monitoring should essentially be carried out through an independent agency, using a transparent methodology and with extensive involvement of communities within the target area. A consultative workshop should be organized at the beginning of project implementation to define a log frame in consultation with all stakeholders, with specific indicators at all result levels, risks and assumptions. The log frame should be periodically reviewed and updated to incorporate changes in implementation strategy.

5. Budget and Workplan

5. Budget and Workplan

An overall budget of Rs. 386.39 crores is proposed for implementation of the Comprehensive Management Action Plan for Wular Lake. Water management, which is critical to lake rejuvenation has been allocated 72% of the overall investment, followed by 10% for catchment conservation. Sustainable resource development and livelihood improvement has been allocated 7% of the budget. The components on biodiversity conservation and institutional development have been apportioned 4% each of the budget. Three percent of the budget is earmarked for ecotourism development. Component wise allocation is as follows:

Components		Amount (In Rupees Lakhs)
Land and Water Management		31,952.86
Survey and demarcation	225.00	
Catchment conservation	3,732.25	
Water management	27,995.60	
Biodiversity Conservation		1,372.00
Ecotourism Development		1,145.00
Sustainable Resource Development and Livelihood Improvement		2,579.50
Institutional Development		1,590.00
		38,639.36

Detailed activity wise budget along with their annual phasing is presented in following tables.

Management Action Plan - Budget (2007 - 11)

Components and Activities	Rate	Physical (2007 - 2011)	Financial (2007 - 11) (Rs. Lakhs)
1 Land and Water Resources Management			**31,952.86**
1.1 Survey and Demarcation			225
i Mapping and ground truthing			125
ii Boundary demarcation			100
1.2 Catchment Conservation			3,732.25
a) Treatment of degraded watersheds			**2,549.15**
i. Afforestation			929.50
Preparatory operations	12,000 per Ha	3,718.00 Ha	446.16
Plantation	5,000 per Ha	3,718.00 Ha	185.90
Maintenance for three years	8,000 per Ha	3,718.00 Ha	297.44
ii. Aided regeneration			306.79
Aided regeneration operation	6,000.00 per Ha	2,789.00 Ha	167.34
Maintenance for two years	5,000.00 per Ha	2,789.00 Ha	139.45
iii. Small scale engineering measures			1,312.86
Check dams			
DRSM	144,000 per Ha	470.00 Ha	676.80
Gunny bag	180,000 per Ha	75.00 Ha	135.00
Crate Wire dams	213,000 per Ha	70.00 Ha	149.10
Landslide control	16,200 per strct	762.00 srtct	123.44
Stream bank protection spurs	16,200 per Ha	200.00 Ha	32.40
Water harvesting structures	10,000 per strct	1,500.00 str	150.00
Vegetative spurs and plantations	LS		46.12
b) Management of high altitude pastures			**580.60**
i. Regeneration of degraded pastures			487.60
Fodder and forage plantation	10,000 per Ha	3,000.00 Ha	300.00
Small scale engineering measures			
Check dams			
DRSM	144,000 per Ha	20.00 Ha	28.80
Crate Wire dams	213,000 per Ha	20.00 Ha	42.60
Vegetative spur	10,000 per Ha	500.00 Ha	50.00
Stream bank protection spurs	16,200 per Ha	100.00 Ha	16.20
Gully plugging	10,000 per Ha	500.00 Ha	50.00
ii. Grazing Management			93.00
Silvipasture	10,000 per Ha	500.00 Ha	50.00
On farm fodder production	3,000 per Ha	600.00 Ha	18.00
Veterinary Health Support	LS		25.00
c) Management of horticulture and dry land agriculture			**252.50**
i. Promoting agro forestry	20,000 per Ha	1,000.00 Ha	200.00
ii. Improved management of homesteads	7,500 per Ha	100.00 Ha	7.50
iii. Promotion of sustainable horticulture practices	7,500 per Ha	600.00 Ha	45.00
d) Alternate source of energy			**350.00**
i. Development of village woodlots	10,000 per Ha	1,500.00 Ha	150.00
ii. Promotion of smokeless hearths	500 per unit	20,000.00 units	100.00
iii. Mini hydel project - Erin Watershed	LS		100.00
1.3 Water Management			**27,995.60**
a) Enhancing water holding capacity			**23,526.58**
a) Removal of Ningli Plantations	95 per tree	2,184,000 trees	2,074.80
b) Selective dredging of silted lake areas			
Willow plantation area	65 cum	11.20 MCM	7,278.38
Critically silted lake areas	65 cum	15.19 MCM	9,870.90
Channels	65 cum	0.15 MCM	97.50

Components and Activities	Rate	Physical (2007 - 2011)	Financial (2007 - 11) (Rs. Lakhs)	
c) Equipment augmentation				
Cut suction dredger incl slurry piping	70,000,000 per unit	5.00 units	3,500.00	
Motorized carriage tucks	50,000 per unit	10.00 units	5.00	
Hydraulic Excavators	10,000,000 per unit	3.00 units	300.00	
Multipurpose maintenance machines	10,000,000 per unit	2.00 units	200.00	
Weed harvesters	10,000,000 per unit	2.00 units	200.00	
b) Rejuvenation of associated wetlands				**23.35**
a) Hydraulic connectivity of marshes with Wular				
Rakh Malgom and Ajas :Desilting of Naz Nullah	250 cum	5,740.55 meters	14.35	
Rakh Haigam and Naugam : Desilting of Haritar	250 cum	3,600.00 meters	9.00	
c) Water Quality Improvement				**4,295.68**
a) Sewage management in urban peripheral towns of Wular				1,462.73
Construction of STP				
Capital costs				
Bandipore - 4 MLD			813.60	
Watlab - 0.5 MLD			90.00	
Nadihal - 1 MLD			200.00	
Operations and Maintenance for 5 years			288.00	
Community based solid waste management systems				
Markets	250,000 per unit	25.00	62.50	
Villages	34,500 per unit	25.00	8.63	
b) Low cost sanitation	15,000 per unit	18,600.00	2,790.00	2,790.00
c) Control of diffused pollution through wetland technology				42.95
Category A (200 HH)	216,640 per unit	3.00	6.50	
Category B (350 HH)	329,300 per unit	4.00	13.17	
Category C (900 HH)	775,960 per unit	3.00	23.28	
d) Allocation of water for human and ecological purposes				**150.00**
a) Environmental Flow Assessment	LS		100.00	
b) Implementation	LS		25.00	
c) Monitoring and Evaluation	LS		25.00	
2 Biodiversity Conservation				**1,372.00**
2.1 Waterbird Conservation				**952.00**
a) **Inventorization and assessment**				548.00
Species wise estimates of waterbird populations			58	
Water regimes assessment			10	
Key biodiversity assessment			25	
Human activities and their impacts			5	
Migration studies (bird banding and satellite and VHF tracking)			400	
Avian influenza surveillance			50	
b) **Strengthening existing network of protected areas**				40.00
Habitat restoration			20	
Rehabilitation of threatened / rare species			20	
c) **Control of poaching**				69.00
Strengthening protection staff			55	
Formation of bird protection committees			14	
d) **Networking with national / international treaties**			15	15.00
e) **Establishment of new bird sanctuaries**				100.00
Survey and demarcation			30	
Habitat inventorization and avifauna relationships			10	
Identification of critical species for protection			10	
Community consultation for compensation provisions			50	
f) **Monitoring and Research**			75	75.00
e) **Capacity building**				105.00
Training			30	
Infrastructure development			75	

Components and Activities	Rate		Physical (2007 - 2011)		Financial (2007 - 11) (Rs. Lakhs)	
2.2 Wildlife Conservation						**370**
a) Demarcation of proposed wildlife sanctuary					50	
b) Fencing exisiting sanctuaries					100	
c) Construction of rescue and rehabilitation centers	500,000	per cen	10	center	50.00	
d) Construction of breeding centers	10,000,000	per cen	1	center	100.00	
e) Land transport and patrolling					55	
f) Compensation for man-animal conflict victims					15	
2.3 Management of Aquatic Vegetation						**50.00**
a) **Optimization of EIPs**					25	25.00
b) **Control of invasive species**					25	25.00
3 Ecotourism Development						**1,145.00**
3.1 Development of recreational facilities						**300.00**
Board Walk and Nature Trails	1,000,000.00	per unit	2.00	units	20.00	
Guided boat rides	500,000.00	per unit	10.00	units	50.00	
Watch Towers	400,000.00	per unit	10.00	units	40.00	
Angling Spots	500,000.00	per unit	25.00	units	125.00	
Landscape Gardens	1,000,000.00	per unit	4.00	units	40.00	
Improving the sports facilities	LS				25.00	
3.2 Development of visitor education facilities						**480.00**
a) Hajan	12,000.00	per sqm	2,500	sqm	300.00	
b) Haigam	12,000.00	per sqm	1,500	sqm	180.00	
3.3 Infrastructure Development						**265.00**
a) Communication					100.00	
b) Accommodation	500,000	per unit	25	units	125.00	
c) Signage					25.00	
d) Boating	100,000.00	per boat	15	boats	15.00	
3.4 Publication of posters, brochures and booklets					**100.00**	**100.00**
4 Sustainable Resource Development and Livelihood Improvement						**2,579.50**
4.1 Sustainable Fisheries Development						**617.00**
a) Establishment of Schizothorax fish seed farm	10,000,000	per unit	3	unit	300.00	300.00
b) Auto recruitment enhancement					25.00	25.00
c) Restocking					25.00	25.00
d) Enhancement of culture fisheries						35.00
i. Construction of community owned hatcheries	300,000.00	per unit	5	units	15.00	
ii. Integrated farming	40,000.00	per ha	50	ha	20.00	
e) Improvement of fish harvesting and post harvesting infrastructure						**220.00**
i. Strengthening of landing centers	1,000,000.00	per center	9	centers	90.00	
ii. Provision of improvised crafts and gears	50,000.00	per set	50	sets	25.00	
iii. Enhancing live fish storage capacity						
Reshaping existing fish tanks					5.00	
Provision of new holding tanks					30.00	
iv. Post harvest management						
Construction of ice plants	500,000.00	per unit	4	units	20.00	
Establishment of fish processing unit	5,000,000.00	per unit	1	units	50.00	

Components and Activities	Rate		Physical (2007 - 2011)		Financial (2007 - 11) (Rs. Lakhs)	
f) **Strengthening fish cooperative societies**						12.00
i. Establishment of cooperative societies					2.00	
ii. Development of fisheries policy					5.00	
iii. Capacity building					5.00	
4.2 Economic utilization of aquatic vegetation						**10.00**
a) Establishment of vegetation based micro enterprise	100,000.00	per unit	10	units	10.00	10.00
4.3 Livelihood improvement						**1,952.50**
a) Micro enterprise for hill communities						**627.50**
i Mushroom cultivation	90,000.00	per unit	100	units	90.00	
ii Medicinal Plants	75,000.00	per unit	50	units	37.50	
iii Sericulture	150,000.00	per unit	50	units	75.00	
iv Apiculture	75,000.00	per unit	100	units	75.00	
v Minor Forest Produce based value added unit	1,000,000.00	per unit	35	units	350.00	
b) Micro enterprise for lakeshore communities						**725.00**
i Poultry development	100,000.00	per grp	100	grps	100.00	
ii Apiculture	75,000.00	per unit	100	units	75.00	
iii Natural dyes	500,000.00	per unit	50	units	250.00	
iv Floriculture	600,000.00	per unit	50	units	300.00	
c) Improvement of quality of life						**600.00**
i Safe drinking water	500,000.00	per unit	100	units	500.00	
ii Strengthening rural markets	1,000,000.00	per mkt	10	mkt	100.00	
5 Institutional Development						**1,590.00**
5.1 Establishment of Wular Development Authority					10.00	**10.00**
5.2 Capacity Building						**200.00**
i Training						
WDA and other concerned government agencies					65	
Communities					15	
ii Infrastructure Development					120	
5.3 Communication, education and awareness generation						**130.00**
Rallies and Padyatras					5	
Nature Camps					10	
World Wetland Day and other special occasions					15	
Film on Wular					50	
Newsletters and special publications					50	
5.3 Monitoring and Evaluation						**1,250.00**
i. Inventorisation and assessment						
Establishment of Lake Monitoring Laboratory					-	
Building					150	
Equipment					600	
Vehicles and Boats					100	
Personnel					150	
Monitoring					150	
ii Management Plan monitoring					100	
						38,639.36

WorkPlan

Components and Activities	2007	2008	2009	2010	2011
1 Land and Water Resources Management					
1.1 Survey and Demarcation					
i Mapping and ground truthing					
ii Boundary demarcation					
1.2 Catchment Conservation					
a) Treatment of degraded watersheds					
i. Afforestation					
ii. Aided regeneration					
iii. Small scale engineering measures					
b) Management of high altitude pastures					
i. Regeneration of degraded pastures					
ii. Grazing Management					
c) Management of horticulture and dry land agriculture					
i. Promoting agro forestry					
ii. Improved management of homesteads					
iii. Promotion of sustainable horticulture practices					
d) Alternate source of energy					
i. Development of village woodlots					
ii. Promotion of smokeless hearths					
iii. Mini hydel project - Erin Watershed					
1.3 Water Management					
a) Enhancing water holding capacity					
a) Removal of Ningli Plantations					
b) Selective dredging of silted lake areas					
c) Equipment augmentation					
b) Rejuvenation of associated wetlands					
a) Hydraulic connectivity of marshes with Wular					
c) Water Quality Improvement					
a) Sewage management in urban peripheral towns of Wular Construction of STP					

Components and Activities	2007	2008	2009	2010	2011
Community based solid waste management systems					
b) Low cost sanitation					
c) Control of diffused pollution through wetland technology					
d) Allocation of water for human and ecological purposes					
a) Environmental Flow Assessment					
b) Implementation					
c) Monitoring and Evaluation					
2 Biodiversity Conservation					
2.1 Waterbird Conservation					
a) **Inventorization and assessment**					
b) **Strengthening existing network of protected areas**					
c) **Control of poaching**					
d) **Networking with national / international treaties**					
e) **Establishment of new bird sanctuaries**					
f) **Monitoring and Research**					
e) **Capacity building**					
2.2 Wildlife Conservation					
a) Demarcation of proposed wildlife sanctuary					
b) Fencing exisiting sanctuaries					
c) Construction of rescue and rehabilitation centers					
d) Construction of breeding centers					
e) Land transport and patrolling					
f) Compensation for man-animal conflict victims					
2.3 Management of Aquatic Vegetation					
a) **Optimization of EIPs**					
b) **Control of invasive species**					
3 Ecotourism Development					
3.1 Development of recreational facilities					
3.2 Development of visitor education facilities					
3.3 Infrastructure Development					
3.4 Publication of posters, brochures and booklets					
4 Sustainable Resource Development and Livelihood Improvement					

Components and Activities	2007	2008	2009	2010	2011
4.1 Sustainable Fisheries Development					
a) Establishment of Schizothorax fish seed farm					
b) Auto recruitment enhancement					
c) Restocking					
d) Enhancement of culture fisheries					
e) Improvement of fish harvesting and post harvesting infrastructure					
f) Strengthening fish cooperative societies					
4.2 Economic utilization of aquatic vegetation					
a) Establishment of vegetation based micro enterprise					
4.3 Livelihood improvement					
a) Micro enterprise for hill communities					
b) Micro enterprise for lakeshore communities					
c) Improvement of quality of life					
5 Institutional Development					
5.1 Establishment of Wular Development Authority					
5.2 Capacity Building					
5.3 Communication, education and awareness generation					
5.3 Monitoring and Evaluation					

Management Action Plan - Yearwise Physical and Financial Phasing (2007 - 11)

Components and Activities	Year 1		Year 2		Year 3		Year 4		Year 5	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
1 Land and Water Resources Management		**7,614.77**		**12,437.74**		**7,669.80**		**3,998.12**		**182.44**
1.1 Survey and Demarcation		175.00		50.00						
i Mapping and ground truthing		100.00		25.00						
ii Boundary demarcation		75.00		25.00						
1.2 Catchment Conservation		**701.67**		**1,216.35**		**1,250.06**		**458.73**		**105.44**
a) Treatment of degraded watersheds		**626.67**		**794.29**		**860.85**		**161.90**		**105.44**
i. Afforestation										
Preparatory operations	1200	144.00	1200	144.00	1318	158.16		-		
Plantation			1200	60.00	1200	60.00	1318	66		
Maintenance for three years					1200	96.00	1200	96	1318	105.44
ii. Aided regeneration										
Aided regeneration operation	1300	78.00	1489	89.34						
Maintenance for two years			1300	65.00	1489	74.45				
iii. Small scale engineering measures										
Check dams										
DRSM	150	216.00	150	216.00	170	244.80				
Gunny bag	25	45.00	25	45.00	25	45.00				
Crate Wire dams	25	53.25	25	53.25	20	42.60				
Landslide control	100	16.20	300	48.60	362	58.64				
Stream bank protection spurs	50	8.10	50	8.10	100	16.20				
Water harvesting structures	500	50.00	500	50.00	500	50.00				
Vegetative spurs and plantations		16.12		15.00		15.00				
b) Management of high altitude pastures				**206.56**		**198.71**		**175.33**		
i. Regeneration of degraded pastures										
Fodder and forage plantation			1000	100.00	1000	100.00	1000	100.00		
Small scale engineering measures										
Check dams										
DRSM			10	14.40	5	7.20	5	7.20		
Crate Wire dams			10	21.30	5	10.65	5	10.65		
Vegetative spur			200	20.00	200	20.00	100	10.00		
Stream bank protection spurs			30	4.86	30	4.86	40	6.48		
Gully plugging			100	10.00	200	20.00	200	20.00		
ii. Grazing Management										
Silvipasture			200	20.00	200	20.00	100	10.00		
On farm fodder production			200	6.00	200	6.00	200	6.00		
Veterinary Health Support				10.00		10.00		5.00		

Components and Activities	Year 1		Year 2		Year 3		Year 4		Year 5	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
c) Management of horticulture and dry land agriculture				**78.00**		**78.00**		**96.50**		
i. Promoting agro forestry			300	60.00	300	60.00	400	80.00		
ii. Improved management of homesteads			40	3.00	40	3.00	20	1.50		
iii. Promotion of sustainable horticulture practices			200	15.00	200	15.00	200	15.00		
d) Alternate source of energy		**75.00**		**137.50**		**112.50**		**25.00**		
i. Development of village woodlots	500	50.00	500	50.00	500	50.00				
ii. Promotion of smokeless hearths	5000	25.00	7500	37.50	2500	12.50	5000	25.00		
iii. Mini hydel project - Erin Watershed				50.00		50.00				
1.3 Water Management		**6,738.10**		**11,221.39**		**6,419.73**		**3,539.39**		**77.00**
a) Enhancing water holding capacity		**5,329.80**		**10,048.37**		**5,395.00**		**2,753.41**		
a) Removal of Ningli Plantations	1184000	1,124.80	1000000	950.00						
b) Selective dredging of silted lake areas										
Willow plantation area			7	4,548.37	4.2	2,730.00				
Critically silted lake areas			7	4,550.00	4	2,600.00	4.19	2720.90		
Channels					0.1	65.00	0.05	32.51		
c) Equipment augmentation										
Cut suction dredger incl slurry piping	5.00	3,500.00								
Motorized carriage tucks	10.00	5.00								
Hydraulic Excavators	3.00	300.00								
Multipurpose maintenance machines	2.00	200.00								
Weed harvesters	2.00	200.00								
b) Rejuvenation of associated wetlands				**8.50**		**10.10**		**4.75**		
a) Hydraulic connectivity of marshes with Wular										
Rakh Malgom and Ajas :Desilting of Naz Nullah			2500	6.25	2240.55	5.60	1000	2.50		
Rakh Haigam and Naugam : Desilting of Haritar Nullah			900	2.25	1800	4.50	900	2.25		
c) Water Quality Improvement		**1,308.30**		**1,139.52**		**999.63**		**776.23**		**72.00**
a) Sewage management in urban peripheral towns of Wular										
Construction of STP										
Capital costs										
Bandipore - 4 MLD		406.80		203.40		203.40				
Watlab - 0.5 MLD		45.00		22.50		22.50				
Nadihal - 1 MLD		100.00		50.00		50.00				
Operations and Maintenance for 5 years				72.00		72.00		72.00		72
Community based solid waste management systems										
Markets			10	25.00	10	25.00	5	12.50		
Villages			10	3.45	10	3.45	5	1.73		
b) Low cost sanitation	5000	750.00	5000	750.00	4000	600.00	4600	690.00		

Components and Activities	Year 1		Year 2		Year 3		Year 4		Year 5	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
c) Control of diffused pollution through wetland technology										
Category A (200 HH)	3	6.50								
Category B (350 HH)			4	13.17						
Category C (900 HH)					3	23.28				
d) Allocation of water for human and ecological purposes		**100.00**		**25.00**		**15.00**		**5.00**		**5.00**
a) Environmental Flow Assessment		100.00								
b) Implementation				25.00						
c) Monitoring and Evaluation						15.00		5.00		5
2 Biodiversity Conservation		**322.00**		**408.00**		**269.00**		**194.00**		**179.00**
2.1 Waterbird Conservation		**214.00**		**245.00**		**171.00**		**161.00**		**161.00**
a) **Inventorization and assessment**										
Species wise estimates of waterbird populations		14.00		11.00		11.00		11.00		11.00
Water regimes assessment		2.00		2.00		2.00		2.00		2.00
Key biodiversity assessment		5.00		5.00		5.00		5.00		5.00
Human activities and their impacts		1.00		1.00		1.00		1.00		1.00
Migration studies (bird banding and satellite and VHF tracking)		80.00		80.00		80.00		80.00		80.00
Avian influenza surveillance		10.00		10.00		10.00		10.00		10.00
b) **Strengthening existing network of protected areas**										
Habitat restoration				5.00		5.00		5.00		5.00
Rehabilitation of threatened / rare species				5.00		5.00		5.00		5.00
c) **Control of poaching**										
Strengthening protection staff		25.00		10.00		10.00		5.00		5.00
Formation of bird protection committees		3.00		2.00		3.00		3.00		3.00
d) **Networking with national / international treaties**		3.00		3.00		3.00		3.00		3.00
e) **Establishment of new bird sanctuaries**										
Survey and demarcation		20.00		10.00						
Habitat inventorization and avifauna relationships		5.00		5.00						
Identification of critical species for protection		5.00		5.00						
Community consultation for compensation provisions				50.00						
f) **Monitoring and Research**		15.00		15.00		15.00		15.00		15.00
e) **Capacity building**										
Training		6.00		6.00		6.00		6.00		6.00
Infrastructure development		20.00		20.00		15.00		10.00		10.00
2.2 Wildlife Conservation		**98.00**		**153.00**		**88.00**		**23.00**		**8.00**
a) Demarcation of proposed wildlife sanctuary		25.00		25.00						
b) Fencing exisiting sanctuaries		50.00		25.00		25.00				
c) Construction of rescue and rehabilitation centers			4.00	20.00	3.00	15.00	3.00	15.00		

Components and Activities	Year 1		Year 2		Year 3		Year 4		Year 5	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
d) Construction of breeding centers				60.00		40.00				
e) Land transport and patrolling		20.00		20.00		5.00		5.00		5.00
f) Compensation for man-animal conflict victims		3.00		3.00		3.00		3.00		3.00
2.3 Management of Aquatic Vegetation		**10.00**		**10.00**		**10.00**		**10.00**		**10.00**
a) **Optimization of EIPs**		5.00		5.00		5.00		5.00		5.00
b) **Control of invasive species**		5.00		5.00		5.00		5.00		5.00
3 Ecotourism Development		**108.00**		**563.00**		**363.00**		**96.00**		**15.00**
3.1 Development of recreational facilities		**78.00**		**98.00**		**93.00**		**31.00**		-
Board Walk and Nature Trails			1	10.00	1	10.00				
Guided boat rides			2	10.00	8	40.00				
Watch Towers	2	8.00	2	8.00	2	8.00	4	16.00		
Angling Spots	10	50.00	10	50.00	5	25.00				
Landscape Gardens	2	20.00	2	20.00						
Improving the sports facilities						10.00		15.00		
3.2 Development of visitor education facilities		-		**320.00**		**160.00**		-		-
a) Hajan				200.00		100.00				
b) Haigam				120.00		60.00				
3.3 Infrastructure Development		**20.00**		**105.00**		**90.00**		**50.00**		-
a) Communication		20.00		50.00		30.00				
b) Accommodation			8	40.00	8	40.00	9	45.00		
c) Signage				15.00		5.00		5.00		
d) Boating					15	15.00				
3.4 Publication of posters, brochures and booklets		**10.00**		**40.00**		**20.00**		**15.00**		**15**
4 Sustainable Resource Development and Livelihood Improve		**623.50**		**656.50**		**484.50**		**422.50**		**392.50**
4.1 Sustainable Fisheries Development		**201.00**		**234.00**		**112.00**		**50.00**		**20.00**
a) **Establishment of Schizothorax fish seed farm**		**150.00**		**150.00**						
b) **Auto recruitment enhancement**		**5.00**		**5.00**		**5.00**		**5.00**		**5.00**
c) **Restocking**		**5.00**		**5.00**		**5.00**		**5.00**		**5.00**
d) **Enhancement of culture fisheries**		-		**13.00**		**14.00**		**4.00**		**4.00**
i. Construction of community owned hatcheries			3	9.00	2	6.00				
ii. Integrated farming			10	4.00	20	8.00	10	4.00	10	4
e) **Improvement of fish harvesting and post harvesting infrastructure**		**40.00**		**55.00**		**85.00**		**35.00**		**5.00**

Components and Activities	Year 1		Year 2		Year 3		Year 4		Year 5	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
i. Strengthening of landing centers	3	30.00	3	30.00	3	30.00				
ii. Provision of improvised crafts and gears		5.00		5.00		5.00		5.00		5
iii. Enhancing live fish storage capacity										
Reshaping existing fish tanks		5.00								
Provision of new holding tanks				10.00		10.00		10.00		
iv. Post harvest management										
Construction of ice plants			2	10.00	2	10.00				
Establishment of fish processing unit						30.00		20.00		
f) Strengthening fish cooperative societies		**1.00**		**6.00**		**3.00**		**1.00**		**1.00**
i. Establishment of cooperative societies				2.00						
ii. Development of fisheries policy				3.00		2.00				
iii. Capacity building		1.00		1.00		1.00		1.00		1
4.2 Economic utilization of aquatic vegetation		**2.00**		**2.00**		**2.00**		**2.00**		**2.00**
a) Establishment of vegetation based micro enterprise		2.00		2.00		2.00		2.00		2
4.3 Livelihood Improvement		**420.50**		**420.50**		**370.50**		**370.50**		**370.50**
a) Micro enterprise for hill communities		**155.50**		**155.50**		**105.50**		**105.50**		**105.50**
i Mushroom cultivation	20	18.00	20	18.00	20	18.00	20	18.00	20	18.00
ii Medicinal Plants	10	7.50	10	7.50	10	7.50	10	7.50	10	7.50
iii Sericulture	10	15.00	10	15.00	10	15.00	10	15.00	10	15.00
iv Apiculture	20	15.00	20	15.00	20	15.00	20	15.00	20	15.00
v Minor Forest Produce based value added unit	10	100.00	10	100.00	5	50.00	5	50.00	5	50.00
b) Micro enterprise for lakeshore communities		**145.00**		**145.00**		**145.00**		**145.00**		**145.00**
i Poultry development	20	20.00	20	20.00	20	20.00	20	20.00	20	20.00
ii Apiculture	20	15.00	20	15.00	20	15.00	20	15.00	20	15.00
iii Natural dyes	10	50.00	10	50.00	10	50.00	10	50.00	10	50.00
iv Floriculture	10	60.00	10	60.00	10	60.00	10	60.00	10	60.00
c) Improvement of quality of life		**120.00**		**120.00**		**120.00**		**120.00**		**120.00**
i Safe drinking water	20	100.00	20	100.00	20	100.00	20	100.00	20	100.00
ii Strengthening rural markets	2	20.00	2	20.00	2	20.00	2	20.00	2	20.00
5 Institutional Development		**357.00**		**701.00**		**324.00**		**104.00**		**104.00**

Components and Activities	Year 1		Year 2		Year 3		Year 4		Year 5	
	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial	Physical	Financial
5.1 Establishment of Wular Development Authority		**8.00**		**2.00**						
5.2 Capacity Building		**78.00**		**78.00**		**28.00**		**8.00**		**8.00**
i Training										
WDA and other concerned government agencies		25.00		25.00		5.00		5.00		5
Communities		3.00		3.00		3.00		3.00		3
ii Infrastructure Development		50.00		50.00		20.00				
5.3 Communication, education and awareness generation		**41.00**		**41.00**		**16.00**		**16.00**		**16.00**
Rallies and Padyatras		1.00		1.00		1.00		1.00		1.00
Nature Camps		2.00		2.00		2.00		2.00		2.00
World Wetland Day and other special occasions		3.00		3.00		3.00		3.00		3.00
Film on Wular		25.00		25.00						
Newsletters and special publications		10.00		10.00		10.00		10.00		10.00
5.3 Monitoring and Evaluation		**230.00**		**580.00**		**280.00**		**80.00**		**80.00**
I. Inventorisation and assessment										
Establishment of Lake Monitoring Laboratory										
Building		150.00								
Equipment				400.00		200.00				
Vehicles and Boats				100.00						
Personnel		30.00		30.00		30.00		30.00		30.00
Monitoring		30.00		30.00		30.00		30.00		30.00
ii Management Plan monitoring		20.00		20.00		20.00		20.00		20.00
		9,025.27		**14,766.24**		**9,110.30**		**4,814.62**		**872.94**

5.2 Economic Analysis

Economic analysis of the Management Action Plan has been carried out to assess the overall efficiency of investment. Assessment of costs and benefits has been carried out using the tools of market and non market evaluation. Estimation of Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio of the proposed investment has been carried out for assessment of investment efficiency.

5.2.1 Project Costs and Benefits

The overall investment into MAP which includes the cost of manpower, equipment and other resources to be used for implementation of the activities has been taken as the project costs. Costing of activities is based on the current schedule of rates provided by the Department of Forests, prevalent norms of Government of India, existing market rates, and implementation of similar activities within Kashmir valley. The annualized cash flow for the project is presented in Table 5.1:

Table 5.1: Project Annualized Cash Flow

	Survey and Demarcation	*Catchment Cons.*	*Water Mgt*	*Biodiversity Cons.*	*Ecotourism Dev.*	*Sustainable Resource Dev. and Livelihood Imp.*	*Institutional Dev.*	*Component Costs*
Year 1	175.00	701.67	6,738.10	322.00	108.00	623.50	357.00	9,025.27
Year 2	50.00	1,216.35	11,221.39	408.00	563.00	656.50	701.00	14,816.24
Year 3	-	1,250.06	6,419.73	269.00	363.00	484.50	324.00	9,110.30
Year 4	-	458.73	3,539.39	194.00	96.00	422.50	104.00	4,814.62
Year 5	-	105.44	77.00	179.00	15.00	392.50	104.00	872.94
	225.00	**3,732.25**	**27,995.61**	**1,372.00**	**1,145.00**	**2,579.50**	**1,590.00**	**38,639.36**

As can be seen from fig 5.1, of the total investment, 60% of the investment is concentrated in th first 2 years of project implementation, with 23% being in the first year and 37% in the second year, primarily into interventions for restoration of hydrological regimes. This will be followed by gradually declining investments of 24%, 13% and 2% in the last three years of implementation.

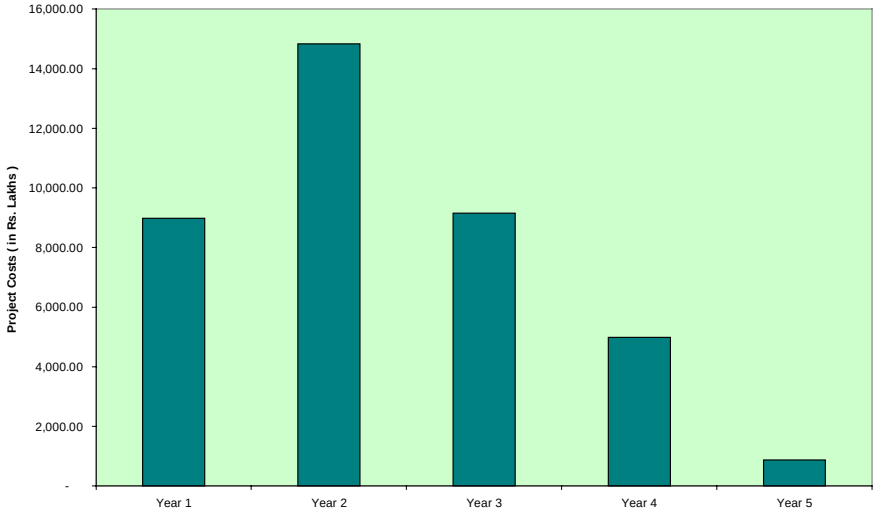


Fig. 5.1 Phasing of project costs

Benefits through implementation of management action plan are defined as the incremental traded and non traded output valued using tools of market and non market valuation. The following benefits are envisaged through implementation of the MAP:

Ecological

- Reduction in overall soil loss from degraded watersheds through enhancement of dense forest cover to 40% of direct catchment area, reduction in area under degraded pastures and erosion enhancing agro practices to less than 1% of the catchment area and reducing harvest of fuel wood by 50%
- Rejuvenation of hydrological functions of Wular lake through 54% enhancement to present water holding capacity and restoration of hydrological connectivity to the marshes
- Water quality of Wular improved to B category as per CPCB designated best use criteria through management of sewage and sewerage from adjoining settlements and water quality regulations
- Allocation of water for human and ecological purposes through formulation and operationalization of stakeholder endorsed water management plan
- Enhancement of biodiversity through wildlife waterbird conservation
- Enhancement of water bird population through control of poaching, strengthening existing protected area network and habitat improvement
- Optimization of economically important plant species through water level enhancement
- Control of invasive species through effective flushing of lake

Socioeconomic

- Enhanced availability of 0.33 Mcum of small timber, 0.55 Mcum of firewood and 2,200 cum of leaf fodder to 8,500 hill households through restocking of 7,436 ha of degraded forests and agro forestry in 1,000 ha of croplands/ homesteads
- Enhanced availability of 800 MT of fuelwood to 32,000 lakeshore households through development of 500 ha of village woodlots
- Reduced fuelwood consumption by 30% through usage of fuel saving hearths by 4,000 hill and 16,000 lakeshore households
- Enhancement of annual capture fisheries production by 800 MT and culture fish yield by 1300 MT leading to an increase in annual income by Rs. 34,000 for 2,300 fisher households
- Community led management of lake fisheries and aquatic vegetation resources through establishment and operationalization of 24 cooperatives
- Enhanced access to fisheries infrastructure (landing, storage and processing facilities) to 2,200 fisher households through strengthening of 9 landing centers and creation of 4 fish processing and value addition units around Wular Lake
- Enhanced incomes of 6,000 hill and 8,200 lakeshore households by Rs. 35,000 / annum through operationalization of micro enterprise based on sustainable use of locally available natural resources
- Improved quality of life of 18,600 household through access to safe sanitation and drinking water facilities
- Opportunities of livelihood diversification to 8,000 lakeshore households through development of ecotourism

Institutional

- Establishment of an integrated policy framework for conservation and development of Wular and associated wetland
- Establishment of separate and accountable funding mechanism for conservation and management of Wular

- Enhanced awareness of decision makers and stakeholders on values, functions and attributes of Wular
- Enhanced technical and managerial capacity of WDA, government agencies and communities to implement wetland conservation and management initiatives
- Establishment of monitoring mechanisms for implementation of Action Plan

For the purpose of economic assessment, the following direct benefits have been accounted for:

Project Benefit	Valuation Methodology	Assumptions
Enhanced availability of fuelwood through development of village woodlots	Market Price Method	1. 1 ha of village woodlot has 200 trees with an annual dry fuelwood out turn of 8 quintals, with full production capacity achieved after 10 years. 2. Market rate of fuelwood is Rs. 200 / qtl 3. Annual productivity of Ningli plantation is 0.45 qtls/ ha which would be lost due to its removal (Source : Working Plan, Ningli Forest Circle)
Enhanced availability of timber, firewood and leaf fodder	Market Price Method	1. Tree cover is fully established in a period of 8 years and provides timber and NTFPs benefits 2. Tree cover established under afforestation programme provides 10 cum/ha of small timber;15 cum/ha of fuelwood and 0.15 cum of lead fodder. 3. Productivity under agroforestry programmes is 5 cum /ha of small timber, 7.5 cum/ha of firewood, and 0.07 cum/ha of leaf fodder
Enhancement of capture fisheries	Market Price Method	1. 50% of the produce from fish seed farms in used for lake restocking 2. There is a 40% mortality of fish seeds when restocked in lake 3. Policies for prevention of catching fingerlings are in place 4. Fish is sold at an average market rate of Rs. 50/kg
Additional income generation through micro enterprise development	Market Price Method Value of output through micro enterprise	1. The enterprise is operationalized and sustains its operations within six years
Additional income generation through ecotourism	Incremental Income	1. There is a 5% annual growth in tourist inflow to Kashmir 2. Wular and associated wetlands are able to attract 10% of the tourist inflow to the state 3. An incremental expenditure of Rs. 1500 per head is made by a tourist which is shared by travel, accommodation and local expenses heads, and is realized by the local economy

The cumulative net present benefit from the project derived using a discount rate of 5% is as follows:

Table 5.2 : Project Benefits

	Catchment Conservation	Fisheries Development	Livelihoods Improvement	Tourism Development	Cumulative Benefits (Rs. Lakhs)
1	(2.59)	-		-	(2.59)
2	(1.79)	-	-	-	(4.38)
3	(0.59)	-	-	-	(4.97)
4	1.01	99.84	954.84	-	1,050.73
5	2.41	166.41	1,021.41	1,414.85	3,655.80
6	3.21	277.34	1,132.34	1,485.59	6,554.29
7	5.01	462.24	1,317.24	1,559.87	9,898.65
8	6.61	770.40	1,625.40	1,637.86	13,938.93
9	9.41	1,284.00	2,139.00	1,719.76	19,091.09
10	11.41	1,284.00	2,139.00	1,805.75	24,331.25
11	12.81	1,284.00	2,139.00	2,844.05	30,611.11
12	13.21	1,284.00	2,139.00	2,986.25	37,033.57
13	13.41	1,284.00	2,139.00	3,135.57	43,605.55
14	13.41	1,284.00	2,139.00	3,292.34	50,334.30
15	13.41	1,284.00	2,139.00	3,456.96	57,227.67
16	13.41	1,284.00	2,139.00	4,839.74	65,503.83
17	13.41	1,284.00	2,139.00	6,352.17	75,292.40
18	13.41	1,284.00	2,139.00	6,669.77	85,398.58
19	13.41	1,284.00	2,139.00	7,003.26	95,838.26
20	13.41	1,284.00	2,139.00	7,353.43	106,628.09

An appraisal of project costs and benefits indicates that the overall investment would translate into pecuniary gains to the communities within 12 years of project implementation (Fig 5.2). This gestation period is primarily due to the lag in project benefits which are contingent primarily on restoration of hydrological regimes, which would then provide conducive environment for enhancement of resource base and development of ecotourism. In terms of composition of benefits, ecotourism would remain the largest driver contributing 40% of the overall benefits, followed by resource based micro enterprise and fisheries

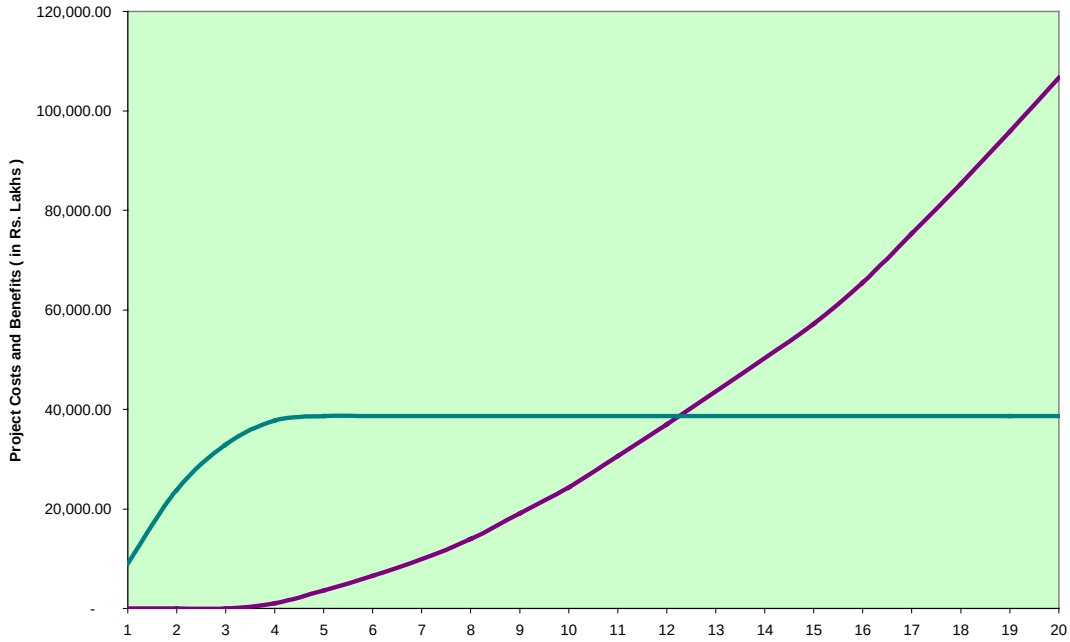


Fig 5.2: Project Costs and Benefits

5.2.2 Project Efficiency

Based on the assessment of project cost and local benefit flows, the following indicators have been assessed to determine the overall efficiency of the project investment:

Benefit Cost Ratio

For a project to be acceptable, the discounted valve of its benefits should exceed the discounted value of its costs . The benefit costs ratio for the present investment has been estimated as follows:

$$BCR = \frac{\sum_t (B(t))/(1+r)^t}{\sum_t (C(t)/(1+r)^t}$$

Where, BCR is the benefit cost ratio, B(t) and C(t) are the stream of project incremental costs and benefits , r is the rate of discount (5% for the present analysis) and t is the number of years from the base year. The BCR for the project at 20 years is 2.74/

Net Present Value

The Net Present Value of the project indicates the net return of the investment and has been estimated as following:

$$NPV = \sum_t (B(t) - C(t)/(1+r)^t$$

The NPV of the project at 20 years is Rs. 101.40 Lakhs.

Internal Rate of Return

The internal rate of return of the investment indicates the rate of return at which the project benefits equal the project costs, and has been estimated as following:

$$NPV = \sum_{t} (B(t) - C(t))/(1+r)^{t} = 0$$

Where, r represents the internal rate of return. The internal rate of return for the project investment is 6% at the end of 20 years

Positive IRR and NPV values and a BCR >1 indicate the strong economic efficiency of the investment. The project is expected to break even within a period of 12-13 years and achieve 80% of targeted benefits within a period of 16 years.

5.2.3 Sensitivity Analysis

Sensitivity analysis has been carried out to assess the economic feasibility of project implementation in various scenarios of changes in cost and benefit schedules. For the purpose of assessment, a 20% deviation in costs and benefits has been assumed. The sensitivity analysis matrix indicates that the benefit cost ratio remains positive under all circumstances, and ranges between 1.84 to 4.14. The net project NPV also remains positive and ranges between 46.10 – 144.73 crores. The IRR remains positive expect in the situations wherein the costs increase by 20% and the benefits decrease by 20%. The impact of these changes on the break even point of the project is presented in Fig 5.3, which indicates that the break even point is likely to shift from 10 to 15 years due to the anticipated changes.

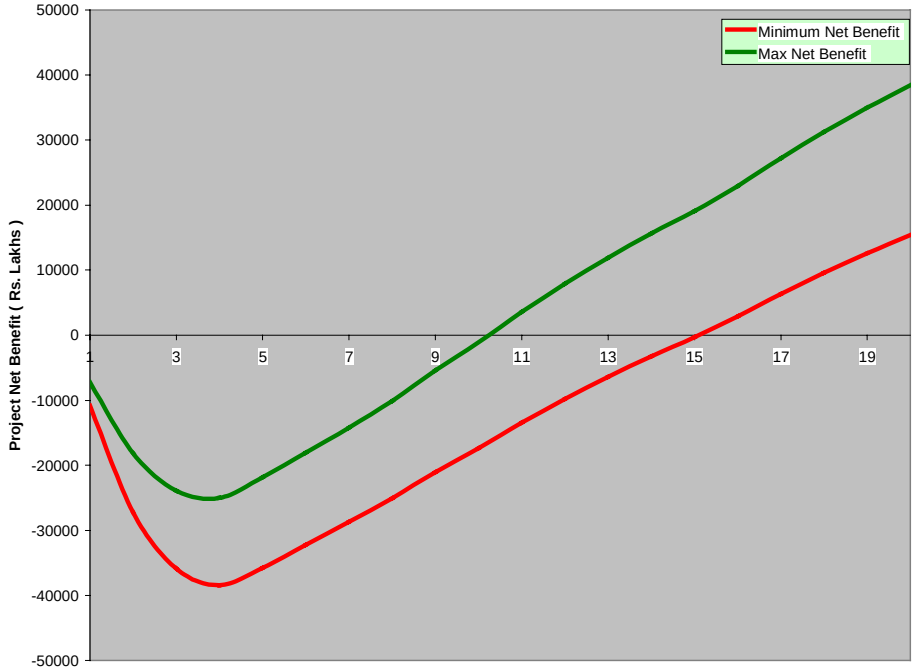


Fig 5.3 : Changes in project break even point

5.2.4 Risk Analysis

Risk analysis was carried out to assess the overall impacts of the changes in project costs and benefit flows. The analysis takes the variables to which the project is most sensitive and simulates simultaneous variations in each, using the probability that such a variation will occur, and results in description of the risk profile of the project. Probability weighted changes in NPV arising of a variation in local benefit and / or cost streams has been simulated 100 times using random numbers at ranges specified in the basic data. Fig 5.4. The table indicates that the probability of having a positive NPV at the best estimates is high, i.e. 62%. This is also substantiated by the clustering of the expected NPVs towards the positive segment of the frequency distribution.

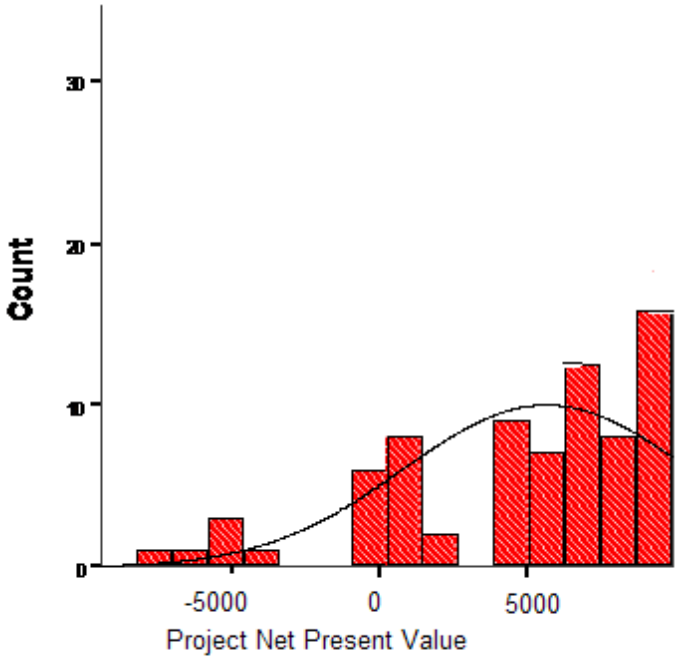


Fig 5.4 : Distribution of simulated project Net Present Values

Annexes

Annex I

Checklist of waterbird species of India and the Jhelum River Basin

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]	CAF AP Species[8]
1	Arctic Loon	*Gavia arctica*	WM	V						II	1
2	Little Grebe	*Tachybaptus ruficollis*	R/LM	C	R	C		IV			1
3	Red-necked Grebe	*Podiceps grisegena*	WM	UC				IV		II	1
4	Great Crested Grebe	*Podiceps cristatus*	R/WM	UC				IV			1
5	Horned Grebe	*Podiceps auritus*	WM	V				IV			1
6	Black-necked Grebe	*Podiceps nigricollis*	WM/R	R				IV			1
7	Great White Pelican	*Pelecanus onocrotalus*	R/WM	LC				IV		I,II	1
8	Dalmatian Pelican	*Pelecanus crispus*	WM	R			VU	IV			1
9	Spot-billed Pelican	*Pelecanus philippensis*	R/LM	LC			VU	IV	I	I,II	
10	Little Cormorant	*Phalacrocorax niger*	R/LM	C				IV			1
11	Indian Cormorant	*Phalacrocorax fuscicollis*	R/LM	C				IV			1
12	Great Cormorant	*Phalacrocorax carbo*	R/WM	C	WM	VR		IV			1
13	Oriental Darter	*Anhinga melanogaster*	R/LM	LC			NT	IV			1
14	Little Egret	*Egretta garzetta*	R/LM	C	R	C		IV			1
15	Western Reef-egret	*Egretta gularis*	R/LM	R				IV			1
16	Pacific Reef-egret	*Egretta sacra*	R	R				IV			1
17	Grey Heron	*Ardea cinerea*	R/WM	LC	R	C		IV			1
18	Goliath Heron	*Ardea goliath*		V				IV			1
19	White-bellied Heron	*Ardea insignis*	R	VR			EN	IV			1
20	Purple Heron	*Ardea purpurea*	R/LM	LC				IV			1
21	Great Egret	*Casmerodius albus*	R/LM	LC				IV			1
22	Intermediate Egret	*Mesophoyx intermedia*	R/LM	LC				IV			1
23	Cattle Egret	*Bubulcus ibis*	R/LM	C	R	C		IV			1
24	Indian Pond-heron	*Ardeola grayii*	R/LM	C	R	C		IV			1

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]	CAF AP Species[8]
25	Chinese Pond-heron	*Ardeola bacchus*						IV			
26	Striated Heron	*Butorides striatus*	R	R				IV			1
27	Black-crowned Night-heron	*Nycticorax nycticorax*	R/LM	LC	R	C		IV			1
28	Malaysian Night-heron	*Gorsachius melanolophus*	R	R				IV			1
29	Little Bittern	*Ixobrychus minutus*	R/LM	R	SM	C		IV			1
30	Yellow Bittern	*Ixobrychus sinensis*	R/LM	UC				IV			1
31	Cinnamon Bittern	*Ixobrychus cinnamomeus*	R/LM	LC				IV			1
32	Black Bittern	*Ixobrychus flavicollis*	R/LM	UC				IV			1
33	Great Bittern	*Botaurus stellaris*	WM	R				IV		II	1
34	Painted Stork	*Mycteria leucocephala*	R/LM	LC			NT	IV			1
35	Asian Openbill	*Anastomus oscitans*	R/LM	LC				IV			1
36	Black Stork	*Ciconia nigra*	WM	UC				IV	II	II	1
37	Woolly-necked Stork	*Ciconia episcopus*	R	R				IV		II	1
38	White Stork	*Ciconia ciconia*	WM	LC	PM	VR		IV		II	1
39	Oriental Stork	*Ciconia boyciana*	WM	R			EN	I	I	I	1
40	Black-necked Stork	*Ephippiorhynchus asiaticus*	R	R			NT	IV			1
41	Lesser Adjutant	*Leptoptilos javanicus*	R/LM	R			VU	IV			1
42	Greater Adjutant	*Leptoptilos dubius*	R/LM	R			EN	IV			1
43	Glossy Ibis	*Plegadis falcinellus*	R/LM/WM	UC				IV		II	1
44	Black-headed Ibis	*Threskiornis melanocephalus*	R/LM	LC			NT	IV			1
45	Red-naped Ibis	*Pseudibis papillosa*	R	UC				IV			1
46	Eurasian Spoonbill	*Platalea leucorodia*	R	LC				I	II	II	1
47	Greater Flamingo	*Phoenicopterus roseus*	R/LM/WM	LC				IV			1
48	Lesser Flamingo	*Phoenicopterus minor*	R/LM	LC			NT	IV			1
49	Fulvous Whistling-duck	*Dendrocygna bicolor*	R/LM	LC				I			1
50	Lesser Whistling-duck	*Dendrocygna javanica*	R/LM	LC				IV			1
51	White-headed Duck	*Oxyura leucocephala*	WM	R		VR	EN	IV	II	I	1

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]	CAF AP Species[8]
52	Mute Swan	*Cygnus olor*	WM	V				IV			
53	Whooper Swan	*Cygnus cygnus*	WM	V				IV			
54	Tundra Swan	*Cygnus columbianus*	WM	V				IV			
55	Bean Goose	*Anser fabalis*	WM	V				IV			1
56	Greater White-fronted Goose	*Anser albifrons*	WM	R				IV			1
57	Lesser White-fronted Goose	*Anser erythropus*	WM	R			VU	IV		I	1
58	Greylag Goose	*Anser anser*	WM	C	WM	C		IV			1
59	Bar-headed Goose	*Anser indicus*	R/WM	LC				IV			1
60	Snow Goose	*Chen caerulescens*	WM	V				IV			1
61	Red-breasted Goose	*Branta ruficollis*	WM	V			VU	IV	II	I	1
62	Ruddy Shelduck	*Tadorna ferruginea*	R/LM/WM	LC	WM	FC		IV			1
63	Common Shelduck	*Tadorna tadorna*	WM	R				IV			1
64	White-winged Duck	*Cairina scutulata*	R	R			EN	I	I		1
65	Comb Duck	*Sarkidiornis melanotos*	R/LM	UC				IV	II		1
66	Cotton Pygmy-goose	*Nettapus coromandelianus*	R/LM	LC				IV			1
67	Gadwall	*Anas strepera*	WM	C	WM	A		IV			1
68	Falcated Duck	*Anas falcata*	WM	R		V		IV			1
69	Eurasian Wigeon	*Anas penelope*	WM	C	WM	A		IV			1
70	Mallard	*Anas platyrhynchos*	R/LM	UC	WM/BR?	VC		IV			1
71	Spot-billed Duck	*Anas poecilorhyncha*	R/LM	C	?			IV			1
72	Northern Shoveler	*Anas clypeata*	WM	C	WM	VC		IV			1
73	AndamanTeal	*Anas gibberifrons*	R	LC				I			
74	Northern Pintail	*Anas acuta*	WM	VC	WM	VC		IV			1
75	Garganey	*Anas querquedula*	WM	VC	WM	FC		IV			1
76	Baikal Teal	*Anas Formosa*	WM	R			VU	IV	II	I	1
77	Eurasian Teal	*Anas crecca*	WM	VC	WM	VC		IV			1

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]	CAF AP Species[8]
78	Marbled Teal	*Marmaronetta angustirostris*	WM	R		VR	VU	IV		I	1
79	Pink-headed Duck	*Rhodonessa caryophyllacea*	R	E?			CR	I	II		
80	Red-crested Pochard	*Netta rufina*	WM	LC	WM	C		IV			1
81	Common Pochard	*Aythya ferina*	WM	LC	WM	C		IV			1
82	Ferruginous Duck	*Aythya nyroca*	R/WM	LC	WM	UC	NT	IV		I	1
83	Baer's Pochard	*Aythya baeri*	WM	R			VU	IV			1
84	Tufted Duck	*Aythya fuligula*	WM	LC	WM	FC		IV			1
85	Greater Scaup	*Aythya marila*	WM	V				IV			1
86	Long-tailed Duck	*Clangula hyemalis*	WM	V		V		IV			
87	Common Goldeneye	*Bucephala clangula*	WM	R				IV			1
88	Smew	*Mergellus albellus*	WM	R				IV			1
89	Red-breasted Merganser	*Mergus serrator*	WM	V				IV			1
90	Common Merganser	*Mergus merganser*	R/WM	LC	WM	R		IV			1
91	Siberian Crane	*Grus leucogeranus*	WM	VR			CR	I	I	I	1
92	Sarus Crane	*Grus antigone*	R/LM	LC			VU	IV	II		1
93	Demoiselle Crane	*Grus virgo*	WM	LC				IV			1
94	Common Crane	*Grus grus*	WM	LC	WM	VR		IV			1
95	Hooded Crane	*Grus monacha*	WM	V			VU	IV	I	I	
96	Black-necked Crane	*Grus nigricollis*	R/WM	VR			VU		I		1
97	Andaman Crake	*Rallina canningi*	R	R			DD	IV			1
98	Red-legged Crake	*Rallina fasciata*	R	R				IV			
99	Slaty-breasted Rail	*Gallirallus striatus*	R/LM	UC				IV			
100	Water Rail	*Rallus aquaticus*	R/WM	LC	SM	VR		IV			1
101	Corncrake	*Crex crex*	WM	V			NT	IV		II	1
102	Brown Crake	*Amaurornis akool*	R/LM	UC				IV			1
103	White-breasted Waterhen	*Amaurornis phoenicurus*	R	C				IV			1
104	Black-tailed Crake	*Amaurornis bicolor*	R	R				IV			1

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105	Little Crake	*Porzana parva*	WM	R				IV		II	1
106	Baillon's Crake	*Porzana pusilla*	R/WM	LC	SM	VR		IV		II	1
107	Spotted Crake	*Porzana porzana*	WM	R				IV		II	1
108	Ruddy-breasted Crake	*Porzana fusca*	R	R	SM	VR		IV			1
109	Watercock	*Gallicrex cinerea*	R/LM	LC				IV			1
110	Purple Swamphen	*Porphyrio porphyrio*	R/LM	LC	SM	UC		IV			1
111	Common Moorhen	*Gallinula chloropus*	R/WM	C	SM	VC		IV			1
112	Common Coot	*Fulica atra*	R/WM	VC	WM	VC		IV			1
113	Masked Finfoot	*Heliopais personata*	R	VR			VU				1
114	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	R/LM/SM	UC	SM	FC		IV			1
115	Bronze-winged Jacana	*Metopidius indicus*	R	LC				IV			1
116	Greater Painted-snipe	*Rostratula benghalensis*	R/LM	LC							
117	Eurasian Oystercatcher	*Haematopus ostralegus*	WM	R				IV			1
118	Eurasian Golden-plover	*Pluvialis apricaria*	WM	V				IV			1
119	Pacific Golden-plover	*Pluvialis fulva*	WM	UC				IV			1
120	Grey Plover	*Pluvialis squatarola*	WM	UC				IV			1
121	Common Ringed Plover	*Charadrius hiaticula*	WM	R				IV			1
122	Long-billed Plover	*Charadrius placidus*	WM	R				IV			1
123	Little Ringed Plover	*Charadrius dubius*	R/WM	C	SM	U		IV			1
124	Kentish Plover	*Charadrius alexandrinus*	R/WM	LC				IV			1
125	Mongolian Plover	*Charadrius mongolus*	R/WM	LC				IV			1
126	Greater Sand Plover	*Charadrius leschenaultii*	WM	UC				IV			1
127	Caspian Plover	*Charadrius asiaticus*	WM	V				IV			1
128	Oriental Plover	*Charadrius veredus*	WM	V				IV			
129	Black-fronted Dotterel	*Elseyornis melanops*		V				IV			
130	Northern Lapwing	*Vanellus vanellus*	WM	LC				IV			1
131	Yellow-wattled Lapwing	*Vanellus malarbaricus*	R/LM	LC				IV			1

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132	River Lapwing	*Vanellus duvaucelii*	R/LM	LC				IV			1
133	Grey-headed Lapwing	*Vanellus cinereus*	WM	UC				IV			1
134	Red-wattled Lapwing	*Vanellus indicus*	R/LM	C				IV			1
135	Sociable Lapwing	*Vanellus gregarius*	WM	R			CR	IV		I	1
136	White-tailed Lapwing	*Vanellus leucurus*	WM	LC				IV			1
137	Eurasian Woodcock	*Scolopax rusticola*	R/AM/LM	LC	R	UC		IV			1
138	Solitary Snipe	*Gallinago solitaria*	R/AM/LM	R				IV			1
139	Wood Snipe	*Gallinago nemoricola*	R/AM/LM	R			VU	IV			1
140	Pintail Snipe	*Gallinago stenura*	WM	LC				IV			1
141	Swinhoe's Snipe	*Gallinago megala*	WM	R				IV			
142	Great Snipe	*Gallinago media*	WM	V			NT	IV			1
143	Common Snipe	*Gallinago gallinago*	R/WM	C	R	UC		IV			1
144	Jack Snipe	*Lymnocryptes minimus*	WM	UC	WM	UC		IV			1
145	Black-tailed Godwit	*Limosa limosa*	WM	LC				IV			1
146	Bar-tailed Godwit	*Limosa lapponica*	WM	UC				IV			1
147	Whimbrel	*Numenius phaeopus*	WM	UC				IV			1
148	Eurasian Curlew	*Numenius arquata*	WM	UC				IV			1
149	Spotted Redshank	*Tringa erythropus*	WM	LC				IV			1
150	Common Redshank	*Tringa totanus*	R/WM	C				IV			1
151	Marsh Sandpiper	*Tringa stagnatilis*	WM	LC				IV			1
152	Common Greenshank	*Tringa nebularia*	WM	LC				IV			1
153	Spotted Greenshank	*Tringa guttifer*	WM	V			EN	IV	I	I	1
154	Green Sandpiper	*Tringa ochropus*	WM/PM	LC				IV			1
155	Wood Sandpiper	*Tringa glareola*	WM	LC				IV			1
156	Terek Sandpiper	*Xenus cinereus*	WM/PM	UC				IV			1
157	Common Sandpiper	*Actitis hypoleucos*	R/WM	LC	R	FC		IV			1
158	Ruddy Turnstone	*Arenaria interpres*	WM	LC				IV			1

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159	Long-billed Dowitcher	*Limnodromus scolopaceus*	WM	V				IV			
160	Asian Dowitcher	*Limnodromus semipalmatus*	WM	R			NT	IV			1
161	Great Knot	*Calidris tenuirostris*	WM	UC				IV			1
162	Red Knot	*Calidris canutus*	WM	V				IV			1
163	Sanderling	*Calidris alba*	WM	LC				IV			1
164	Little Stint	*Calidris minuta*	WM	LC				IV			1
165	Rufous-necked Stint	*Calidris ruficollis*	WM	R				IV			1
166	Temminck's Stint	*Calidris temminckii*	WM	LC				IV			1
167	Long-toed Stint	*Calidris subminuta*	WM	UC				IV			
168	Dunlin	*Calidris alpine*	WM	UC				IV			1
169	Curlew Sandpiper	*Calidris ferruginea*	WM	UC				IV			1
170	Buff-breasted Sandpiper	*Tryngites subruficollis*	WM	V			NT	IV		I	
171	Spoon-billed Sandpiper	*Eurynorhynchus pygmeus*	WM	R			EN	IV		I	1
172	Broad-billed Sandpiper	*Limicola falcinellus*	WM	UC				IV			1
173	Ruff	*Philomachus pugnax*	WM/PM	LC				IV			1
174	Ibisbill	*Ibidorhyncha struthersii*	R/AM	UC				IV			1
175	Black-winged Stilt	*Himantopus himantopus*	R/LM	C	R	UC		IV			1
176	Pied Avocet	*Recurvirostra avosetta*	WM/R	LC				IV			1
177	Red-necked Phalarope	*Phalaropus lobatus*	WM	R							1
178	Grey Phalarope	*Phalaropus fulicarius*	WM	V							
179	Crab Plover	*Dromas ardeola*	WM	R						II	1
180	Eurasian Thick-knee	*Burhinus oedicnemus*	R	LC*				IV			1
181	Great Thick-knee	*Esacus recurvirostris*	R/LM	UC				IV		II	1
182	Beach Thick-knee	*Esacus magnirostris*	R	LC			NT	IV			1
183	Collared Pratincole	*Glareola pratincola*	WM	R						II	1
184	Oriental Pratincole	*Glareola maldivarum*	R/LM/SM	LC							1
185	Small Pratincole	*Glareola lactea*	R/LM/SM	LC							1

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186	Sooty Gull	*Larus hemprichii*	S/WM	V				IV		II	1
187	Mew Gull	*Larus canus*	WM	V				IV			1
188	Yellow-legged Gull	*Larus cachinnans*	WM/PM	UC				IV			1
189	Heuglin's Gull	*Larus heuglini*	WM	R				IV			1
190	Great Black-headed Gull	*Larus ichthyaetus*	WM	LC				IV		II	1
191	Brown-headed Gull	*Larus brunnicephalus*	WM/R	LC	WM	VC		IV			1
192	Black-headed Gull	*Larus ridibundus*	WM	LC				IV			1
193	Slender-billed Gull	*Larus genei*	WM/R	R				IV			1
194	Little Gull	*Larus minutus*	WM	V				IV			1
195	Gull-billed Tern	*Sterna nilotica*	R/WM	LC				IV		II	1
196	Caspian Tern	*Sterna caspia*	WM/R	UC				IV		II	1
197	River Tern	*Sterna aurantia*	R	LC				IV			1
198	Lesser Crested-tern	*Sterna bengalensis*	R/WM	LC				IV		II	1
199	Great Crested-tern	*Sterna bergii*	R/WM	LC				IV		II	1
200	Sandwich Tern	*Sterna sandvicensis*	WM	LC				IV		II	1
201	Roseate Tern	*Sterna dougallii*	R	UC				IV			1
202	Black-naped Tern	*Sterna sumatrana*	R	LC				IV			1
203	Common Tern	*Sterna hirundo*	WM/R	LC				IV		II	1
204	Arctic Tern	*Sterna paradisaea*		V				IV			1
205	Little Tern	*Sterna albifrons*	WM/R	LC				IV		II	
206	Saunders's Tern	*Sterna saundersi*	R/SM	UC				IV		II	1
207	White-cheeked Tern	*Sterna repressa*	R/SM	LC				IV		II	1
208	Black-bellied Tern	*Sterna acuticauda*	R	LC			NT	IV			1
209	Bridled Tern	*Sterna anaethetus*	R/WM	LC				IV			1
210	Sooty Tern	*Sterna fuscata*	R	LC				IV			1
211	Whiskered Tern	*Chlidonias hybrida*	R/WM/PM	LC	SM	VC		IV			1
212	White-winged Tern	*Chlidonias leucopterus*	WM/PM	UC				IV		II	1

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213	Black Tern	*Chlidonias niger*	PM	V				IV		II	1
214	Indian Skimmer	*Rynchops albicollis*	R/LM	UC			VU				1
		Totals	**214**	**214**	**45**	**45**	**37**	**203**	**15**	**43**	**194**

1. Common and Scientific names follow the BirdLife International (2006)
2. Residential status and Abundance of birds in India – follows Kumar et al. (2005)
3. Residential status and Abundance of birds in the Jhelum basin follows Shah Mustapha (2007) and Holmes & Parr (1988)
4. Globally threatened species CR – Critically Endangered; EN – Endangered; VU – Vulnerable; nt - near threatened;
5. W (P) Act 1972 Schedule – Wildlife Protection Act 1972 (as amended up to 2003), adapted from Kumar et al. (2005)
6. CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora (List as per 2002), adapted from Kumar et al. (2005)
7. CMS Appendices - Appendix I and II listed species under the Convention on the Conservation of Migratory Species of Wild Animals (downloaded from CMS website on 1 Dec. 2005; effective from 23 Dec. 2002).
8. CAF AP Species – Migratory waterbird species included in Appendix I of the Central Asian Flyway Action Plan For The Conservation Of Migratory Waterbirds And Their Habitats. As finalised by Range States of the Central Asian Flyway at their second meeting in New Delhi, 10-12 June 2005. Convention on the Conservation of Migratory Species of Wild Animals, Secretariat, Bonn.

Annex II

Wetland and forest birds recorded in the Jhelum Basin

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]
1	Black Kite	*Milvus migrans*			R	C		I		
2	Brahminy Kite	*Haliastur indus*	R/LM	LC				I		
3	White-bellied Fish-eagle	*Haliaeetus leucogaster*	R	R				I		
4	Pallas's Fish-eagle	*Haliaeetus leucoryphus*	R/WM	R	R	R	VU	I	I	I
5	White-tailed Eagle	*Haliaeetus albicilla*	WM	R			NT	I	I	I
6	Lesser Fish-eagle	*Ichthyophaga humilis*	R/AM	R			NT	I		
7	Grey-headed Fish-eagle	*Ichthyophaga ichthyaetus*	R	UC			NT	I		
8	Himalayan Griffon	*Gyps himalayensis*			R	R		I		
9	Western Marsh-harrier	*Circus aeruginosus*	WM	LC				I		
10	Eastern Marsh-harrier	*Circus spilonotus*	WM	LC				I		
11	Northern Goshawk	*Accipiter gentilis*			PM					
12	Indian Spotted Eagle	*Aquila hastata*	?				VU	I		
13	Greater Spotted Eagle	*Aquila clanga*	WM/R	R			VU	I	II	I
14	Steppe Eagle	*Aquila nipalensis*	WM	LC				I		
15	Imperial Eagle	*Aquila heliaca*	WM	R			VU	I	I	I
16	Osprey	*Pandion haliaetus*	WM/R	UC				I		II
17	Eurasian Hobby	*Falco subbuteo*			WM					
18	Peregrine Falcon	*Falco peregrinus*	R/WM	UC				I	I	
19	Swamp Francolin	*Francolinus gularis*	R	LC			VU	IV		
20	Rock Pigeon	*Columba livia*			R	C				
21	Spotted Dove	*Streptopelia chinensis*			SM	FC				
22	Eurasian Collared-dove	*Streptopelia decaocto*			SM	C				
23	Slaty-headed Parakeet	*Psittacula himalayana*			SM	UC				
24	Common Cuckoo	*Cuculus canorus*			SM	FC				
25	Asian Koel	*Eudynamys scolopacea*								

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26	Barn Owl	*Tyto alba*			LAM	UC				
27	Brown Fish-owl	*Ketupa zeylonensis*	R	UC				IV		
28	Buffy Fish-owl	*Ketupa ketupu*	R	V						
29	Scully's Wood-owl	*Strix aluco*			LAM	R				
30	Blyth's Kingfisher	*Alcedo hercules*	R	R			NT	IV		
31	Common Kingfisher	*Alcedo atthis*	R/WM/SM	C	R	C		IV		
32	Blue-eared Kingfisher	*Alcedo meninting*	R	R				IV		
33	Black-backed Kingfisher	*Ceyx erithaca*	R/LM	R				IV		
34	Brown-winged Kingfisher	*Pelargopsis amauroptera*	R	LC			NT	IV		
35	Stork-billed Kingfisher	*Pelargopsis capensis*	R	LC	M			IV		
36	Ruddy Kingfisher	*Halcyon coromanda*	R/LM	R				IV		
37	White-throated Kingfisher	*Halcyon smyrnensis*	R/LM	C	R	C		IV		
38	Black-capped Kingfisher	*Halcyon pileata*	R/LM	LC				IV		
39	Collared Kingfisher	*Todiramphus chloris*	R	LC				IV		
40	Crested Kingfisher	*Megaceryle lugubris*	R	LC				IV		
41	Pied Kingfisher	*Ceryle rudis*	R	C	R	C		IV		
42	Blue-cheeked Bee-eater	*Merops persicus*	SM/PM	LC						
43	Blue-tailed Bee-eater	*Merops philippinus*	R/WM	LC						
44	European Bee-eater	*Merops apiaster*			SM	R				
45	Chestnut-headed Bee-eater	*Merops leschenaulti*	R	LC						
46	European Roller	*Coracias garrulus*			SM	FC				
47	Eurasian Hoopoe	*Upupa epops*			SM	FC				
48	Eurasian Wryneck	*Jynx torquilla*			SM	UC				
49	Brown-fronted Woodpecker	*Dendrocopos auriceps*			LAM	UC				
50	Himalayan Woodpecker	*Dendrocopos himalayensis*			LAM	UC				
51	Scaly-bellied Green (Streak-throated) Woodpecker	*Picus xanthopygaeus*	R	FC						
52	Sand Martin	*Riparia riparia*	R/WM	LC						

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]
53	Plain Martin	*Riparia paludicola*	R/WM	LC	PM					
54	Barn Swallow	*Hirundo rustica*	R/WM	LC	SM	VC				
55	Red-rumped Swallow	*Hirundo daurica*	R/SM/WM	LC						
56	Streak-throated Swallow	*Hirundo fluvicola*	R/SM	LC						
57	White Wagtail	*Motacilla alba*	R/WM/PM	C	SM	FC		IV		
58	Large-pied Wagtail	*Motacilla madaraspatensis*	R/WM/PM	LC				IV		
59	Citrine Wagtail	*Motacilla citreola*	R/AM/WM	LC	SM	FC		IV		
60	Yellow Wagtail	*Motacilla flava*	R/AM/WM/PM	LC				IV		
61	Grey Wagtail	*Motacilla cinerea*	R/AM/WM	LC	SM	FC		IV		
62	Red-throated Pipit	*Anthus cervinus*	PM	R				IV		
63	Water Pipit	*Anthus spinoletta*	WM	LC				IV		
64	American Pipit	*Anthus rubescens*	WM	R				IV		
65	Short-billed Minivet	*Pericrocotus brevirostris*			SM	R				
66	Himalayan Bulbul	*Pycnonotus leucogenys*			R	C				
67	Long-tailed Shrike	*Lanius schach*			SM	FC				
68	White-throated Dipper	*Cinclus cinclus*	R/AM	UC						
69	Brown Dipper	*Cinclus pallasii*	R/AM	LC						
70	Winter Wren	*Troglodytes troglodytes*	R/AM	LC	LAM	R		IV		
71	Blue Whistling-thrush	*Myophonus caeruleus*			LAM	C				
72	Tickell's Thrush	*Turdus unicolor*			SM	C				
73	White-tailed Rubythroat	*Luscinia pectoralis*			LAM	R				
74	White-winged Redstart	*Phoenicurus erythrogastrus*	R/AM/WM	LC				IV		
75	White-capped Water-redstart	*Chaimarrornis leucocephalus*	R/AM/WM	C				IV		
76	Plumbeous Water-redstart	*Rhyacornis fuliginosus*	R/AM	LC				IV		
77	Little Forktail	*Enicurus scouleri*	R	LC	LAM	R		IV		
78	Black-backed Forktail	*Enicurus immaculatus*	R	LC				IV		
79	Slaty-backed Forktail	*Enicurus schistaceus*	R/AM	LC				IV		
80	White-crowned Forktail	*Enicurus leschenaulti*	R/AM	UC				IV		

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]
81	Spotted Forktail	*Enicurus maculatus*	R/AM	LC	SM	C		IV		
82	Common Stonechat	*Saxicola torquata*			SM	FC				
83	White-tailed Stonechat	*Saxicola leucura*	R/LM	LC				IV		
84	Pied Bushchat	*Saxicola caprata*			SM	UC				
85	Streaked Laughingthrush	*Garrulax lineatus*			LAM	R				
86	Marsh Babbler	*Pellorneum palustre*	R	R			VU	IV		
87	Jerdon's Babbler	*Chrysomma altirostre*	R	R			VU	IV		
88	Black-breasted Parrotbill	*Paradoxornis flavirostris*	R	VR			VU	IV		
89	Rufous-vented Prinia	*Prinia burnesii*	R	LC			NT	IV		
90	Paddyfield Warbler	*Acrocephalus agricola*			SM					
91	Blunt-winged Warbler	*Acrocephalus concinens*			SM	C				
92	Blyth's Reed-warbler	*Acrocephalus dumetorum*			SM					
93	Clamorous Reed-warbler	*Acrocephalus stentoreus*			SM	C				
94	Booted Warbler	*Hippolais caligata*			SM					
95	Common Chiffchaff	*Phylloscopus collybita*			SM					
96	Mountain Chiffchaff	*Phylloscopus sindianus*			SM					
97	Inornate Warbler	*Phylloscopus inornatus*			SM					
98	Greenish Warbler	*Phylloscopus trochiloides*			SM					
99	Rufous-rumped Grassbird	*Graminicola bengalensis*	R	LC			NT	IV		
100	Broad-tailed Grassbird	*Schoenicola platyura*	R	R			VU	IV		
101	Lesser Whitethroat	*Sylvia curruca*			PM					
102	Ultramarine Flycatcher	*Ficedula superciliaris*			SM	R				
103	Asian Paradise-flycatcher	*Terpsiphone paradisi*			SM	U				
104	Mangrove Whistler	*Pachycephala grisola*	R	UC						
105	Great Tit	*Parus major*			R	FC				
106	Wallcreeper	*Tichodroma muraria*			WM	UC				
107	Bar-tailed Tree-creeper	*Certhia himalayana*			LAM	UC				
108	European Goldfinch	*Carduelis carduelis*			SM					

Sr. No.	Common name[1]	Scientific name[1]	India Residential status[2]	India Abundance[2]	Jhelum basin Residential status[3]	Jhelum basin Abundance[3]	Globally threatened sp[4]	W(P)Act 1972 Schedule[5]	CITES[6]	CMS Appendices[7]
109	Common Rosefinch	*Carpodacus erythrinus*			SM					
110	Scaly-breasted Munia	*Lonchura punctulata*			SM					
111	House Sparrow	*Passer domesticus*			R	C				
112	Common Starling	*Sturnus vulgaris*			SM	C				
113	Common Myna	*Acridotheres tristis*			R	C				
114	Eurasian Golden-oriole	*Oriolus oriolus*			SM	FC				
115	Black (Fork-tailed) Drongo	*Dicrurus adsimilis*			SM					
116	Ashy Drongo	*Dicrurus leucophaeus*			SM	FC				
117	Eurasian Jackdaw	*Corvus monedula*			R	C				
118	House Crow	*Corvus splendens*			R	C				
	Total		**118**		**66**	**50**	**16**	**54**	**5**	**5**

1. Common and Scientific names follow the BirdLife International (2006)
2. Residential status and Abundance of birds in India – follows Kumar et al. (2005)
3. Residential status and Abundance of birds in the Jhelum basin follows Shah Mustapha (2007) and Holmes & Parr (1988)
4. Globally threatened species CR – Critically Endangered; EN – Endangered; VU – Vulnerable; nt - near threatened;
5. W (P) Act 1972 Schedule – Wildlife Protection Act 1972 (as amended up to 2003), adapted from Kumar et al. (2005)
6. CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora (List as per 2002), adapted from Kumar et al. (2005)
7. CMS Appendices - Appendix I and II listed species under the Convention on the Conservation of Migratory Species of Wild Animals (downloaded from CMS website on 1 Dec. 2005; effective from 23 Dec. 2002).

Annexture III

List of fish species from Wular and associated wetlands

		Zoological name	Kashmiri name
Order Cypriniformes			
Family Cyprinidae			
Sub-family Schizothoracine	1	*Schizothorax curvifrons Heckel*	Sater gaad
	2	*S. esocinus Heckel*	Chhuroo
	3	*S. hugeli Heckel*	
	4	*S. longipinnus Heckel*	
	5	*S. micropogon Heckel*	Ramgaad
	6	*S.nasus Heckel*	
	7	*S. niger Heckel*	
	8	*S. planifrons Heckel*	
	9	*S. progastus Heckel*	
	10	*S. punctatus Heckel*	
	11	*Oreinus plagiostomus Mclelland*	Khont
	12	*O. sinutatus (Heckel)*	Khnot
	13	*Ptychobarbus conirostris Steind*	
	14	*Schizopygopsis stoliczkae Steind*	
Sub-family Cyprininae	15	*Cyprinus carpio Linn.*	Panjaeb gaad
	16	*Labeo dero (Heckel)*	Roput
	17	*L. dyocheilus (Mc Clelland)*	Heol, roput
	18	*Carassius carassius (Linn)*	Gang
	19	*Puntius conshonius*	Safed bacha
Sub-family Garrinae	20	*Gara gotyla (gray)*	
	21	*Crosocheilus diplochilus Heckel Tetthur*	
Order Siluriformes			
Family Cobitidae			
Sub-family Botinae	22	*Botia birdi Chaudhury*	Rama gurun
Sub-family Nemachilinae	23	*Nemachilus gracilis Day*	Ara gurun
	24	*N. vitatus Heckel*	Ara gurun
	25	*N. kashmirensis Hora*	Ara gurun
	26	*N. marmoratus Heckel*	Ara gurun
	27	*N. rupicola McClelland*	Ara gurun
	28	*N. yasinensis Alcock*	Ara gurun
	29	*N. stoliczki steind*	Ara gurun
Family Sisoridae	30	*Glyptothorax kashmirensis Hora*	Anuir
	31	*G. reticulatum McClelland*	Anuir
	32	*Exostoma stoliczki Day*	
Family Siluridae	33	*Ompok bimaculatus (Bloch)*	
Family Cyprinodoniformes			
Family Poecilidae	34	*Gambusia affinia (baird & Girard)*	Mahe gad
Order Salmoniformes			
Family Salmonidae	35	*Salmo trutta Linn*	Trouth
	36	*S. gairdnri Richardson*	Trouth

Annex – IV

List of Macrophytes in Wular and associated wetlands

Acorus calamus
Alisma plantigina
Arthroxon lancifolia
Butomus umbellatus
Carex scrotinus
Chara zeylanica
Cladium mariscus
Cyperus rotundus
Cyperus serorinus
Echinochloa crusgalli
Eleocharis palustris
Hydrocharis morsusranae
Hydrocharis dubia
Lycopus europqeus
Marsilea quadrifolia
Menyanthes trifoliata
Myosotis sylvatica
Phragmites communis
Polygonum hydropiper
Potentilla repans
Rananculus scleratus
Rumex maritimus
Scripus lacustris
Scripus palustris
Sium latijugum
Sparganium errectum
Typha angustata
Veronica anagallis
Ceratophyllum demersum
Hydrilla verticillata
Myriophullum verticellatum
Myrophyllum spicatum
Najas graminea
Potamogeton pusillus
Potamogeton natans
Potamogeton lucens
Potamogeton pectinatus
potamogeton crispus
Rooted floating
Trapa bispinosa
Trapa natans
Nelumbium nucifera
Nymphaea stellata
Nymphaea alba
Nymphoides peltatum
Salvinia natans
Lemna Sp.
Azolla Sp.

Annex V

Pour Flush Water Seal Latrines

The pour flush latrine consist of a squatting pan with steep bottom slope (25-30 degrees) and is fixed in cement concrete floor. After use it is flushed by hand using a small container holding 1.5 to 2 litres of water. The excreta is carried through a drain into honey combed leaching pits, which are used alternately. The liquid in the pits percolates and gases are absorbed by the soil leaving the solids behind in these pits. The pits are used alternatively, each designed to last for about three years when one is filled, the excreta is then diverted to the second pit. After about two years the content of the manure become rich organic humus and is safe for handling. The pit after emptying is then again ready for use when other pit is full after a period of two years.

Size and Shape of Leach pits:

The size of the leach pits depend upon a number of factors such as number of users, cleaning interval, solid composition including permeability, water table conditions and the quality of water used for flushing. As per studies out by various research institutions of India and as per UNDP project, an effective capacity of 0.045 to 0.0602 cum have to be provided per capita per year for dry conditions whereas for wet conditions the capacity of the pit has to be increased. The shape of the pits can be circular or rectangular. However, circular pits should be constructed, as these are more stable and cost effective.

The minimum space between the two pits should be equivalent to atleast the effective depth of the pit. The pits should be provided with cement concrete cover. The structure of the latrine shall be made of bricks masonry in cement mortar with CGI sheet and wooden half door in the front.

Annex VI

Mass Balance Design Model for Artificial Wetlands:

In order to design the artificial wetland, the general mass balance model as suggested by Kadlec & Knight (1996) for predicting wetland size necessary to reduce inlet concentration (C_1) to an outlet concentration (C_2) at a known average flow rate (Q) adopted is as:

$$A = -\frac{Q}{K} \ln\left[\frac{C_2 - C^*}{C_1 - C^*}\right]$$

Where:
A = wetland area, (m^2) Q = flow rate, ($m^3\ yr^{-1}$) K = rate constant, ($m\ yr^{-1}$)
C_1 = inflow concentration, ($mg\ l^{-1}$) C_2 = out flow concentration, ($mg\ l^{-1}$)
C^* = irreducible background concentration, ($m\ l^{-1}$)
Values for area based rate constant and irreducible background concentration in this model has been given in table below:

Model Parameter values (Source: Kadlec & Knight 1996)

Surface Flow	BOD	TSS	Org. N	NH_4-N	NO_X-N	TN	TP	FC
K, m yr^{-1}	34	1000	17	18	35	22	12	75
C*, mg l^{-1}	3.5+ 0.53Ci	5.1+ 0.16Ci	1.50	0.00	0.00	1.50	0.02	300
Subsurface Flow								
K, m yr^{-1}	180	3000	35	34	50	27	12	95
C*, mg l^{-1}	3.5+ 0.53Ci	7.8+ 0.63Ci	1.50	0.00	0.00	1.50	0.02	10

Hydraulic loading rate (q) : Hydraulic loading rate, the rainfall equivalent of flow under consideration was measured by the formula given below and result are expressed as m d^{-1}.

$$q = \frac{Q}{A}$$

Where:
q = hydraulic loading rate, m d^{-1} Q = water flow rate, $m^3\ d^{-1}$ A = wetland area, m^2

Wetland water volume (V) : The wetland water volume was measured by the formula given below and results are expressed as m^3.

$$V = \varepsilon A h$$

Where:
V = wetland water volume, m^3 A = wetland area, m^4 h = water depth, m
ε = water volume fraction in water column, $m^3\ m^{-3}$

Wetland water depth (m) : The wetland water depth considered in the Treatment compartment design has been taken form the Hydroperiod Tolerance ranges for wetland plant species given by Kadlec & Knight (1996).
The Artificial wetland design has been envisaged to be built on wastewater entering the Lake from a village with a population of 1500. The wastewater is presumed to carry domestic waste in liquid phase with characteristics and flow given in table below:

Physico-chemical characteristics of wastewater

Parameters	Units	
Flow	m^3 yr^{-1}	17520
pH		7.3
Specific conductivity	µs cm^{-1}	693
Dissolved oxygen	mg l^{-1}	2.5
Total nitrogen	mg l^{-1}	6.0
Total phosphorus	mg l^{-1}	4.0

Before diverting the effluents into the wetland compartments the effluents shall be allowed to settle in a primary settlement tank, wherein fine screening of the particles shall be carried out and a detention period of 1 day allowed the heavier particles to settle down.
For each nutrient the detention period related to their uptake by macrophyte varied significantly and this problem has been overcome by designing artificial wetlands of different dimensions in a series to bring about more than 70% reduction in Phosphorous and Nitrogen besides other chemical constituents.

For nitrogen and phosphorus removal three stage treatment is proposed. First compartment shall be constructed at the upper elevation of the drain. The compartment construction is based on surface flow having mixed stands of *Typha angustata* and *Phragmites communis* in it. A 60% reduction in nitrogen and phosphorus under temperate climatic condition has been worked out. In order to achieve the requisite reduction, the dimensions have been suggested as:

Parameters	Units	compartment 1st
Wetland type		Surface flow
Substrate		Soil bed
vegetation		*Typha angustata and Phragmites communis*
Area	m^2	1367
Depth	m	0.50
Hydraulic loading	m d^{-1}	0.0035
Wetland volume	m^3	683.5
Flow rate	m^3 yr^{-1}	17520
Reduction	%	60 N & P

In compartment 2nd the nitrogen and phosphorus from the wastewater shall be reduced by free floating macrophytes *Salvinia natans* and *Lemna* sp.
The specification for the construction of this compartment has been given in table below. This compartment brings about 25% reduction in nitrogen and 40% reduction in phosphorus.

Parameters	Units	Compartment 2nd
Wetland type		Surface flow
Substrate		Soil bed
vegetation		*Salvinia natans* & *Lemna* Sp
Area	m^2	868
Depth	m	1.0
Hydraulic loading	m d^{-1}	0.0055
Wetland volume	m^3	434
Flow rate	m^3 yr^{-1}	17520
Reduction	%	25 for N % 40 for P

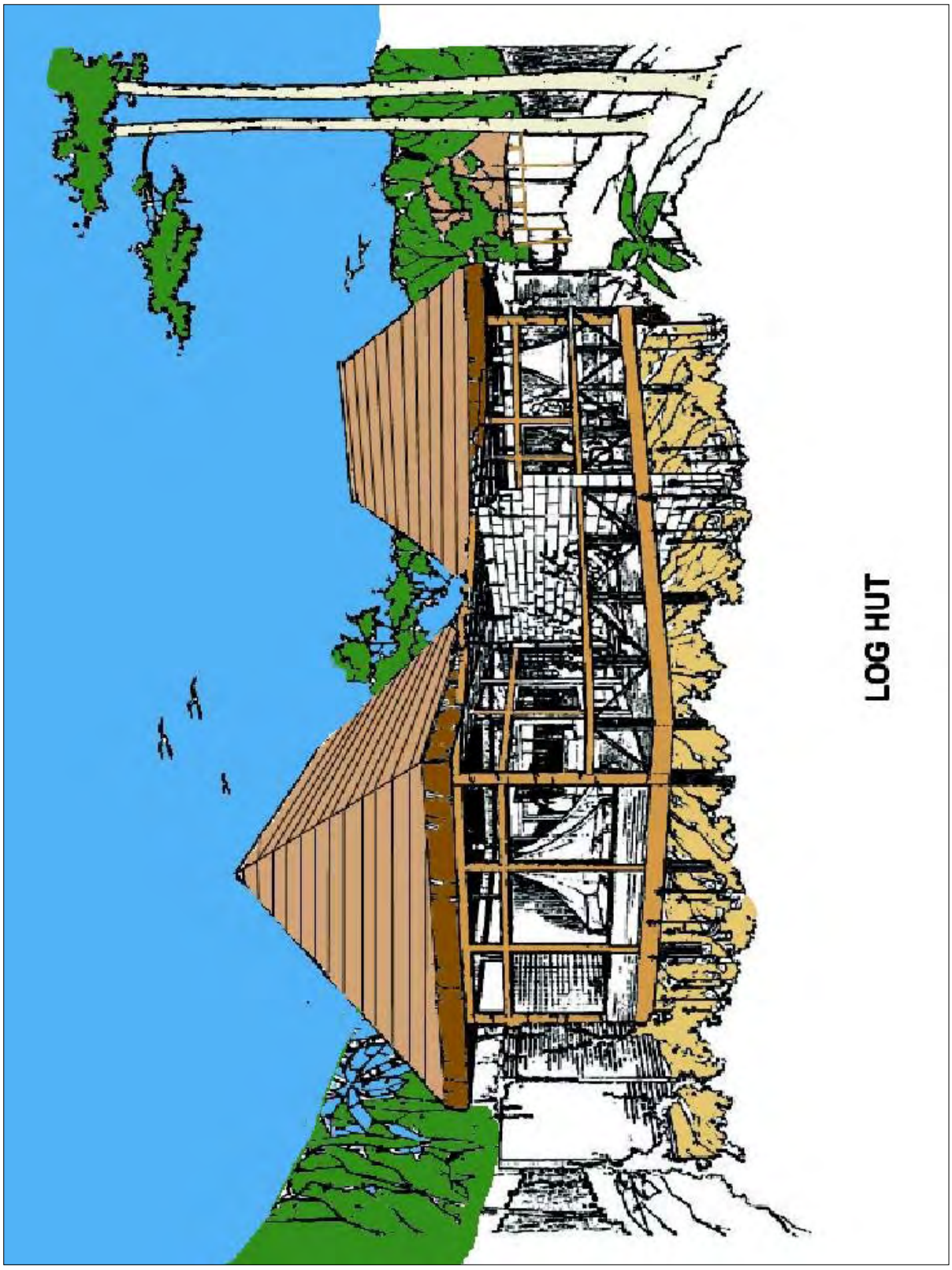
The compartment 3rd in the series further reduces the nitrogen content by 10% and phosphorus by 30% using submerged macrophyte viz., *Ceratophyllum demersum*. This compartment also helps in the oxygenation of the partially treated effluents. The dimensions required for achieving this goal has been given below.

Parameters	Units	compartment 3rd
Wetland type		Surface flow
Substrate		Soil bed
vegetation		*Ceratophyllum demersum*
Area	m^2	730
Depth	m	1.0
Hydraulic loading	m d^{-1}	0.0065
Wetland volume	m^3	730
Flow rate	m^3 yr^{-1}	17520
Reduction	%	10 for N & 30 for P

Thus, the artificial wetland compartments built in series can reduce about 73% and 83% of nitrogen and phosphorus respectively from the wastewater.

Annex VII

Design Model for Log Hut :



Annex VIII

List of necessary equipment required for monitoring programme

Hydrological Equipment and Material

- Automatic Weather Station
- Sunshine recorder
- Automatic water level recorder
- Current meters
- Wireless Station
- Thermo-hydrograph
- Digital depth- temperature analysers
- Ecosounders
- Fibreglass boat with outboard motor
- Poles fixed for float observations, Wading rods and cable and drum (cranes) for lowering current meters
- Metal plates with levels marked and fixed on permanent piers (outflow site)

Fisheries Equipment

- Fishing gears
- Plankton nets
- Buoys
- GPS
- Fisheries Assessment Softwares (ELEFAN, CEDA, etc)
- Fish base Application – Fish identification

Research Equipment

- DR 4000 Spectophotometer (Hach, USA)
- UV spectrophotometer
- Digital pH and conductivity meters (Hanna)
- Multiparameter Water quality meter
- Water quality multi parameter probes
- Paqua Lab with bacteriological assembly (U.K)
- Distillation unit
- Kjeldahl assembly
- Incubators
- Autoclave
- COD digester (Hach USA)
- BOD Incubator - one
- Automatic pippettes
- Digital Flame photometers (Systronics)
- Electronic Balance
- Centrifuge machines
- Cold centrifuge machine
- Grinders
- Automatic sieves
- Hot air oven
- Magnetic stirrers
- Burners & heaters

- Ekmans Grab and potable dredgers
- Plankton samplers
- Glassware and Chemicals

GIS Equipment

- GIS softwarers
- GIS Workstation
- A0 Size Digitizer
- Plotters (HP)
- A0 size scanner
- GPS

Computing and Networking Equipment

- PC Nodes / terminals (P IV)
- Notebooks
- Laser printer Colour
- Deskjet / Inkjet printer A3
- Online UPS 2KVA
- Broadband Internet connection
- MS Project softwares, MS Office softwares and other softwares

Documentation and Display equipment

- Photocopier (Cannon)
- Fax machine
- Slide projector
- Overhead projector
- LCD Panel
- Digital camera
- Video camera
- Binoculars
- Telescope

Facilities

- Project office
- Furnishing and accessories
- Laboratory space
- Vehicles – three
- Mobile laboratory vans
- Silent Generator 15 KVA

Annex IX

Schedule for Hydrobiological and GIS monitoring

Hydrology

This includes estimation of inflows, outflows, hydroperiod, water balance and water holding capacity of the wetland.
The activities that will be carried out under hydrology are:

a) Selection of stream gauging stations and meteorological stations

Stream Gauging Stations
The criteria for selection of gauging stations include:

- Accessibility and located in a straight and stable section of the river / stream
- Water levels not effected by backward flows
- Encompassing all important water courses

Based on the above criteria, survey shall be carried out and stream gauging stations identified to determine inflow of water and sediments and outflow discharges. For estimation of suspended sediments, samples will be taken from all the outflow and inflow gauging stations.

Meteorological stations
The criteria for selection of meteorological stations network are:

- Representatives of different physiographic zones
- Representation of different landuse zones
- Coverage of different hydro-climatic regions

Based on the above criteria and a preliminary survey meteorological yards will be set up at different identified locations.

b) Installation of Automatic Weather Station and Meteorological equipments

Meteorological Equipment
Automatic Weather stations will be set up at stations with additional following equipment:

- automatic rain gauge
- evaporimeter
- windvane
- wet and dry bulb thermometer
- stevenson screen
- sunshine recorder
- thermo-hydrograph
- wireless station (at Pallel to transmit data to WDA)

Standard and automatic rainfall gauging recorders will be installed at different stations.

Stream Guaging and Sediment Sampling Equipment
Inflow
Stream gauging and sediment sampling equipment will be installed at discharge stations with automatic level recorders with conventional/standard water level recorders. The following equipment will be set up at each station:

- Gauge posts (4 nos) of 2m fixed on angle iron poles with support
- Automatic water level recorders installed in stilling wells
- Sample collection bottles with necessary facilities for collecting samples from different depths
- Current meters:
- Cup type – 3 Nos.
- Direct reading propeller type – 1 No.
- Pigmy type – 3 Nos.
- Poles fixed for float observations, 7 wading rods and 2 cable and drum (crane) arrangement for lowering the current meters

Outflow
The following equipment will be installed to determine outflow discharge.

- Metal plates with levels marked and fixed on permanent piers
- Automatic water level recorder in stilling well at Ithai barrage

Sediment Estimates

- Estimation of suspended sediments from inflows and outflows will be carried out at discharge sites
- Estimation of suspended sediments in the Lake will be carried out by standard procedures
- Estimation of accumulated sediment and determining its characteristics

c) Data Collection

- Data on meteorological parameters viz. rainfall, evaporation, wind velocity and direction, solar radiation, temperature and humidity, will be collected on daily basis
- Data on water inflow and suspended sediments from gauging stations by recording stream flow at least thrice daily at 0800 hrs, 1300 hrs and 1800 hrs
- Data on water outflow from discharge stations at will be carried out thrice daily at 0800 hrs, 1300 hrs and 1800 hrs
- Data on suspended silt will be carried out on monthly basis
- Data on sediment accumulation be carried on monthly basis
- Data on Lake bathymetry using echosounders once a year

d) Analysis of data and estimation of water balance and water holding capacity

- The data on meteorology, stream gauging, sediment load and other parameters will be compiled and represented in the form of hydrographs, flow duration curves, sediment rating curves, simple models relating to stream flow and geomorphology.
- Based on the data collected on inflow, outflow, evaporation losses, water level fluctuations and ground water recharge and discharge and other hydrological parameters water balance of the Lake will be estimated. The water holding capacity will be estimated based on bathymetric survey and water levels.

Limnological Analysis

a) Selection of stations for water analysis

All the stations identified for stream gauging will be assessed for water quality to determine nutrient level concentrations. In addition, different stations in the Lake will be selected to assess the nutrient load from point and non-point sources. At least 15 stations will be selected along a transect of the Lake to assess the dispersal of nutrients.

b) Data Collection and Analysis

Water

Identification of the monitoring sites is to depend upon

- Available remote sensing maps, toposheets, contour and depth profiles etc
- Flow patterns within the water body
- Present zones of stagnant and backwaters
- Inflows and outflows of the lake
- Waste water inputs areas
- Ground water influences

Frequency of Sampling: **Monthly**

Sites identified for sampling

- All inflows
- All outflows
- Backwater areas
- Open water
- Areas of dredging
- Areas of weed removal
- Areas under willow removal

Parameters

Physical	Colour, turbidity, transparency, temperature profile
Chemical	pH, conductivity, DO, BOD, COD, free CO_2, alkalinity - total, hardness, Ca, Mg, Na, K, Cl, Si, nitrates, nitrites, ammonia, total nitrogen, orthophosphates, total phosphorus, Fe. Among the hazardous contaminant trace metals the important are Zn, Hg, Cu, Mn, Pb, and Cr. Pesticide residues must be gauged by assessing organo-chlorine compounds.

Soil

Identification of the monitoring sites is to depend upon :

- Available remote sensing maps, toposheets, contour and depth profiles etc
- Zones of stagnant and backwaters
- Inflows and outflows of the lake
- Waste water inputs areas
- Dredging sites
- Weed harvesting sites
- Specific reference to sedimentation and erosion

Frequency of sampling: **Monthly**

Sites identified for sampling

- All inflows
- All outflows
- Open water
- Dredging sites
- Weed harvesting sites

Parameters

Physical	particle size (sand, silt and clay), soil moisture
Chemical	Redox potential at the soil-water interface, pH, conductivity, Ca, Mg, Na, K, available phosphorus, total phosphorus, available nitrogen, total nitrogen, organic carbon, chlorides, organic matter. Zn, C, Fe, Pb, Cd, Ni, Mn, Si.

Biological Studies

- Vegetation - macrophytes
- Plankton - phytoplankton, zooplankton, periphyton.
- Fauna

Macrophytes

Identification of sites must be on the basis of :

- A vegetation map
- Remote sensing maps and GIS surveys
- Inflow and outflow points

Sites identified for sampling

On the basis of vegetation maps.

- Inflow points
- Outflow points
- Floating garden areas
- Stagnant areas
- Marginal and silted up areas
- Open water

Frequency of sampling: **Monthly**

Studies to be carried out as:

- Community structure and vegetational changes, abundance, frequency, density.
- Primary production - seasonal biomass harvesting, above ground and below ground, random sampling
- Chlorophyll estimations
- Nutrients (biologically important) - above and below ground for dominant species.
- Phenology and harvesting time.
- Preparation of Vegetation maps for comparing changes in cover and density of various species.

Bacteriological Studies

Sampling sites to include:

- Open water
- Backwaters
- Waste and sewage incoming drains

Parameters

- Membrane filter method for Total, Fecal and Fecal Streptococci count
- Plate counts (culture mediums)

Phytoplankton

Sampling sites to be identified on the basis of:

- Drainage, including inflow and outflow points
- Contour map, remote sensing maps
- Vegetation distribution
- Human habitat locations
- Disturbed areas

Frequency of sampling: **Monthly**

Sites identified for sampling
All inflow points
Back waters
Open water
Dredging site
Willow removal sites

Parameters

- Species counts and identification
- Species distribution pattern
- Abundance and density
- Biomass
- Chlorophyll
- Primary productivity
- Algal blooms study their development and seasonal cycles.

Zooplankton

Sampling sites to be identified on the basis of:

- Drainage, including inflow and outflow points
- Contour map, remote sensing maps
- Vegetation distribution
- Human habitat locations
- Disturbed areas

Frequency of sampling: **Monthly**

Sites identified for sampling
All inflow points
Back waters
Open water

Dredging site
Willow removal sites

Parameters

- Species counts and identification
- Species distribution pattern
- Biomass
- Algal blooms study their development and seasonal cycles.

Periphyton

Frequency of sampling: **Monthly**

Parameters

- Species count
- Seasonal succession
- Biomass

Benthic fauna

Sampling sites to be identified on the basis of :

- Drainage
- Contour map, remote sensing maps
- Human habitat locations
- Disturbed areas

Frequency of sampling: **Monthly**

Sites identified for sampling
Inflow points,
Outflow points
Back waters
Open water, along depth gradient

Parameters

- Species counts and identification
- Species distribution pattern
- Density

Fish

Parameters to be studied include :

- Identification of species
- Distribution and diversity
- Population estimates
- Breeding patterns, migration patterns
- Food and feeding patterns based on gut content

Waterbirds

Parameters to be studied include

- Regular census counts (fortnightly) at important sites
- Species wise estimates of waterbird populations and identification
- Information on habitat structure and seasonal abundance and changes in different prey items
- Breeding waterbird surveys
- Feeding and breeding habits
- Habitat requirements

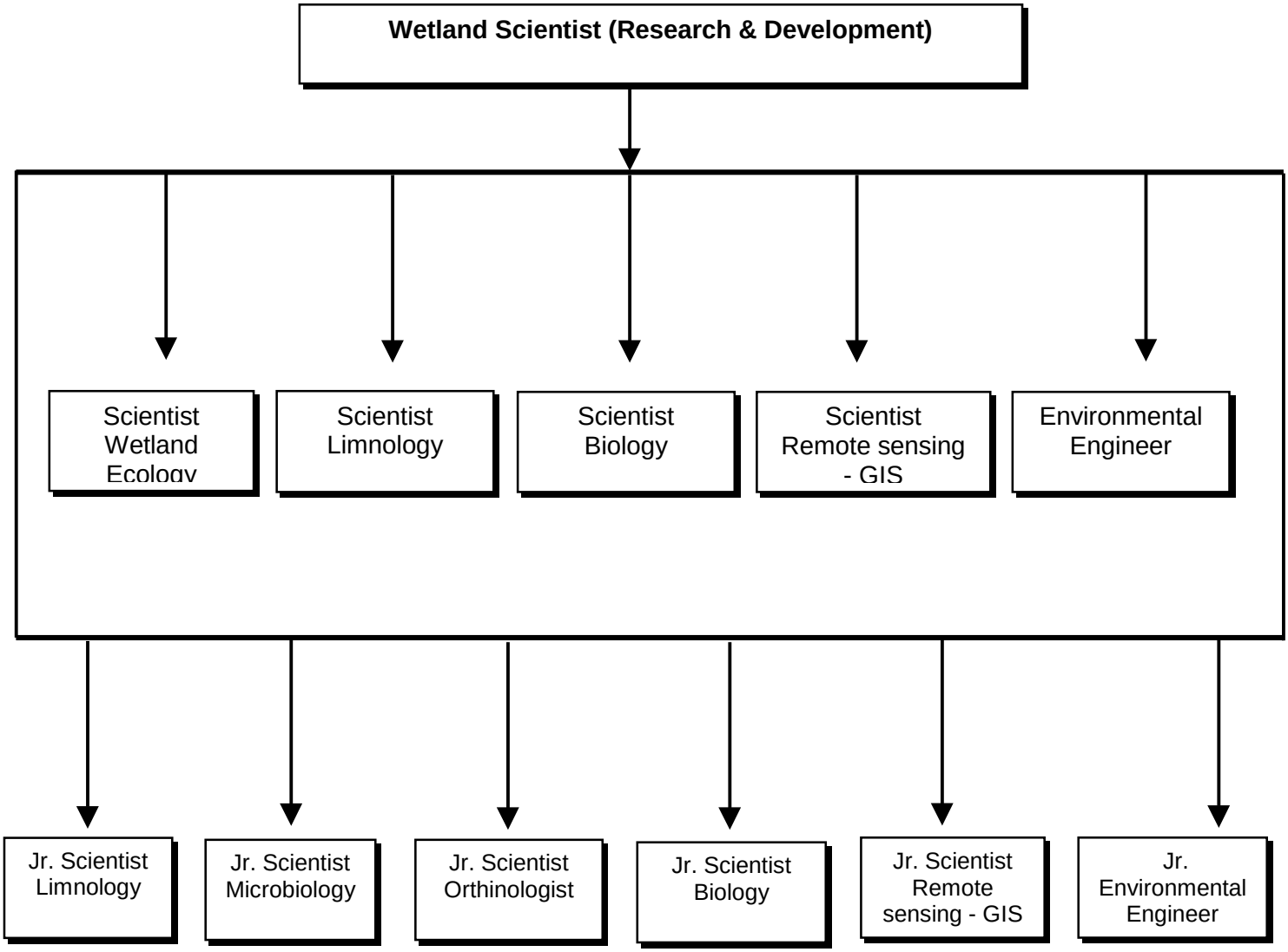
Details about monitoring and methodology may are provided in Biodiversity conservation section 4.3.

Geographical Information System (GIS):

- Survey and assessment of the status and resources of the lake using remote sensing and GIS techniques with emphasis on change in lake area,
- Lake delineation
- zonation
- drainage pattern
- vegetation cover
- faunal distribution,
- siltation
- encroachments

Annex X

Organizational setup of Hydrobiological and GIS Laboratory



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Glossary

Aerate	to supply air to water, soil, or other media
Aerobic	(of an organism or tissue) requiring air for life; pertaining to or caused by the presence of oxygen
Aesthetic	of beauty or the study of beauty
Algae	Simple rootless plants that grow in sunlit waters in relative proportion to the amounts of light and nutrients available. They are food for fish and small aquatic animals.
Algal Bloom	the rapid proliferation of passively floating, simple plant life, such as blue–green algae, in and on a body of water
Alkaline	has a pH greater than 7
Alluvium, Alluvial Soil	soil composed primarily of eroded material such as sand, silt, or clay, that has been deposited on land or on the bottom of water bodies by rivers and streams overflowing their banks
Anaerobic	living in the absence of air or free oxygen; pertaining to or caused by the absence of oxygen
Anoxic	without oxygen
Anthropogenic	having to do with or caused by humans
Assessment	evaluation of the condition of an area
Backwater	a body of water in which the flow is slowed or turned back by an obstruction such as a bridge or dam, an opposing current, or the movement of the tide
Bank	the rising ground that borders a stream, pond or other body of water
Base Flow	the sustained low flow of a stream, usually resulting from groundwater inflow to the stream channel
Bed	the ground under a river, pond or other body of water
Benthic Organism	a form of aquatic life that lives on the bottom or near the bottom of streams, lakes, or oceans
Biochemical–Oxygen Demand (BOD) –	the amount of oxygen, in milligrams per liter, that is removed from aquatic environments by the life processes of micro-organisms
Biodiversity	the sum of all species of plants and animals. An ecosystem is considered healthy when it supports the most diverse numbers and types of species it is capable of supporting
Bioaccumulative Substances	substances that increase in concentration in living organisms (that are very slowly metabolized or excreted) as they breathe contaminated air or water, drink contaminated water, or eat contaminated food.
Biological Assessment (Bio-assessment)	using bio-monitoring data of samples of living organisms to evaluate the condition or health of a place (e.g., a stream, or a wetland)
Biomass	the amount of living matter, in the form of organisms, present in a particular habitat, usually expressed as weight-per-unit area
Biota	the plants and animals living in a habitat
Channelization	the straightening and deepening of a stream channel to permit the water to move faster or to drain a wet area for farming
Constructed or Created Wetlands	former terrestrial environments that have been designed or engineered to establish the necessary conditions (soils, hydrology, and flora/fauna) for a wetland

Conventional Pollutants	such contaminants as organic waste, sediment, acid, bacteria and viruses, nutrients, oil and grease, or heat.
Delineation	identification and documentation of the boundary between wetlands and uplands
Diversity	a combination of the number of taxa (see taxa richness) and the relative abundance of those taxa; a variety of diversity indexes has been developed to calculate diversity
Dissolved Oxygen (DO)	the oxygen freely available in water. Dissolved oxygen is vital to fish and other aquatic life. Traditionally, the level of dissolved oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life.
Drainage Basin	a water body and the land area drained by it.
Dredging	removal of sediment from the bottom of a water body.
Drought	a prolonged period of less–than–normal precipitation such that the lack of water causes a serious hydrologic imbalance; a period of very dry weather
Endangered Species	any species of plant or animal that is having trouble surviving and reproducing; often caused by loss of habitat, not enough food, or pollution; protected by governments in an effort to keep them from becoming extinct
Ephemeral Stream	a stream or part of a stream that flows only in direct response to precipitation; it receives little or no water from springs, melting snow, or other sources; its channel is at all times above the water table
Erosion	the process whereby materials of the Earth's crust are loosened, dissolved, or worn away and simultaneously moved from one place to another
Eutrophic	The most productive state of a lake, characterized by high nutrient concentrations which result in algal growth, cloudy water, and low dissolved oxygen levels.
Eutrophication	The process of fertilization that causes high productivity and biomass in an aquatic ecosystem. Eutrophication can be a natural process or it can be a cultural process accelerated by an increase of nutrient loading to a lake by human activity.
Exotic Species	Species that are not native and that have been intentionally introduced to or have inadvertently infiltrated the system. Exotics prey upon native species and compete with them for food or habitat.
Effluent	Wastewater--treated or untreated--that flows from a treatment plant, sewer, or industrial outfall. Generally refers to discharges into surface waters.
Evapotranspiration	a term that includes water discharged to the atmosphere as a result of evaporation from the soil and surface-water bodies and by plant transpiration
Floating Plants	water plants with floating leaves; may be free-floating, such as duckweed, or attached to the bottom by a root system as in the case with pond lilies
Flyway	the concept developed to describe areas of the world used by migratory waterbirds and defined as the migration routes(s) and areas used by waterbird populations in moving between their

	breeding and wintering grounds. Each individual species and population migrates in a different way and uses a different suite of breeding, migration staging and wintering sites. Hence a single flyway is composed of many overlapping migration systems of individual waterbird populations and species, each of which has different habitat preferences and migration strategies.
Groundwater	the supply of fresh or saline water found beneath the Earth's surface, usually in aquifers, often supplying wells and springs
Globally threatened species	species or subspecies which are listed by IUCN Species Survival Commission's Specialist Groups or Red Data Books as either Critically Endangered, Endangered or Vulnerable. Note that, especially for invertebrate taxa, IUCN's Red Data listings may be both incomplete and dynamic, reflecting poor knowledge of the global status of many taxa. Interpretation of the terms 'vulnerable' 'endangered' or 'critically endangered' species should thus always be undertaken at a national level in the light of the best available scientific knowledge of the status of the relevant taxa.
Hydrology	the study of the cycle of water movement on, over and through the earth's surface; the science dealing with the properties, distribution, and circulation of water
Hydroperiod	depth, duration, seasonality, and frequency of flooding
Indicator	organism, ecological community, or structural feature so strictly associated with a particular environmental condition that its presence indicates the existence of the condition
Indigenous species	a species that originates and occurs naturally in a particular country.
Introduced (non-native) Species	a species that does not originate or occur naturally in a particular country.
Macrophyte	any plant species that can be readily observed without the aid of optical magnification; this includes all vascular plant species and mosses (e.g., *Sphagnum* spp.), as well as large algae (e.g. *Chara* spp.,)
Marsh	an area of soft, wet, low–lying land, characterized by grassy vegetation and often forming a transition zone between water and land; marshes are dominated by non-woody vegetation and they tend to develop in zones progressing from terrestrial habitat to open water
Mass Balance Approach	An analytic method, based on conservation of mass, used to assess the quantity and cycling of contaminants throughout a water system.
Mesotrophic	The trophic state of a lake that falls along the continuum somewhere between oligotrophic and eutrophic.
Monitoring	the regular measurement of an area or quantity/quality over time (generally of things that can change)
Migration path	the route along which fishes, such as salmon and eels, swim when moving to or from a spawning or feeding ground or nursery. Migration paths often cross international boundaries or boundaries between management zones within a country.

Migratory species	the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries
Nonpoint Source	Pollution sources that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off land by stormwater runoff. Commonly used categories for nonpoint sources are agriculture, forestry, urban, mining, construction, dams and channels, and land disposal.
Native	an animal or plant that lives or grows naturally in a certain region
Nutrient	any inorganic or organic compound that provides the nourishment needed for the survival of an organism
Oxbow	a bow–shaped lake formed in an abandoned meander of a river
Oligotrophic	Lakes that are typically cool and clear, and have relatively low nutrient concentrations.
Point Source	A stationary facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution (e.g., a pipe, ditch, ship, ore pit, factory smokestack).
Pristine	the earliest condition of the quality of a water body; unaffected by human activities
Retention Time	The time it takes for the volume of water in a lake to exit through its outlet (i.e., total volume/outlet flow = retention time).
Ramsar Convention	an intergovernmental treaty for the conservation of wetlands
Ramsar sites	wetlands designated by the Contracting Parties for inclusion in the List of Wetlands of International Importance because they meet one or more of the Ramsar Criteria
Sewage	The waste and wastewater discharged into sewers from homes and industry.
Sewer	A channel or conduit that carries wastewater and stormwater runoff from its source to a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste; storm sewers carry runoff from rain or snow; and combined sewers carry both.
Surface Water	All water open to the atmosphere (e.g., rivers, lakes, reservoirs, streams, impoundments, seas, estuaries) and all springs, wells, or other collectors that are directly influenced by surface water.
Spawning ground	that part of a wetland used by fishes for courting, mating, gamete release, gamete fertilization and/or the release of the fertilized eggs, e.g. herring, shad, flounder, cockles, and many fishes in freshwater wetlands. The spawning ground may be part of a river course, a stream bed, inshore or deep water zone of a lake, floodplain, mangrove, saltmarsh, reed bed, estuary or the shallow edge of the sea. The freshwater outflow from a river may provide suitable spawning conditions on the adjacent marine coast.
Waterbirds	The Convention functionally defines waterfowl (a term which, for the purposes of these Criteria and Guidelines, is considered to be synonymous with "waterbirds") as "birds ecologically dependent on wetlands". This definition thus includes any

wetland bird species. However, at the broad level of taxonomic order, it includes especially:

• penguins	:	*Sphenisciformes*.
• divers	:	*Gaviiformes*;
• grebes	:	*Podicipediformes*;
• wetland related pelicans, cormorants, darters and allies	:	*Pelecaniformes*;
• herons, bitterns, storks, ibises and spoonbills	:	*Ciconiiformes*;
• flamingos	:	*Phoenicopteriformes*:
• screamers, swans, geese and ducks (wildfowl)	:	*Anseriformes*;
• wetland related raptors	:	*Accipitriformes* and *Falconiformes*
• wetland related cranes, rails and allies	:	*Gruiformes*;
• Hoatzin	:	*Opisthocomiformes*;
• wetland related jacanas, waders (or shorebirds), gulls, skimmers and terns	:	*Charadriiformes*;
• coucals	:	*Cuculiformes*;
• wetland related owls	:	*Strigiformes*

Wetland benefits the services that wetlands provide to people, e.g. flood control, surface water purification, supplies of potable water, fishes, plants, building materials and water for livestock, outdoor recreation and education.

Wetland values the roles that wetlands play in natural ecosystem functioning, e.g. flood attenuation and control, maintenance of underground and surface water supplies, sediment trapping, erosion control, pollution abatement and provision of habitat.

Waste Treatment Plant A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.

Wastewater The spent or used water from individual homes, a community, a farm, or an industry that often contains dissolved or suspended matter.

Watershed The land area that drains into a river, stream, or lake.

Water Table The level of groundwater.

Acronyms

ADB	Asian Development Bank
a msl	Above mean sea level
BNHS	Bombay Natural History Society
BOD	Biochemical Oxygen Demand
CAF	Central Asian Flyways
CBO	Community Based Organization
CMAP	Comprehensive Management Action Plan
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEC	Central Public Health and Environmental Engineering Organisation
Cumec	Cubic meters per second
Cuses	Cubic seconds
DO	Dissolved Oxygen
DOWP	Department of Wildlife Protection, Government of Jammu and Kashmir
ERA	Economic Reconstruction Authority
FDA	Forest Development Authority
IWRM	Integrated Water Resources Management
J&KLWWDA	Jammu & Kashmir Lakes and Waterways Development Authority
JFMC	Joint Forest Management Committees
JRCP	Jhelum River Conservation Plan
MCM	Million cubic meters
MAP	Management Action Plan
MFP	Minor Forest Produce
Mg/l	Milligrams per liter
MGD	Million Gallons per day
ML	Milliliter
MLD	Million liter per day

Mm	Millimeter
MoEF	Ministry of Environment and Forest, Government of India
MT	Metric Tonnes
MW	Mega Watt
NAEB	National Afforestation and Ecodevelopment Board
NGO	Non Governmental Organization
NIAE	National Institute of Aquatic Ecology
PCU	Project coordination unit
PIC	Project Implementation Committee
PMU	Project Management Unit
PRA	Participatory Rural Appraisal
SACON	Salim Ali Centre for Ornithology and Natural History
Sq. km	Square kilometer
SWG	Solid Waste Generation
WDA	Wular Development Authority
WISA	Wetlands International South Asia
µg/l	Micrograms per liter

"To sustain and restore wetlands, their resources and biodiversity for future generations"

Wetlands International - South Asia
A - 25, (2nd Floor), Defence Colony
New Delhi - 110 024
Fax: +91-11- 24338906
Email: wisaind@del2.vsnl.net.in
URL : www.wetlands.org