Wetlands Management Planning

Methodology Manual for Indian Managers

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Wetlands INTERNATIONAL
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1. Introduction

Wetlands are invaluable natural asset endowments playing a central role in ensuring our food and water security. They provide natural infrastructure that can help meet a range of policy objectives. Beyond water availability and quality, they are invaluable in supporting climate change mitigation and adaption, support health as well as livelihoods, local development and poverty eradication.

Despite their values and the potential policy synergies, wetlands have been, and continue to be, lost or degraded. As per estimates, since 1900, the world has lost around 50% of its wetlands. Recent coastal wetland loss in some places, notably East Asia, has been up to 1.6% a year, and is on-going. It is estimated that nearly one third of Indian wetlands have been lost and converted for alternate uses since the last three decades. This has triggered biodiversity loss, changes to ecological functions, and changes to ecosystem service flows with subsequent impacts on the health, livelihoods and wellbeing of communities and economic activity.

Integrated wetland management, recognizing their intersectoral linkages is a key response strategy to stem this loss. By systematically identifying objectives and outcomes, management planning process helps identify optimal intervention strategies and actions for conservation of wetlands, in particular, providing for judicious application of scarce human as well as financial resources.

Wetlands, being at the interface of land and water, require specialized approaches to management. Conventional protected area approaches as applicable to terrestrial ecosystems are not sufficient for wetlands as the drivers of their degradation operate at multiple scales. With water being the dominant constituent, integration of wetlands within the river basin and coastal zone level landscape planning is most crucial. The plan also needs to be diagnostic in nature rather than symptom centric and prescriptive.

This guidance has been prepared for the wetland managers to assist in developing integrated management plans. It focuses on application of an integrated methodology to assist systematic identification of management objectives and an action plan using results based mechanisms to setting goal, outcomes and outputs. The existing guidelines of Ramsar Convention on wetland management planning as well as wise use handbooks have been used to develop the various sections. Examples from Indian wetlands have been used to illustrate application of concepts.

2. Wetland Management

2.1 Wetlands

Wetlands are areas wherein water plays a dominant role in controlling the environment and associated plant and animal life. They occur at places where water covers, or is at or near the surface of land.

There are several definitions of wetlands, with most broad and generically used being the one adopted by Ramsar Convention. Under the Convention text, wetlands are defined as:

> "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"

Natural wetlands can be broadly classified into:

- marine (coastal wetlands, lagoons and coral reefs)
- estuarine (deltas, tidal marshes, and mangrove swamps)
- lacustrine (lakes and associated wetlands)
- riverine (wetlands associated with rivers)
- palustrine (marshes, swamps and bogs)

In addition, there are human-made wetlands as fish and shrimp ponds, irrigated agricultural land, salt pans, reservoirs, and canals. The definition covers lakes and rivers, irrespective of their depth. Knowledge of wetland type provides a very generic sense of the processes which govern the wetland system. A riverine wetland therefore has several of its features and functions linked to riverine processes, for example flow conditions, habitat connectivity, inundation regime etc.

Predominant environmental characteristics of wetlands

Hydric soils: Soil that is saturated, flooded or ponded long enough favouring anaerobic conditions.

Vegetation: Hydrophytic, adapted to wet conditions.

Inundation: Presence of water, permanently or seasonally.

Given a wide span of the ecosystem types considered as wetlands, and often a lack of specific boundaries, it is hard to discern the exact area under wetlands. The global extent of wetlands is estimated to be in excess of 1.2 million square kilometres, but it is well established that this is an underestimate. The most recent assessment of the wetland extent of India was published in the 2011, based on remote sensing images of 2006-07. The overall wetland area was assessed to be 15.26 million hectare of which inland wetlands accounted for 69.22% (10.56 million hectare). Rivers, streams and reservoir / barrages form the major types within inland wetlands.

2.2 Wise Use of Wetlands

Wetlands are one of the most productive environments. The aquatic environment and high primary productivity enables them to support a range of biodiversity, in particular high concentration of birds, mammals, amphibians, fish and invertebrate species. Wetland ecosystems support human well-being by providing food and fiber, water purification, climate regulation, flood regulation, coastal protection, recreational opportunities and tourism. The principal supply of renewable freshwater for human use comes from an array of wetlands, including lakes, rivers and swamps. Fish from wetlands is an important source of animal protein for several developing economies.

Wetlands are unique in these sense that they are one of the most embedded and interlinked ecosystems with human livelihoods. Management of wetlands therefore needs to recognize human beings as a part of the ecosystem, and some level of use and harvest of products as a part of the processes which are bound to take place. Thus, conventional protected area led management approaches, which exclude humans and use of natural resource, are unsuitable for managing a large category of wetlands. It is under these pretexts

that the Ramsar Convention recommends adoption of "wise use" principles as management approach.

Wise use of wetlands involves their sustainable utilization for the benefit of humankind in a way compatible with maintenance of natural properties of the ecosystem. The Ramsar Convention Text defines wise use as:

> "The maintenance of their ecological character within the context of sustainable development, and achieved through implementation of ecosystem approaches."
>
> Ecological character is the "sum of components, processes, and services of that characterize the wetland at any given point in time".

Ecological character therefore is a key instrument for wetland management. Changes in status of ecological character provide insights into the efficiency of wetland management. Human induced adverse changes in ecological character need to be continuously monitored and prevented.

2.3 Functions of Wetland Management

- **Identification of objectives of site management**
  Wetland management plans help determine the objectives of site management. This gives a sense of direction to wetland managers on the purpose, objectives, and outcomes that are expected to be achieved through the management process. The degrees to which management objectives are met indicate management effectiveness.

- **Resolving conflicts**
  Wetlands, being multiple use in character are often linked with conflicts, especially in systems wherein the range of ecosystems service is broad and the community dependence on wetlands high. In certain cases, the institutional arrangements linked with wetland resources are not clearly defined. Management planning provides a platform for resolving conflicts through a stakeholder driven process and establishing commitments for the future.

- **Communication with stakeholders**
  An important function of management plan is to enable communication between various stakeholder groups. Management plan and the planning process are means of presenting information on various site features and the governing factors in a structured manner, thereby enabling a common understanding of wetland conditions and trends. By enabling participation in various stages of planning, the management plan provides opportunities for stakeholders to express their vision of wise use, and also the way management decisions are likely to affect them. Finally, it is a means of collective ownership of wetland resources as a societal good.

- **Defining monitoring requirements**
  Wetland management plan, by determining the features and governing factors, also help set the monitoring requirements for a site. For each of the management objectives, identification of performance indicators helps determine the monitoring system and infrastructure that is required to assess the change (for example, a series of strategically placed water quality sampling stations to assess the biological and chemical quality of water).

- **Building baseline**
  Management plans builds on a set of information that is available at the given point in time. Thus the process builds a baseline on various wetland features and governing factors. This also enables assessing changes in ecological character, and ultimately supporting adaptive management. Baseline creation provides important incentives to researchers who can meaningfully contribute to the review and adaptation of the plan.

- **Obtaining resources**
  Management planning entails assessing resources (financial as well as human) required for implementation. This information can be used to raise and

allocate resources. As a matter of fact, a good proportion of resources required for implementing management plans in our country can be met by creating synergies with ongoing government programmes, for example Total Sanitation Campaign, Rural Employment Guarantee etc.

- **Insure compliance with regulatory frameworks and policy commitments**
  There are a range of international, national and local level policy commitments that need to be kept in mind while developing the management plan. Similarly, the management also needs to demonstrate compliance to regulatory frameworks. Wetland management plans are key instruments through which the nodal authority can identify specific actions to meet the various national and local commitments and compliance to regulatory frameworks.

2.4 Wetland Management Planning Principles

Landscape management
Wetlands are embedded in a landscape. Several of their features (for example availability of water) are related to the elements as forests and agricultural land which determine the runoff. Management of wetlands therefore is linked to management of the landscape within which it sits, for example river basin, lake basin or coastal zone.

Additionally, the management plan for the wetland should be harmonized with that of the landscape. This applies both to developmental as well as conservation planning.

Adaptable management
Given the range of drivers and pressures that act on a wetland at multiple spatial, temporal and political scales, management planning needs to be prepared for and accommodative of uncertainties and challenges. This can be achieved by using an adaptable management approach, which allows for suitable modification of management based on continuous site monitoring and assessment of new information. An adaptable management process includes the following steps: (Fig. 1)

- Setting management objectives for various site features
- Implementing management plans to achieve the objectives
- Monitoring wetland features to assess the degree to which management objectives are being met
- Modifying management if the wetland features do not meet the set management objectives

Precautionary approach
In several instances, the ability of feature to sustain human use cannot be determined offhand due to lack of information. In such circumstances, as is the practise in other spheres of ecosystem management, use of precautionary principle is recommended. This

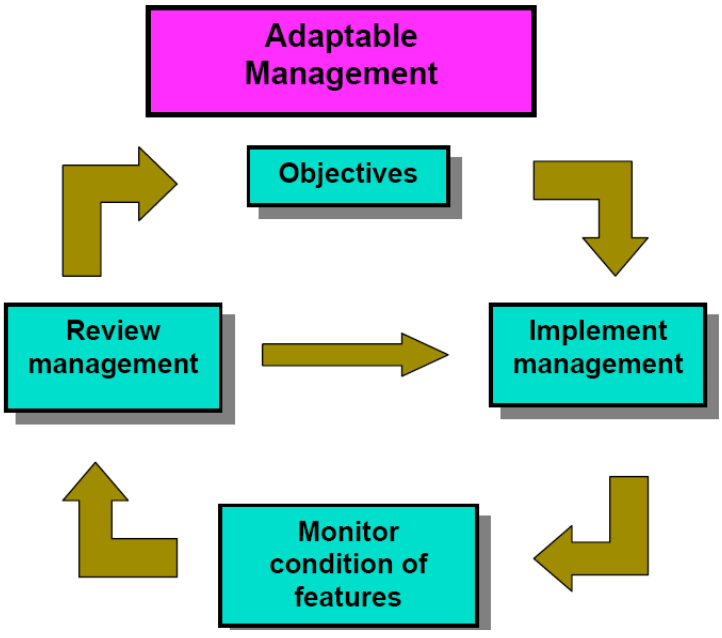


Fig. 1: Adaptable Management Cycle

means that lack of full scientific uncertainty should not be used as a reason to postpone measures to prevent ecological degradation.

Process driven
The ability of a plan to meet all site management objectives is influenced by availability of information as well as resources. Management planning should therefore be considered as a process, with the plan gradually getting complex from a minimal version to the one meeting all site management requirements as resources and information become available. Management planning therefore is a continuous exercise of identifying priorities, evaluating features and modifying management based on interpretation and incorporation of new information.

Stakeholder participation and inclusion
The condition of any wetland feature or a set of features is often an outcome of actions by a range of stakeholders, which are linked to the wetland in a number of ways. Management planning therefore needs to recognize these linkages, and build a mechanism for participation of stakeholders in design, review and implementation processes

3. Wetland Management Planning Methodology

The wetland management planning methodology is a logical process enabling site managers to identify onjectives and an implementation strategy required for ensuring wise use of the site. Building on a systematic analysis of wetland features and governing factors, the methodology enables development of a multi-sectoral and integrated work programme to balance the goals of ecosystem conservation with that of supporting livelihoods of wetland dependent communities. It also explicitly connects the site management plan to developmental planning as well as the broad scale landscape and ecosystem planning (for example, river basin planning).

The management planning methodology comprises five interlinked steps (Fig. 2):

1. **DEFINING PREAMBLE** : providing the policy context of the management planning
2. **WETLAND DESCRIPTION:** collating and synthesizing available information
3. **EVALUATION:** identifying key wetland features and linked threats
4. **SETTING MANAGEMENT OBJECTIVES AND PERFORMANCE INDICATORS:** for the priority features and reviewing effectiveness of management
5. **DEVELOPING ACTION PLAN:** outlining specific projects, resources required and institutional arrangements for implementation

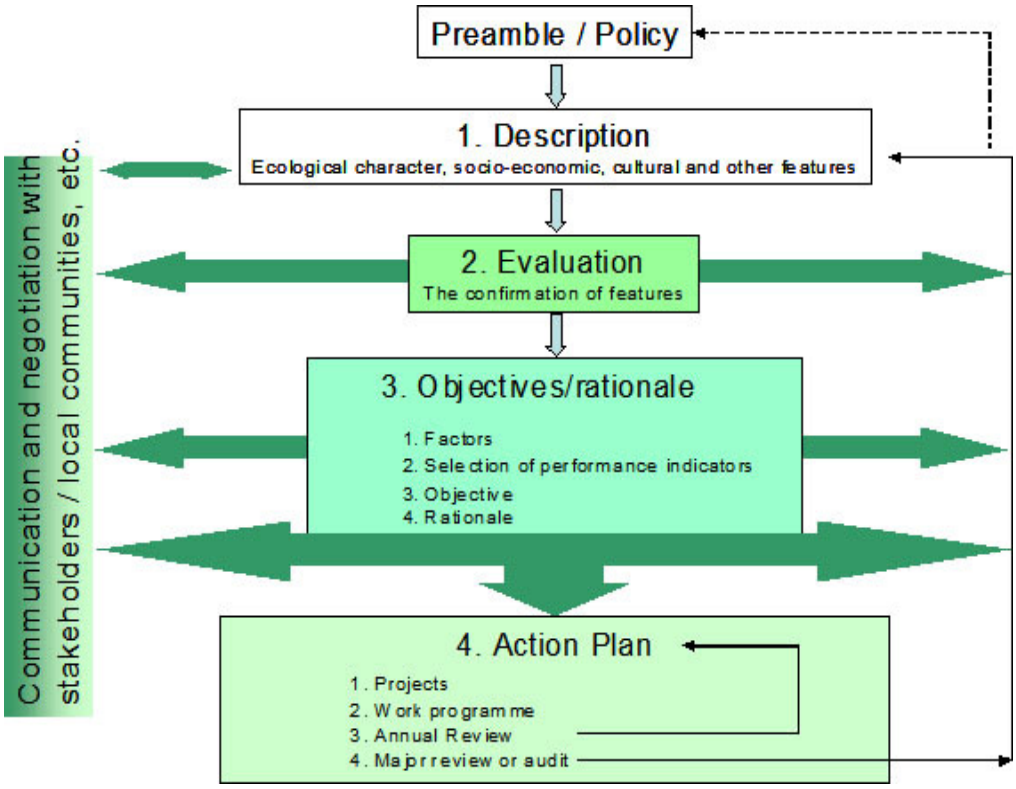


Fig. 2 : Management Planning Framework for Wetlands
(Source : Ramsar Handbook 14)

3.1 Preamble

The preamble section of management plan is a concise policy statement that reflects the commitment of national and state governments, non-government agencies, communities and other stakeholders for wetland management. This section is aimed at describing the overall purpose and an overarching policy context to management planning.

Policy context of wetland conservation in India

International: India as a Contracting Party to Ramsar Convention is committed to ensuring wise use of wetlands within its territory. The national government is also committed to implementation of the 2011-2020 Strategic Plan of the Convention on Biological Diversity, several Targets of which make direct and indirect references to wetlands, particularly their role in maintenance of hydrological regimes. Under the commitments under Convention on Migratory Species (also known as the Bonn Convention, sites hosting migratory species (for example migratory waterbirds) need to be managed in a way that there are no threats to these species and their habitats.

National: The National Environment Policy (2006) recommends adoption of integrated approaches, specifically river basin management and site specific prudent use as guiding actions for management of wetlands. In 2010, the central government introduced The Wetland (Conservation and Management) Rules, 2010 under the The Environment (Protection) Act, 1986. Its coverage rules include Ramsar sites, high altitude wetland sites (wetlands located at an altitude of 2,500 m and above) with area greater than 5 ha, sites or complexes below 2,500 m with an area of 500 ha and above, those designated as World Heritage Sites, and those specifically included under the provisions of the rules. The rules prescribe regulations for a range of activities likely to be detrimental for wetland. A Wetland Regulatory Authority has been constituted for the purpose of enforcement of the rules, to determine the proposals sent by the state governments and set thresholds for activities to be regulated. The state governments have been entrusted with the task of identification of wetlands to be included under the ambit of the act. Conservation of coastal wetlands, as mangroves and coral reefs are included in The Coastal Regulation Zone (CRZ) Notification, 1991 (as amended in 2011).

State: State governments have also enacted rules for conservation and management of wetlands within their jurisdiction. The Government of Manipur notified the Manipur Loktak Lake (Protection) Act, 2006 and Manipur Loktak Lake (Protection) Rules, 2008 which define a core zone and buffer zone, and stipulate specific activities that can be permitted within these designated areas. Similarly, the East Kolkata Wetlands (Conservation and Management) Act, 2006 restricts changes in land uses, diminution of wetland area, change in ecological character and provides the legal framework for East Kolkata Wetland Management Authority for enforcement of the Act.

The government of Orissa is in advanced stages of introducing a bill in its legislative assembly which would empower the Chilika Development Authority to regulate detrimental fishing, amongst various other stipulations. The Orissa Marine Fisheries Regulation Act (OMFRA, 1982) bans several forms of fishing in Chilika. In Kerala, the Conservation of Paddy Land and Wetland Act, 2008, is one of the few examples wherein rice paddies are considered as wetlands and their conversion banned. The Guwahati Water Bodies (Preservation and Conservation) Bill of 2008 empowers the government to preserve wetlands and acquire peripheral areas for protection of waterbodies.

3.2 Description of wetland features

Description of wetland features is essentially a collation and synthesis of existing data and information. This step provides the basic foundation of identifying management objectives and building the action plan. The features of wetlands that need to be focused include location and extent, wetland catchments, hydrological regimes, biodiversity, ecosystem services, socio-economics and livelihoods and institutional mechanisms.

3.2.1 Location and extent

Location and extent provide the information on the size and geographic situation of the wetland within the landscape. This section should be based on a map with atleast the following features:

- Waterspread (areas under permanent and seasonal inundation)
- Inflows , outflows and connectivity with rivers and coastal zones
- Hydraulic structures (dams, barrages, sluices etc.)
- Vegetation (both within as well as around the wetland)
- Land use around the wetland
- Physical features (islands, roads, railways, major towns / settlements, fish jetties etc.)
- Protected areas (for example boundaries of notified sanctuary, heritage sites etc.)

Use of remote sensing imageries of adequate resolution is recommended. Since, waterspread of the wetland system is known to vary significantly; a minimum of three images of a normal monsoon year (post monsoon, monsoon and pre monsoon) should be used to prepare the map. Standard procedures for geo-referencing and ground truthing must be followed.

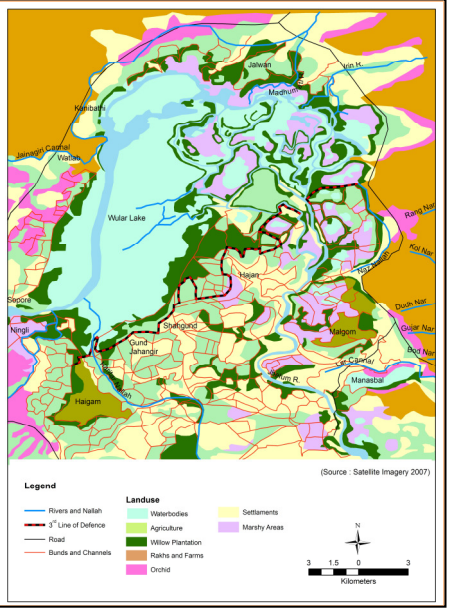
While reporting information on wetland area and extent, it is useful to focus on the range of variation rather than presenting averages (for example, Lake Chilika is known to vary between a monsoon maximum of 1,165 km^2 and a dry season minimum of 906 km^2 is much better way of presenting information than saying Lake Chilika has an average area of 1,041 km^2).

Things to remember while preparing wetland map

- ☞ Use a scale wherein the hydrological connectivity with the wetland complex and river / coastal zone can be clearly displayed
- ☞ Show areas under permanent and seasonal inundation clearly
- ☞ Show vegetation within as well as around the wetland system
- ☞ Show land use and land cover of the entire region

Box 1: Mapping Wular Lake, Kashmir

Wular Lake, a Ramsar site located in Kashmir is a freshwater lake of River Jhelum Basin. The river flows through the lake to form a wide expense of water, finally taking off the bottom to flow downstream into River Indus. The map of the wetland, drawn using remote sensing LISS III images and ground truthing shows the lake as girdled by willow plantations and embankments. It also shows agriculture land located around the inflowing streams. Of particular relevance are the marshes, which alognwith the Wular play a role in regulating hydrological regimes by absorbing high flows in summer and releasing them gradually during lean seasons of winter



3.2.2 Catchments

The next stage of wetland description is describing the catchment area which influences its hydrological regimes and key processes as nutrient enrichment and sedimentation.

A wetland catchment is the region which drains into the wetland. A large catchment has smaller sub-catchments formed by drainage area of contributing streams and tributaries. Description of catchments should be based on the following features:

- **Geology and Geomorphology:** Geology and geomorphology describe the landform within which the catchment is located. There are atleast six landforms types that determine the occurrence of wetlands, and whilst they are intergradational, it is important to describe the entire landform in which the habitat/site is located and not just parts of it (Table 1).

Table 1. Categories of landforms that are host to wetlands

Landform	Definition
Basin	Basins are depressed areas in the landscape with no external drainage. They may be shallow or deep and may have flat or concave bottoms. They usually have clear defined margins.
Channels	Channels refer to any incised water course. They may be shallow or deep but always have clear defined margins.
Flats	Flats are landscapes with a slope less than 1%, little or no relief, and diffused margins. Flat can be incised by a channel thereby giving rise to term 'channelled flats'.
Slopes	Slopes are areas with a gradient of greater than 1%, which may be concave or convex.
Crest of hills or highlands	Crests of hills or highlands are generally convex areas on the top of mountains, hills or similarly raised areas.

- **Altitudinal zonation:** Altitudinal zonation of the wetland catchments is important means to explain variation in environmental conditions (for example precipitation) which directly or indirectly affect the wetland system. The zonation should be based on observation recorded in meters above mean sea level. This information is normally available through topographic maps, orthophotographs, and national and regional land survey or mapping services. Digital elevation models (DEM) are useful tools for undertaking and presenting altitudinal zonations for wetland catchments.

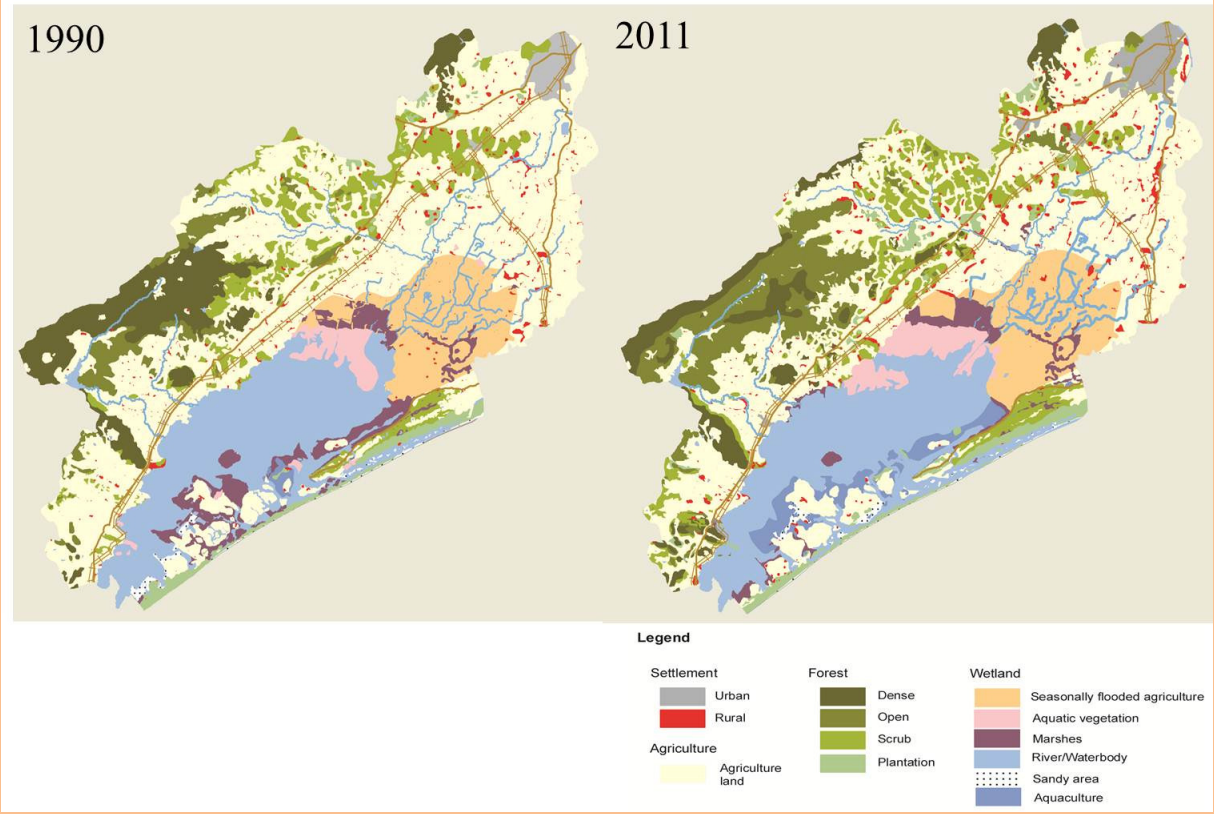
- **Soil types:** The state of soils within wetland catchments has direct as well as indirect influence on wetland processes as sedimentation and nutrient enrichment. The dominant soil types within catchment need to be described using soil maps and reports. Key elements to focus are erodibility status and waterlogged areas. The FAO soil classification (http://www.fao.org/nr/land/soils) is the most commonly used system for naming soils. Harmonised World Soil Database can also be used to develop soil maps.

- **Climate settings:** Climate settings of the wetland catchment can be described using information on precipitation, temperature, wind speed and direction, and relative humidity. If climatic characteristics are described based on information sourced from existing meteorological stations, it is recommended to record the name, code and geographic location of the station (latitude and longitude) which will enable spatial visualisation of the data.

- **Land use and Land cover:** Land use describes the human utilisation of land (agriculture, settlement, aquaculture etc). Land cover is the description of physical features on the surface of earth (forest, river, mountains, lakes etc). An analysis of land use and land cover, as well as land use and land cover change provides important information on condition and trends of various wetland features.

Box 2: Case Study: Land Use and Land Cover Change Assessment in Lake Chilika Basin

The Land use land cover change assessment for Lake Chilika Basin has been done based on available remote sensing information. The base layers have been developed from Survey of India topographical maps. The analysis has been done over a period of four decades. The images used for analysis pertain to 1972 (Landsat-1 MSS digital image of 7 November, 60 m spatial resolution), 1990 (Landsat-5 TM digital image of 28 November, 30 m spatial resolution) and 2011 (IRS P6 LISS-3 digital image of 19 January, 23.5 m spatial resolution). These have been digitally enhanced in ERDAS Imagine for interpretation. Along with these images, few other images from other seasons during nearby years have also been referred for validation of interpreted layers. During interpretation of 1972 image the SOI topographical maps have been referred for field level validations as they have been developed based survey during 1970-71. The digital cum visual interpretation techniques have been used in this mapping coupled with limited field verification, which ensures supervised classification as the interpreter holds the experience of field visit.



The analysis indicates that during the last four decades, the most significant land use / land cover change has been in forests and agricultural lands. Dense forests have been mostly converted into open forests. Similarly, agricultural lands have been converted into settlements (147.79 km^2) and aquaculture (13.28 km^2). Available trends indicate intensification of agriculture, as indicated by increase in are under irrigation, chemical fertilizer use, and crop productivity. The population density of the basin has also increased from 379 – 559 persons per square km during 1971 – 2001 as compared to 140 – 236 persons per square km within the state of Odisha. Within the area under Chilika shoreline, there is an increase in area under aquatic vegetation as well as aquaculture. A transformation of areas under seasonally flooded agriculture to marshes is also indicated in the analysis.

(Source: Chilika Integrated Management Planning Framework for Conservation and Wise Use, 2012)

3.2.3 Hydrological regimes

Hydrological regimes set the template on which the biodiversity and ecosystem services of wetlands are structured. A description of hydrological regimes is based on water inflow and outflow patterns, inundation, bathymetry, quality and use within the basin.

- **Water inflow, outflow and balance:** An assessment of water inflow and outflow and balance indicates the water that is stored into the wetland, and provides information on hydrological functioning, including flood control and groundwater recharge. It also indicates water availability for human as well as ecosystem purposes. The water balance can be estimated through hydrological models based on flow measurements.

Water balance of a wetland can be summarized by the following equation:

$dV = P + Qi + Gi – Ei – Qo ± T ± H$

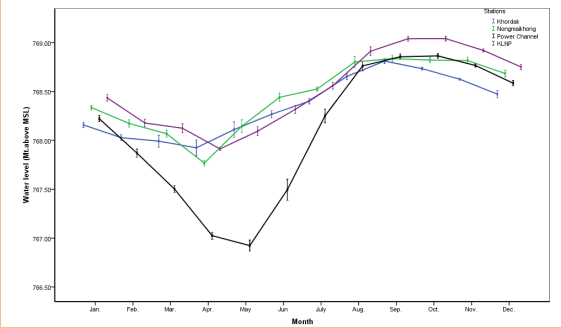
where,
dV is the change in volume of water within the wetland
P is the precipitation directly on the wetland
Qi is the river and other surface water inputs into the wetland
Gi is the groundwater input into the wetland
Ei is the evapotranspiration from the water surface, vegetation and soils of wetland
Qo is the surface outflow from the wetland
Go is the groundwater recharge from the wetland
T is the tidal input (negative when output)
H is the human influence (+ when input and – when abstraction)

- **Inundation:** Inundation pattern can be best characterized with a hydroperiod, which indicates the pattern of water level fluctuation in the wetland. This is developed based on water level information from various stations within the wetland. In large wetland systems, it is likely to have different hydroperiods for different stations, and therefore best to represent through a set of figures rather than just one. Inundation pattern are best represented spatially, and can be classified as in Table 2.

Table 2: Inundation patterns

Inundation pattern	Definition
Permanently inundated	Areas where land surface is permanently covered with standing water (except in years of extreme drought)
Seasonally inundated	Areas where land surface is semi- permanently flooded; when surface water is absent; water table is at or near surface
Intermittently inundated	Areas where the land surface is temporarily flooded; surface water is present for a brief period during the year but water table is otherwise well below the soil surface
Seasonally water logged	Areas where land surface is saturated for extended periods but surface water is seldom present

Box 3: Hydroperiod of Loktak Lake, Manipur



The lake levels of Loktak Lake shows a gradual increase during monsoon and then a gradual decline with a difference of around 2 meters. This difference provides the much needed water storage within the lake, used for hydropower production. Comparison with older water level records indicates that there has been a drastic reduction in lake level fluctuation. The other important thing to note is the variation in lake levels at different points in the lake. The lake levels at power channel dip faster than other parts of the lake.

- **Sedimentation**: Wetlands often serve as sinks of sediments, which plays an important role in their natural succession. Aggravated silt loads, however, can have serious negative implications on their hydrological functioning and ecosystem services. Assessment of overall rates of sedimentation and pattern of sediment distribution are important hydrological regime information. Correlated with information on bathymetric profile and land use and land cover change, information on sediment can be used to identify as well as monitor the impacts of catchment conservation programmes. Information on sedimentation are usually available through specific hydrological investigations.

- **Groundwater:** The relationship between wetlands and groundwater is complex. Many wetlands exist because an impermeable layer of rock or soil restricts vertical movement of water. However, some wetlands arise where groundwater comes to surface as springs. Furthermore, several wetland types as floodplains exist on very permeable soil which replenishes groundwater. The hydrological linkages of wetlands with groundwater vary depending on the local conditions. It is therefore important that the known information on groundwater is described and relationships, if established through specific studies, included in the overall description.

- **Water Quality:** Water quality information provide insight on wetland health with special reference to stressors such as level of nutrients/ toxicants, sediment inputs, acidification, salinisation, heavy metal input. Water physico-chemical quality can be collated from available literature or measured using standard procedures as that of American Public Health Association, 1998. Wherever possible, the source of contributing nutrients (fertilisers in agricultural land, sewage outfalls etc), toxicants (mining, industrial effluents) and sedimentation (cropland, catchment degradation) should be provided. In addition to these, information on waste water discharge, point or non-point source of polluters, indicating specific pollutant should be provided to have comprehensive information on water quality. Table 3 contains ranges related to some water quality parameters that can be used to characterize the wetland.

Table 3: Range of selected water quality parameters

pH	Very strongly acidic (1.0-2.9) Strongly acidic (3.0-3.9) Acidic (4.0-4.9) Weakly acidic (5.0-6.5) Neutral (6.6-7.5) Weakly alkaline (7.6 – 8.5) Alkaline (8.6 – 9.9) Strongly alkaline (10 – 11.5) Very strongly alkaline (11.5+)
Salinity (ppt)	Freshwater (<0.5) Brackish (0.5-18.0) Semi-saline(18.0-30.0) Saline (30.0-40.0) Hyper-saline (40-100) Ultra-saline (>100)
Nutrients (µgm/l)	Oligotrophic (N=250 – 600: P =5-10) Mesotrophic (N=500 – 1000: P=10-30) Eutrophic (N=1000-2000:P=30-100) Hypereutrophic (N>2000: P>100)

- **Water use:** The availability of water to the wetland is linked to water use pattern within basin. Human uses of water can often conflict with requirements for maintaining ecosystem processes. Water needs for irrigation, hydropower or domestic use within a basin is often met through construction of hydraulic structures, which impact the natural regimes of the basin. Fragmentation of landscapes through hydraulic structures is one of the major reasons of degradation of wetlands, worldwide. It is therefore important that the water use pattern within the wetland system is documented systematically, and the implications assessed for the wetland system.

3.2.4 Biodiversity

Description of floral and faunal biodiversity needs to capture the condition and trends, habitat utilization, process that maintain the populations, and threats.

Species richness and diversity
A list of species associated with the site with record of species richness and diversity of the main floral and faunal taxonomic groups should be compiled The population size of species or abundance can also be recorded with information on average abundance during different seasons. Breeding populations and migratory populations and their breeding and migratory periods, as well as required environmental conditions may need to be elaborated for groups wherein migration plays important role in maintaining population (for ex. Birds and fish).

For floral diversity, a listing of species as well as growth strategy (annual, perennial, seasonal), form (terrestrial, aquatic) and structural type (grasses, herbs, sedges, shrubs, ferns, palms and trees) can be described. For aquatic species (plants that have vegetative parts seasonally or permanently inundated) type can be presented as emergent, submerged or free floating vegetation, and areas presented in maps. Vegetation cover can be presented as either peripheral (only on margins of wetland), mosaic (present in patches), peripheral as well as mosaic or complete. Current status of species and their trends overtime need to be discussed to understand the process of succession and occupancy of vacant niches.

Conservation status
The conservation status of wetland species can be assessed using the IUCN Red List (for assessed species). For fish species, the web portal of Fishbase can be used. Similarly, the UNEP-WCMC Threatened Plants Database contains information on status of plant species of conservation significance throughout the world. Anecdotal evidences on historical declines are also important information base to assessing conservation status.

Information on conservation status should also include discussion on the threats.

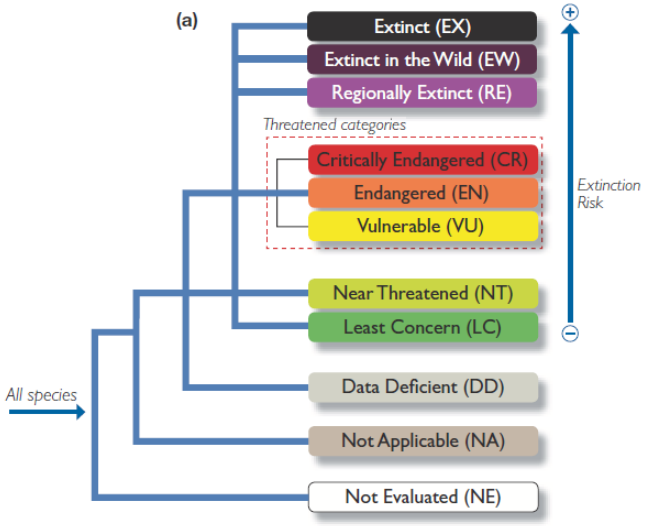


Fig. 3: IUCN conservation status categories

Biological significance of habitat
Along with recording information on biodiversity, it is important to assess the biological significance of the habitat, for example use by a number of waterbird species, presence of endemic species etc.

Assessing biological significance of habitats needs attention, particularly in cases wherein the site is or is proposed to be designated as a Wetland of International Importance (Ransar Site). Presently, the Convention acknowledges nine criteria for site designation, eight of which relate to waterbirds and fish species (Table 4). The population estimates of waterbirds that meet the criteria of internationally important sites can be determined by using 'Waterbird Populations Estimates' available from Wetlands International.

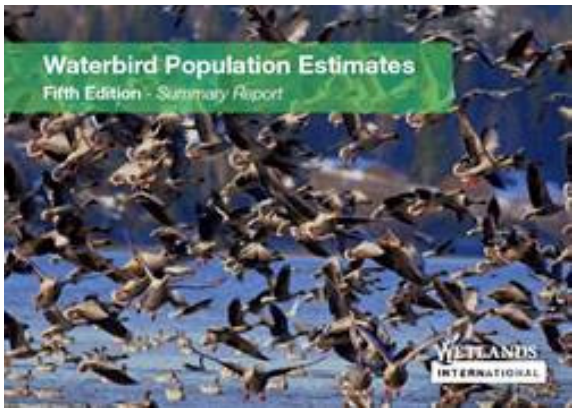


Table 4: Ramsar criteria for site designation

Ramsar Criterion	Description
Criteria 1	A representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region
Criteria 2	Supports vulnerable, endangered, or critically endangered species or threatened ecological communities
Criteria 3	Supports populations of plants and / or animal species important for maintaining the biological diversity of a particular biogeographic region
Criteria 4	Supports plant and / or animal species at a critical stage in their life cycle, or provides refuge during adverse conditions
Criteria 5	Regularly supports 20,000 or more waterbirds
Criteria 6	Regularly supports 1 % of the individuals in a population of one species or subspecies of waterbird
Criteria 7	Supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and / or populations that are representative of wetland benefits and / or values and thereby contributes to global biological diversity
Criteria 8	Important source of food for fishes, spawning ground, nursery and/ or migratory path on which fish stocks, either within the wetland or elsewhere depend
Criteria 9	Regularly supports 1% of the individuals in a population of one species or subspecies of wetland- dependent non-avian animal species

Invasion

Biological invasion is referred to a phenomenon wherein a species enters new environment, establishes itself there and begins to change the populations of species that existed there before, as well as disturbing the balance of plant and animal communities. Invasiveness, or the propensity to become invasive under a range of ideal conditions and ecosystems, can be attributed to a range or combination of characteristics of organisms, which include: a) capacity for rapid growth (and thereby expansion); b) capacity to disburse widely; c) large reproductive capacity; d) broad environmental tolerance; e) effective competition with local species for habitat and growth requirements. However, it is also recognized that species native to a particular area, under the influence of natural events or abrupt changes in ecosystems, can also become invasive.

Invasion by floral as well as faunal species is observed in most of the wetlands. It is therefore important to record the species that are invasive in the system, their physical extent (for plant species in particular) and growth strategy.

3.2.5 Ecosystem Services

Ecosystem services are the benefits people derive from the ecosystems. These are classified broadly into:

- **Provisioning**: The products obtained from wetlands which include food, fiber, firewood, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources and freshwater.
- **Regulating**: Benefits obtained from regulation of wetland processes, including air quality maintenance, climate regulation, water regulation, erosion control, water purification and waste treatment, regulation of human diseases, biological control, pollination and storm protection.
- **Cultural**: These are non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation,

aesthetic experiences, including cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, social relations, senses of place, cultural heritage values, and ecotourism.

- **Supporting:** Includes services necessary for production of all other ecosystem services along with soil formation, nutrient cycling and primary production.

While describing ecosystem services, the following aspects need special consideration:

- Extent to which the service is being provided (for example, level of fish catch)
- Beneficiaries of service provision (for example, fishers)
- Conditions and processes required to maintain the service (for example, fish migration, prevention of unsustainable harvest)
- Institutions regulating ecosystem service provision (for example, customary laws related to fishing)
- Costs and benefits of service provision
- Stakeholder conflicts

The information on ecosystem services, to the extent possible, should be quantified (for example, flood regulation capacity assessed using inflow and outflow hydropgraphs, or water quality change using measurements at inflow and outflow locations).

3.2.6 Socioeconomics and livelihoods

This section of the wetland description focuses on wetland – livelihood linkages. The analysis intends to assess the degree to which the wetland condition and trends are influenced by livelihood choices made by the user communities.

Analysis of livelihoods in the context of wetland management presents conceptual challenges, as unlike features as catchments and hydrological regimes, spatial boundaries for livelihood systems are hard to define as linkages exist at various scales through institutions as markets. Focusing only on communities directly dependant on wetlands is not sufficient as historical analysis indicates that changes in livelihood systems external to these communities (for example, increasing export attractiveness of shrimp farming) have important consequences for the wetland system and dependent communities.

With ecological character being the focus of management, the concept of "wetlands as settings" is useful to help characterize wetland –livelihoods interactions. Derived mainly from usage in the health sector, the concept places ecological character as an outcome of wetland – livelihood interactions. It recognizes a differential capacity for socioeconomic intermediation in wetland ecological character and human well-being interlinkages. The consequence of any change for wetland ecological character becomes the central point of interest, rather than setting a geographical boundary within which the livelihood systems are investigated.

Assessment of wetland livelihood linkages can be approached in the following steps:

- **Developing livelihood profile:** Based on sustainable livelihood approaches, livelihood system can be conceived comprising five broad categories of capitals, namely:
    - **Natural Capital** representing natural capital stocks from which resource flows and services useful for livelihoods is derived
    - **Human Capital** represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve livelihood objectives
    - **Social Capital** comprises social resources upon which people draw in pursuit of livelihood objectives
    - **Physical Capital** comprises basic infrastructure and producer goods needed to support livelihoods
    - **Financial Capital** comprising financial resources that people use to achieve livelihood objectives

- **Assessing wetland- livelihoods interactions:** Mapping of the wetland ecosystem services against livelihood assets provide a fuller understanding of the contribution of wetlands in the particular system. While ecosystem services of wetlands can be considered to form a part of natural capital, through

transforming structures and processes, ecosystem services can contribute to all forms of capitals (Box 4).

- Vulnerability contexts: The capitals are linked to an external environment domain, which consists of direct and indirect drivers of change. Operating at multiple scales, and across stakeholders, the indirect drivers may include demographic, economic, socio-political, science and technology, and cultural and religious; wherein the direct drivers include changes in local land use and cover, species introduction or removal, technology adaptation and use, external inputs, harvest and resource consumption, climate change, and other natural, physical, and biological drivers.

- **Livelihood strategies:** The capability of the communities to employ livelihood capitals, and wetland ecosystem services embedded within the capital set, define livelihood strategies. Livelihood analysis starts from the premise that access to services and benefits, and therefore well-being outcomes, is likely to be distributed in an unequal way along socio-economic lines. Management interventions for wetlands must also seek to address these inequities. The capability to access livelihood capitals are influenced by institutional arrangements, formal and informal. Inequality in access to resources, often attributed to scarcity, and opportunities of value addition create incentives for powerful groups to gain privileged access by influencing political, economic and social institutions that govern their access, management and use. The ability to create, revise and / or modify institutions is linked to the degrees of freedoms to the community. The broad six categories of freedoms include:

    - **participative freedom** which allows people to be involved in an active manner without intimidation or fear in deciding issues related to their well being
    - **economic facilities** enabling people to convert ecosystem services for production / exchange
    - **social opportunities** as arrangements societies make for education, health and other related sectors in order to allow them to live better lives and be productive members of society, specific reference being made to gender equality
    - **transparency guarantees,** referring to openness and trust
    - **protective security** creating safety nets against adverse events that make individuals helpless, and
    - **ecological security,** referring to minimum levels of ecosystem services required to sustain livelihoods .

- **Livelihood outcomes:** The livelihood strategies finally lead to a livelihood outcome, or changes in well-being status. A strategy can therefore be leading to a change in poverty status depending on the changes induced in the five broad elements of human well-being i.e the necessary material for good life, health, good social relations, security and freedoms and choice. The sustainability of the wetlands–livelihoods interlinkages could be assessed for a livelihood system in terms of achieving at least three pre-conditions:

    - **Internal sustainability,** wherein it has the ability to cope and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in future;
    - **Social sustainability** , wherein it enhances or does not diminish the livelihood of others; and
    - **Ecological sustainability,** wherein it does not deplete or disrupt ecosystem services to the prejudice of livelihoods and well-being of others, now or in future. Inherent in this definition is livelihood systems enabling maintenance or enhancement of wetland ecological character.

Box 4: Linking wetland ecosystem services to livelihood assets

Ecosystem Services of Wetlands		Livelihood assets				
		Natural: Land, Soil, Water, Fisheries etc	**Physical**: Basic infrastructure and producer's goods	**Human**: Skills, knowledge, health and ability to work	**Social**: Informal networks, formalized groups membership, relationships	**Financial**: Savings, credit, incomes, trade and remittances
	Provisioning	**Food and Water Security (subsistence)** Drinking water for human and livestock; water for agriculture; Food for humans and livestock		**Wetlands and Human Health**: Medical products	Community institutions based on water (eg. water user associations) and wetlands (e.g. mangrove associations) to manage their use and allocation	**Products for trading**: Food for Humans; food for livestock; Water, reed fiber and peat; Medicinal plants
	Regulating	Water purification; flood control; flood storage; soil; sediment and nutrient retention; coastal shoreline stabilization; storm protection; carbon storage; climate buffering	**Wetlands as Water Infrastructure** Flood control; flood storage; coastal shoreline stabilization; storm protection	Biological control agent for pest diseases		**Insurance values of wetlands** Coastal shoreline protection; carbon storage
	Cultural	Recreational hunting and fishing; Cultural heritage; Contemporary cultural significance; spiritual and religious values; Water sports; Nature study pursuits; Educational values; Aesthetic and sense of place values; knowledge systems; Other recreation and tourism		Wetlands and Human Health Water sports; Nature study pursuits; Educational values; Aesthetic and sense of place values; knowledge systems	Recreational hunting and fishing; Cultural heritage; Contemporary cultural significance; spiritual and religious values	**Revenue generation opportunities** Other recreation and tourism
	Supporting	Primary production; Nutrient cycling	Support all ecosystem services and livelihood capitals			

Data for livelihood analysis can be either collected through baseline surveys at household level or specifically designed participatory appraisals.

3.2.7 Institutional regimes

Institutions play an important role in influencing human behaviour towards wetlands by defining and delimiting the resource use patterns and thereby defining incentive structures for the related stakeholders. A description of institutional regimes should focus on:

- Formal and informal institutions related to wetlands
- Roles and responsibilities, with focus on conflicting interests
- Governance mechanisms
- Gaps in institutional arrangements

Points to remember for wetland description

- **Use multiple information sources.** For several features it is difficult to avail data from systematic monitoring or research. Getting insights from stakeholder consultations provides useful information on the conditions and trends of features, provided carefully interpreted and adequately triangulated. These should be recorded and made part of description.
- **Pay special attention to the feature(s) which support site designation,** for example as a Wetland of International Importance under Ramsar Convention.
- **Include a bibliography containing references used for collating information.** All forms of publications, whether published or unpublished should be cited.

- ☞ **Present the information in language that can be commonly understood by stakeholders.** Avoid using too much technical language and jargon of interest only to scientific and technical community.
- ☞ **Identify uncertainties and gaps in data.** This will help design a robust monitoring and research plan to support wetland management. To the extent possible, review the methodology and source of data before using it for making conclusions on site features.
- ☞ **Prevent information overload.** To the extent possible, focus on the relevance of information in the context of describing the condition and trend of wetland feature and its governing factors.

3.3 Wetland evaluation

Wetland evaluation is intended to provide a means of confirming important site features and identify the focus of management. It assists in setting priorities to wetland features described in the previous step by identifying a narrow set, maintaining which can ensure that the wetland continues to deliver the range of ecosystem services and support biodiversity.

3.3.1 Status and trends in ecological character

The first step in wetland evaluation process involves assessing the status and trends in ecological character (Table 5). The information for each of the wetland component, processes and services is analysed to assess their condition and trends. This step gives the first understanding of the overall condition of the wetland system.

An assessment of trend in particular wetland feature may require knowledge on the thresholds (for example, salinity levels linked with freshwater, brackish or marine conditions). To the extent possible, historical information on the ecological character elements must be summarized and analysed for discerning the trends. However, care must be taken to evaluate the information source, data generation methodology and associated uncertainties.

Table 5: Ecological Character Description

Ecological character features		Descriptors
Ecosystem Components	The living (biotic) and non-living (abiotic) constituents of wetland ecosystem	• Geomorphic setting (landscape, catchment, river basin, coastal zone) • Climate (precipitation , wind, temperature, evaporation, humidity) • Physical setting (area, boundaries, topography, shape, bathymetry, habitat type and connectivity) • Water regime (inflow, outflow, balance, surface – groundwater interactions, inundation regime, tidal regime, quality) • Wetland Soil (texture, chemical and biological properties) • Biota (Plant and animal communities)
Ecosystem Processes	Processes that occur between organisms and within and between populations and communities, including interactions with non-living environment, that result in existing ecosystem state	• Physical processes (water stratification, mixing, sedimentation, erosion) • Energy – nutrient dynamics (primary production, nutrient cycling, carbon cycling, decomposition, oxidation – reduction) • Processes that maintain animal and plant population (recruitment, migration) • Species interaction (Competition, predation, succession, herbivory)

	and bring about changes in ecosystems over time.	
Ecosystem Services	Benefits obtained by humans from ecosystems	• Provisioning (fisheries, use of aquatic vegetation for economic propose, water transport, biochemical products) • Regulating (maintenance of hydrological regimes) • Cultural (recreation and tourism, spiritual , scientific and educational value)

3.3.2 Identification of priority features

The ecological character description process yields a range of information on wetland features, not all of which have the same priority for management. The next step therefore is to evaluate the features to come up with a priority list.

The process for identification of priority features involves filtering the data using prioritization criterions. Some of the recommended criterions include:

- **Adherence to regulatory regimes / policy commitments:** Certain features need to be made the focus of management as per requirement of the existing legal and policy frameworks. For example, for sites notified under Wetland (Conservation and Management) Rules, 2010, changes in hydrological regimes are not permitted. For designated Ramsar sites, changes in boundaries are not permitted. These automatically set the boundary conditions for certain features.
- **Naturalness:** In general, the more natural a feature is, the greater its value of ecological character. However, determining naturalness often requires availability of historical data on the site. It is also recognized that often highly modified habitats can sustain high biodiversity and ecosystem services.
- **Rarity:** Presence of rare /endangered species and habitats is known to enhance ecological character value and thereby management attention.
- **Biological Diversity:** Maintenance of biological diversity is one of the important objectives of conservation planning. Sites with high biological diversity tend to have high ecological character value.
- **Potential for improvement and /or restoration:** This evaluation criterion can be used to justify action for restoration considering the possibility of restoration of a feature. Severally degraded features have a varying degree of restoration potential, and in most cases, only a few or limited features can be restored through appropriate management.
- **Criticality in sustaining ecosystem services and biodiversity:** Maintenance of state of certain features (for example hydrological connectivity) is crucial for ecosystem services provision and biodiversity. Such features need to be prioritized for management planning.
- **Socioeconomic importance:** Certain features as levels of harvest of fish, or availability of water have distinct socioeconomic importance for livelihoods or even in the cultural contexts. It is important that such features are identified and made the focus of management.

- Given the criticality of criterions in identification and prioritization of features, it is important that these are robust and derived through a consultative process.

3.3.3 Threats to ecological character

Following prioritization of features, the next stage involves undertaking a threats analysis to assess the risks of adverse changes in ecological character, as well as the root causes of ecological character change. This step ensures that management planning is not focused on symptoms, but uses a diagnostic approach to identify the real direct and indirect drivers of wetland degradation.

Identification of threats can be done using a DPSIR (Driver – Pressure- State-Impact-Response) analysis, or a problem tree analysis determining cause effect relationship.

3.4 Setting management objectives

The evaluation process leads to an assessment of existing condition of the wetland system, key features that need to be maintained, and the threats that need to be managed to achieve its conservation and wise use. The next step in the management planning process is to define a response strategy outlining a management framework and specific management objectives that need to be met in order to maintain the site in a desired condition. This involves:

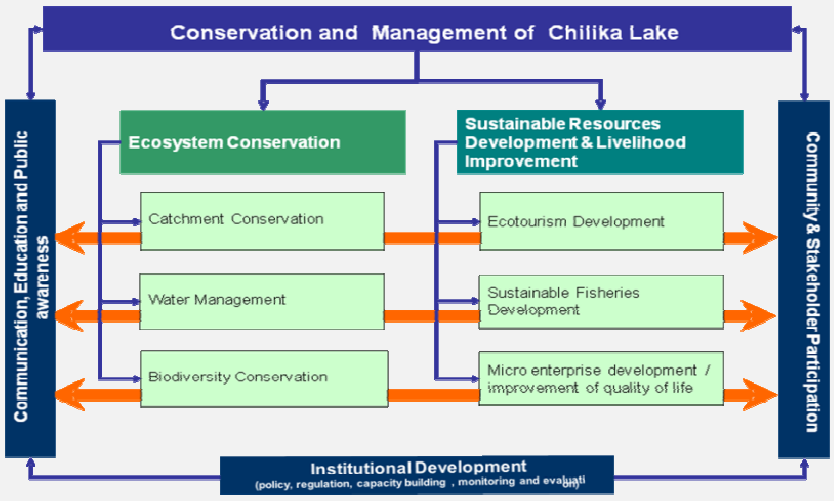
- Defining a management planning framework outlining the management goal and management components
- Outlining management objectives under each management component
- Developing performance indicators and a monitoring system for management objectives

3.4.1 Defining management planning framework

A management framework aims at describing the overall management goal, and broad components of actions that are required to address the need for maintaining the important wetland features in a desired state. It provides a structure for developing management objectives for each of the features of interest. It is a means to check whether sufficient number of objectives have been identified to be able to address the full range of divers and pressures related to the wetlands.

Generically, the management goal statement reflects the vision of wise use for the site, achieving which ensures that the range of services and the biodiversity are maintained. It is useful to structure the components along four broad areas: a) ecological restoration; b) sustainable livelihoods; c) institutional development; and, d) communication, education, participation and awareness (CEPA).

Box 5: Management framework for Lake Chilika, Orissa



The management planning framework for Lake Chilika envisages ecosystem conservation and sustainable resource development and livelihood improvement supported by institutional development; communication, education and public awareness; and institutional development as the key management components. The ecosystem conservation is proposed to address catchment conservation; water management and biodiversity conservation as its sub-components. Ecotourism development, sustainable fisheries development and micro-enterprise development / improvement of quality of life are subcomponents for sustainable resource development and livelihood improvement.

The ecological restoration component of the plan is aimed at conserving the conditions of the wetland and its associated basin. The objectives herein relate to managing the catchments, restoring hydrological regimes and habitat conditions for wetland dependent biodiversity. The component on sustainable livelihoods is focused on managing the ways community use the resources and providing incentives for the local communities to participate in wetland management. A separate work component on institutional arrangements is to bring focus on the ways and means by which various agencies related to management of different wetland features will collaborate and coordinate to manage the wetland. For several sites, the component focuses on creating and setting operational procedures for a wetland management authority. Finally, the CEPA component assists in developing a work programme on communication of wetlands and enhancing participation of stakeholders.

3.4.2 Defining management objectives

Management objectives state the condition that needs to be achieved within the priority features as a contribution to the overall management goal for the site.

The management objectives are defined based on the knowledge of the factors that govern the feature of interest. These could be broadly classified into being natural or human-induced and operating within and/or outside the wetland. A knowledge of these factors helps understand which of these can actually be managed and thereby are worth allocating resources for. Changes in features attributed to natural factors in most of the circumstances need to be accepted and factored in the management plan as a part of overall system behaviour.

Factor types	Examples
Natural factors	With the wetland system: Natural succession in vegetation External to wetland: changes in climate, sea- level rise
Human induced factors	
a) Attributed to wetland use pattern	Spread of invasive species, discharge of pollutants Traditions associated with resource harvest (rules for management of fisheries), stakeholder conflicts
b) Attributed to changes in landscape within with wetland is located	Degradation of catchment, fragmentation of hydrological regimes
Institutional factors	Limitations of existing legal arrangement to address unsustainable harvest of resources

Setting of management objectives can often be assisted by identifying operational limits. Operational limits define a range of values for each factor which can be considered acceptable and tolerable. An upper limit can be set for undesirable factors, whereas a lower limit for positive factors. For example, dissolved oxygen levels below 5 parts per million are unsuitable for fisheries. This information can be used to set the lower limits for this water quality feature. The spread of invasive species can be threat, and therefore needs to be managed based on an upper limit.

Box 6: Setting management objectives for management of *phumdi* in Loktak Lake

In Loktak Lake, Manipur, the management plan targets to maintain *phumdi* (a mix of over 60 species of plants and sediments in various stages of decomposition, spread of which is considered harmful especially in the central part of the lake) only in the northern and southern region, thereby specifying an upper limit. In Southern Sector of the lake, wherein a globally endangered deer species, *Ruvercus eldii* inhabits the *phumdi*, the extent is used to set the lower bound of habitat condition. Management planning therefore recognizes the positive as well as negative role of phumdi in ecosystem management.

Things to keep in mind while defining objectives

- **Measurable** – the objectives must be measurable so as to enable reporting on progress towards meeting them (for example, reducing silt load from the lake basin by xx %)
- **Achievable** – the objectives must be achievable atleast in the medium or long term. An objective that cannot be achieved can lead to an overall loss of sense of direction and misallocation of resources (for example, completely preventing nutrient enrichment in a wetland located in an intensive agricultural landscape is an unachievable objective, a much better proposition would be to reduce the current rate by xx%).
- **Indicative of purpose and not the process** – the objectives should not be prescriptive stating the way the objective should be achieved. It should ideally reflect the purpose of management. (for example – afforestation in xxx ha is not an objective but a way to reduce siltation. Focusing just on afforestation then limits use of other options for reducing siltation in the wetland). The processes are generally used to define the action plan for the management objective.

3.4.3 Setting performance indicators and monitoring plan

The process of setting performance indicators is about creating mechanisms for assessing efficiency of the plan and to provide inputs to a review and adaptation. The performance indicators provide evidences on the condition of one or a set of features. Some examples are provided below:

Feature	Performance Indicator	Means of measurement
Catchments	Reduction in silt load	Monitoring pilot watersheds
Hydrological regimes	Improvement in water quality (reduction in coliforms , reduction in nutrient levels)	Water quality monitoring
	Enhanced connectivity	Monitoring flows, surface water exchange
Socioeconomics	Decreased use of harmful fishing practices	Socioeconomic surveys
	Reduced dependence on wetlands	Socioeconomic surveys

When the full range of performance indicators for all the management objectives have been identified, it is useful to combine them into a monitoring plan to enable systematic capture of the monitoring outcomes and use in informing the planning process. The hierarchical framework for wetland inventory, assessment and monitoring systems provides useful way for spatially organizing the plan (Fig. 4).

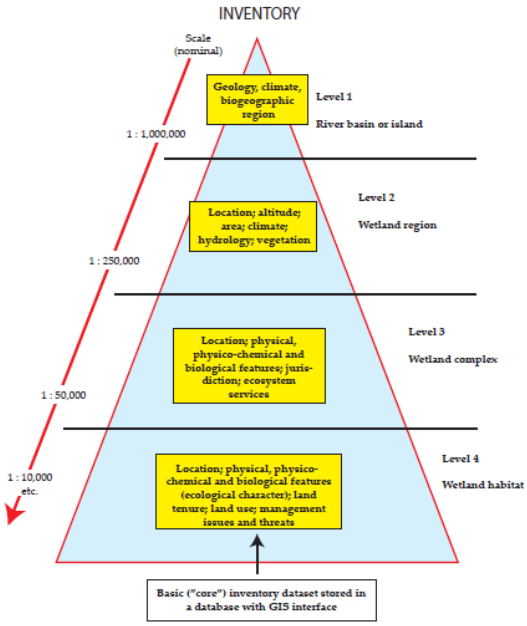


Fig. 4: A hierarchical system of Wetland Inventory Assessment and Monitoring (Source: Ramsar Resolution 1X. 1 Annex E)

Linked with the action plan, the performance indicators may also be set at various results level. For example, in a wetland catchment conservation programme, the various results could be:

Outcome: Reduction in silt load
Output: Increase in vegetative cover
Activity: Afforestation

A results based logical framework for Loktak Lake is given at Annex 1 for illustration.

Criterions for identifying performance indicators

- Is relevant to site condition
- Is quantifiable and measurable
- Provides information on condition of certain wetland feature
- Is economic to measure

3.5 Defining action plan

The final stage of the management planning methodology is defining the action plan, or projects that address the identified management objectives. The projects need to be defined very clearly to ensure good implementation. The following issues need to be considered while drafting the action plan:

- What is the activity ?
- When is to be carried out ?
- Where is the activity to be implemented ?
- Who is responsible for the activity ?
- What priority is to be given for the activity ?
- What budget is required ?

A generic listing of activities for management of wetlands is presented in table below. After the action plan has been defined, it is useful to develop a Gantt Chart for the entire plan, highlighting key milestones and reporting stages.

Generic listing of activities for management of wetlands

Management Plan component	Activities	Key considerations
Boundary delineation and demarcation	Boundary mapping and delineation	Site boundaries should be established with reference of hydrological and ecological conditions as inundation regimes, soil conditions and vegetation types. Landscape connectivity should also be taken into account when aquatic ecosystems exist in patches. All activities should be completed within first year.
	Removal of encroachments	Boundaries should be notified and wherever possible, protected through regulatory regimes. All activities should be completed within first year.
	Shoreline management	Mostly required for lakes in urban and peri-urban setting. For stabilizing bunds of lakes, naturalization of slopes using vegetative measures should be preferred. Development of promenade for urban lakes can be included based on evaluation of natural drainage and shoreline ecosystem niches.
Catchment conservation	Afforestation and aided regeneration	Catchment conservation plans should be developed at watershed scales and based on Joint Forest Management approaches. Only native species should be used for forestry operations. Pilot watershed should be periodically monitored to assess changes in soil moisture regimes. Livelihood interventions for catchment communities aimed at reducing dependence on wood as energy source should be included as appropriate.
	Small scale engineering	Community participation in design, implementation

Management Plan component	Activities	Key considerations
	measures (gully plugging, check dams, gabion structures etc.)	and post project maintenance of structures should be ensured.
Water management	Selective dredging and desilting to improve hydrological connectivity	Dredging to be used only selectively, and be based on assessments of bathymetric profile and species interactions. For inflowing channels, dredging can be used to improve water inflow.
	Interception, diversion and treatment of point sources of pollution	Mostly recommended for lakes in urban and peri-urban setting. Provision of comprehensive sanitation and safe drinking water coverage to communities living around the aquatic ecosystem should be ensured. Engineering (STPs) as well biological options (constructed wetlands) should be evaluated for application. Planning for Operation and Maintenance expenses should be included for all engineering structures.
	Construction and operation of hydraulic structures for maintenance of water regimes and flood control	For each major structure, detailed environmental impact assessments should be carried out prior to construction.
	Balancing water allocation for human and ecological purposes	Environmental flows for aquatic ecosystems, hydrological regimes of which are affected by hydraulic structures, should be assessed and implemented in consultation in water managers
Biodiversity conservation	Habitat evaluation and improvement	Until specifically desired, plantation of terrestrial plant species in aquatic environment should be avoided.
	Improvement and maintenance of migratory routes	Community groups should be involved in habitat monitoring and maintenance of migratory routes
	Maintenance of breeding and spawning grounds for key species	Community groups should be involved in maintenance of breeding and spawning grounds
	Management of invasive species	Mix of mechanical and biological methods for controlling species invasion should be used. For plant invasives, economic utilization alongwith physical removal should be included.
Sustainable resource development and livelihood improvement	Microenterprise development for reducing dependence on aquatic ecosystem resources for livelihoods	Identification of micro-enterprise development options should be based on assessment of community livelihoods, capacities, resources and market linkages.
	Sustainable fisheries	Capture based fisheries techniques should be

Management Plan component	Activities	Key considerations
	development	promoted in natural wetlands Options for improving culture fisheries in areas around wetlands should be included to reduce dependence on capture fisheries
	Sustainable agriculture development	Organic farming practices in immediate catchments and lake basins should be included to minimize nutrient enrichment in water body
Institutional development	Setting regulatory regimes	Site regulation should be harmonized with national and state level regulations. Local customary self-regulation which support maintenance of conservation values should be promoted
	Development of monitoring and evaluation system	Comprehensive monitoring and evaluation mechanism for hydrological, ecological, socio-economic and institutional features should be made a part of management system Involvement of stakeholders in monitoring should be encouraged.
	Communication and Outreach	Increasing awareness on values and functions of aquatic ecosystem should be made an integral part of the management plan
	Research	For each site, key research areas to support management needs should be identified and included in management plan

3.6 Budgeting and financing

A complete costing of the management plan should be done for the entire tenure of implementation, based on existing norms of the state and central government, as may be the case. For each of the activity, an analysis of complementarity with ongoing development or conservation sector schemes should be done to assess the extent of funding that can be generated through convergence with these schemes. Opportunities for private sector participation should also be identified.

4. Format for Compiling Management Plan

Chapter 1: Introduction	1.1 Policy context of wetland management in the state / UT 1.2 Rationale for management planning for the site 1.3 Management planning terms of reference 1.4 Management planning approach 1.5 Management planning methodology
Chapter 2: Description and evaluation of site features	**2.1 Description of site features** 2.1.1 Wetland extent 2.1.2 Geology and geomorphology 2.1.3 Catchment characteristics 2.1.4 Hydrological regimes 2.1.5 Biodiversity 2.1.6 Socioeconomics and livelihoods **2.2 Evaluation of site features** 2.2.1 Status and trends in key site features 2.2.2 Risk of adverse changes in key site features 2.2.3 Analysis of drivers and pressures on site features 2.2.4 Identification of management needs
Chapter 3: Institutional arrangements	**3.1 Review of existing institutional arrangements for site management** 3.1.1 Formal institutional arrangements **3.1.2** Informal institutional arrangements **3.2 Gaps in existing institutional arrangements** **3.3 Proposed institutional arrangements for site management**
Chapter 4: Management Planning Framework	4.1 Management planning goal and purpose 4.2 Management objectives 4.3 Management strategies 4.4 Management Components 4.5 Sustainability of site management
Chapter 5: Monitoring and Evaluation Arrangements	5.1 Monitoring and evaluation objectives 5.2 Monitoring and evaluation strategy 5.3 Monitoring and evaluation institutional design 5.4 Infrastructure and human resource requirements 5.5 Reporting and quality control 5.6 Review and adaptation
Chapter 6: Action Plan	6.1 Component wise activities linked with management objectives
Chapter 7: Budget and Activity Phasing	7.1 Time planning for implementation of activities 7.2 Activity linked budgeting 7.3 Sources of financing (including analysis of sources of co-funding)

Annex 1

Results based Logical Framework for Loktak Management Plan

Narrative Summary	Performance Indicators	Means of Verification	Risks / Assumptions
Goal			
Conservation and sustainable utilization of Loktak and associated wetlands for ecological security and livelihood improvement of communities			
Objectives			
1.1 Management of phumdi proliferation in Loktak Lake 2.1 Enhanced water regimes of wetland	Maintenance of open water surface in central sector of Loktak Lake Increase in thickness of phumdis in national park Sustainable generation of hydropower	Temporal RS and GIS assessments Ecological assessments Hydropower production records	Inter departmental coordination Timely release of funds
3.1 Control of soil erosion from direct catchments	Reduction in soil erosion from direct catchments	Soil erosion and sedimentation assessments	Maintenance of conducive law and order situation
4.1 Enhanced effectiveness of park management	Enhanced ecological status of KLNP	Ecological assessments	
5.1 Reduced livelihood dependence on Loktak Lake	Reduction in capture fisher population Complete abolition of athaphum fishing	Socioeconomic assessments	
6.1 Enhanced institutional effectiveness for lake management			
Outputs			
1.1 Removal of phumdis from central sector and utilization for composting	Extent of phumdis in central sector Number of farmers utilizing phumdi compost	Remote sensing imagery Socioeconomic assessments	Inter departmental coordination
2.1 Barrage operations harmonizing ecological and human demands of water	Number of times barrage operated as per new schedule	Barrage operation records	Timely release of funds
2.2 Increased flushing	Extent of waterlogging	Physical surveys	Maintenance of conducive law and order situation
2.3 Comprehensive coverage of sanitation	Extent of nutrient loading	Water quality assessments	
3.1 Enhancement in dense forest cover in Loktak, Thoubal and Heirok watersheds	Dense cover area in direct catchments	Remote sensing and GIS analysis	
3.2 Reduction in area under shifting cultivation	Permanent vegetative cover in jhum areas Diversification in occupational structure of jhumias	Remote sensing and GIS analysis Socioeconomic surveys	
4.1 Improved knowledgebase on waterbirds	Datasets on various aspects of waterbirds of Loktak lake	Technical reports	
4.2 Enhanced technical and infrastructural capacity for park management			
5.1 Enhanced availability of fish fingerlings	Increase in fish fingerlings production	Records of HMCs Physical verification	
5.2 Diversification of income sources for Loktak fishers	Reduction in contribution of lake resources to household incomes	Socioeconomic surveys	
6.1 Independent monitoring and	Monitoring and evaluation reports	Reports	

evaluation system in place	used for management planning purposes		
6.2 MSF established for conflict resolution	Number of conflicts resolved by MSF	Reports, Personal interviews	
6.3 CEPA activities for enhanced awareness on values and functions of Lake ecosystem	Number of community actions for lake conservation and management	Press, media sources	
6.4 Enhanced capacity of LDA and concerned state government agencies for integrated wetland management			
Activities			
Component 1. Phumdi Management 1.1 Phumdi removal 1.2 Economic utilization	1.1 Volume of phumdis removed 1.2 Volume of phumdi based organic manure produced	Physical verification	Inter departmental coordination Timely release of funds Maintenance of conducive law and order situation
Component 2. Water Management 2.1 Improvement of drainage system 2.2 Desiltation at critical locations 2.3 Implementation of water allocation plan 2.4 Total sanitation	2.1 Length of drains desilted 2.2 Lake area dredged 2.3 Formulation of barrage operational rules 2.4 Number of toilets constructed	Physical verification Water management report Barrage operation schedule	
Component 3. Catchment Conservation 3.1 Treatment of degraded microwatersheds 3.2 Management of shifting cultivation 3.4 Livelihood improvement of hill communities	3.1 Area of microwatersheds treated 3.2 Area under jhums treated 3.3 Number of beneficiaries supported with alternate livelihoods	Physical verification Remote sensing imagery analysis	
Component 4. Biodiversity Conservation 4.1 Waterbirds conservation 4.2 Capacity building for park management	4.1 Database of waterbirds species composition, population; distribution and relationship with lake environment; feeding and foraging behaviour; migration patterns 4.2 Number of trainings for park managers 4.3 Additional infrastructure procured and being utilized	Technical Reports Databases Procurement records	
Component 5. Sustainable Resource Development and Livelihood Improvement 5.1 Operationalization of existing hatcheries 5.2 Pen culture for athaphum fishers 5.3 Microenterprise development for lakeshore communities	5.1 Number of hatcheries operationalized through HMCs 5.2 Number of athaphum owners and capture fishers benefitted under alternate livelihood prgrammes	Physicial verification Fingerlings production and income generation records of HMC Socioeconomic surveys	
Component 6. Institutional Development 6.1 Monitoring and evaluation 6.2 Establishment of Multi Stakeholder Forum 6.3 Communication, education and public awareness 6.4 Capacity building	6.1 Monitoring framework developed 6.2 MSF established and functional 6.3 Number of public awareness events organized 6.4 Number of trainings conducted	Monitoring ToR Monitoring Reports Progress Reports	

5. Glossary

Adaptation

A change by which an organism or species becomes better suited to its environment

Adaptive capacity

The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.

Anthropogenic

Refers to something originating from humans and the impact of human activities on nature.

Aquaculture

Farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic plants

Bathymetry

The study of water depth of lake floors

Biodiversity

The degree of variation of life forms within a given ecosystem, biome, or an entire planet

Biogeochemical Process

Process by which chemical elements and simple substances are transferred between living systems and the environment

Bio-manipulation

Deliberate alteration of an ecosystem by adding or removing species, especially predators

Bio-physical

Part of environment encompassing living species and their physical surroundings

Capacity

Combination of strengths, attributes and resources available to an individual, community, society, or organization, which can be used to achieve established goals.

Carrying capacity

Maximum population of a given species that an area can support without reducing its ability to support the same species in the future.

Catchment area

Area that collects and drains precipitation into an aquifer.

Climate change

A shift in global weather patterns resulting in an increase in the variability of temperature, precipitation, and wind in a region over a period of time.

Conductivity

Measurement of ability of a medium to conduct electric current. It depends upon the number of ions or charged particles in the water.

Conservation

Preservation, protection, or restoration of the natural environment, natural ecosystems, vegetation, and wildlife

Convention on Wetland

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Coping capacity

The ability of people, organizations, and systems, using available skills, resources, and opportunities, to address, manage, and overcome adverse conditions.

Coping

The use of available skills, resources, and opportunities to address, manage, and

overcome adverse conditions, with the aim of achieving basic functioning in the short to medium term.

Cultural services

Non material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences, including cultural diversity, spiritual and religious values, knowledge systems, education values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation and eco-tourism

Destructive fishing practices

Methods that are environmentally destructive or harmful to the habitat and non-target species such as the use of poisons / toxins, other deleterious materials, unregulated size in gears and nets and explosives.

Disaster

A sudden event, such as an accident or a natural catastrophe, that causes great damage or loss of life

Disaster risk

The magnitude of potential disaster losses (in lives, health status, livelihoods, assets and services) in a particular community or group over some time period arising from its exposure to possible hazard events and its vulnerabilities to these hazards.

Disaster Risk Reduction

The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid or to limit the adverse impacts of hazards, within the broad context of sustainable development.

Early warning system

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Ecological Character

Description of components, processes and ecosystem services at a given time.

Economic valuation

Assigning quantitative values to the goods and services provided by environmental resources which are generally measured in terms of what we are willing to pay for the commodity, less what it costs to supply it.

Ecosystem components

Two main components exist in an ecosystem: abiotic and biotic. The abiotic components of an ecosystem include various physical and chemical factors which represent geography, geomorphology, hydrology and climate. Biotic component of an ecosystem include autotrophs (primary producers) and heterotrophs (consumers).

Ecosystem management

A process that aims to conserve major ecological services and restore natural resources while meeting the socioeconomic, political and cultural needs of current and future generations

Ecosystem processes

The biogeochemical processes that transfer energy and matter within and between ecosystems.

Ecosystem restoration

The renewal of a degraded, damaged, or destroyed ecosystem through active human intervention.

Ecosystem services

The direct and indirect benefits that humans derive from ecosystem processes such as pollination, biodiversity and nutrient cycling that are not captured in traditional economic accounting, but that are vital to social, economic and spiritual well-being.

Ecosystem

Community of organisms interacting with each other and with their environment such that energy is exchanged and system-level

processes, such as the cycling of elements, emerge.

Ecotourism

Tourism directed toward exotic, often threatened, natural environments with special efforts support conservation and observes wildlife

Endemism

Species confined to a specific region or site.

Environmental flows

The quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well being that depend on these ecosystems

Exposure

The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.

Fish culture

Raising of fish in natural bodies of water and in artificial ponds.

Geomorphology

The study of the physical features of the surface of the earth and their relation to its geological structures

Human capital

The skills, knowledge, and experience possessed by an individual or population, viewed in terms of their value or cost to an organization or country

Hydraulic structure

A structure submerged or partially submerged in any body of water, which disrupts the natural flow of water. They can be used to divert, disrupt or completely stop the flow. An example of a hydraulic structure would be a dam, which slows the normal flow rate of river in order to power turbines.

Hydrobiology

The study of life and life processes in water

Hydrological regimes

Long-term spatial variation in the water depths and period of inundation within a wetland system.

Inundation regime

The inundation of land that is normally dry through the overflowing of a body of water

Lake Basin

Depressed basin shaped areas in the landscape with no external drainage. They may be shallow or deep and may have flat or concave bottoms. They usually have clearly defined margins.

Landscape

The visible features of an area of land, including the physical elements of landforms such as (ice-capped) mountains, hills, water bodies such as rivers, lakes, ponds and the sea.

Maximum Sustainable Yield

Maximum biomass extraction a renewable resource can sustain without impairing its renewability through natural growth or replenishment.

Micro-enterprise

A small business that employs a small number of employees

Mitigation

The measures to reduce the anticipated adverse impacts of hazard.

Montreux Record

A register of wetland sites on the List of Wetlands of International Importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference.

Natural Capital

The natural environment and its living systems, defined in terms of a stock of environmentally provided assets (soil, atmosphere, forests, minerals, water, fauna, wetlands), that provide the useful materials that represent the raw input or consumable products of human production.

Natural resource

Resources (renewable and non-renewable) supplied by nature

Nutrient cycling

Flow of elements and compounds between living organisms and their physical environment. Chemicals absorbed or ingested by organisms are passed through the food chain and returned to the soil, air, and water by such mechanisms as respiration, excretion, and decomposition.

Poverty alleviation

Any process which seeks to reduce the level of poverty in a community, or amongst a group of people or countries

Precipitation

Rain, snow, sleet, dew, etc. formed by condensation of water vapour in the atmosphere

Primary production

Production of organic compounds from atmospheric or aquatic carbon dioxide, principally through the process of photosynthesis

Provisioning services

Products obtained from the ecosystems, including food and fiber, fuel, genetic resources, biochemical, natural medicines, pharmaceuticals, ornamental resources and freshwater

Recreation

Activity performed during one's leisure or free time. Recreational activities are often done for amusement, enjoyment or pleasure and are considered to be 'fun'

Regulating services

Biogeochemical processes which benefit the society directly like nutrient cycling, climate regulation, water regulation, erosion control, water purification and waste treatment, regulation of human diseases, biological control, pollination and storm protection

Remote sensing

Technique of acquiring information about the Earth's surface without being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information.

Resilience

Ability of a biological organism to return to its original state following exposure to a biological, climatic or other stressor (example: pollution or other anthropogenic disturbance)

Risk

A probability or threat of a damage, injury, liability, loss, or other negative occurrence that is caused by external or internal vulnerabilities.

Risk management

Identification, assessment, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events

Risk transfer

The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise, or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party.

River basin Management

A management tool in Integrated Water Resources Management that generally contain descriptions of the water resources in a drainage basin and water allocation plans

Sedimentation

Tendency for particles in suspension to settle out of the fluid in which they are entrained and come to rest against a barrier.

Social Capital

The networks of relationships among people who live and work in a particular society, enabling that society to function effectively

Socio-ecological system

A set of critical resources (natural, socioeconomic, and cultural) whose flow and use is regulated by a combination of ecological and social systems and a perpetually dynamic, complex system with continuous adaptation

Socio-economic

A branch of economics that focuses on the relationship between social behavior and economics. Social economics examines how social norms, ethics and other social philosophies that influence consumer behavior shape an economy, and uses history, politics and other social sciences to examine potential results from changes to society or the economy.

Species Interaction

Positive and negative associations between species that favour or inhibit mutual growth and evolution of populations. It may take the form of competition, predation, parasitism, commensalism or mutualism.

Succession

The process by which a plant or animal community successively gives way to another until a stable climax is reached

Supporting services

Services necessary for production of all other ecosystem services including soil formation, nutrient cycling and primary production

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Tidal regime

Potential influence of tides on the evolution of a coastline

Topography

Study and depiction of the distribution, relative positions, and elevations of natural and manmade features of a particular landscape, such as mountains, rivers, valleys, and human settlements, railway lines, and roads.

Vulnerability

The propensity or predisposition to be adversely affected.

Wise use

Wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development.

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