INTEGRATED MANAGEMENT PLAN, HANLE

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Department of Wildlife Protection
Union Territory of Ladakh

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Integrated Management Plan developed by WWF India

This publication has been developed by WWF India under the assignment “Developing a model management planning framework for high altitude wetlands” in Ladakh Union Territory by the GEF-GOI-UNDP SECURE Himalaya Project.

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Executive Summary

Hanle Wetland Complex located in the Changthang Cold Desert Wildlife Sanctuary comprises of four key wetlands (Jung Demo, Raar, Chukil and Shado Bug) which range between 47ha to 224ha in area at an elevation range of 4000masl to 4400masl. The Hanle Wetland Complex is one of the most significant wetland complexes of the landscape, which provides vast ecosystem services to the local communities besides supporting key biodiversity supporting more than 310 bird species and key mammal species including the Snow Leopard.

An assessment of the wetland health conducted using the protocol developed by the Ministry of Environment, Forest and Climate Change, Government of India indicated that these wetlands are in moderate to good health. However, there are emerging threats which include changes in the hydrology, pollution, increasing abstraction of water and increasing tourism activities.

WWF-India was assigned the task to prepare the Integrated Management Plan (IMP) for the wetland complex under the UNDP sponsored SECURE Himalayas Project. This integrated management plan has been prepared as per the guidelines of National Plan for Conservation of Aquatic Ecosystems prescribed by the Ministry of Environment, Forest and Climate Change. As per the requirements of the IMP, an assessment of wetland feature, threats and ecosystem services rendered by the wetlands were undertaken. This formed the basis of the management objectives and action plans.

The major threats pertaining to the wetlands are as include changes in land use/land cover within the zone of influence, reduction in water spread area, loss of hydrological connectivity between Jung Demo and Raar, increasing tourism and related impacts which includes water diversions for agriculture, tourism Infrastructure, erection of electric poles, feral dogs and lake bed mining.

The management goals, objectives and activities proposed are as listed below:

Vision: *"A well-protected and healthy wetland complex, rich in biodiversity, which retains the flow of ecosystem services and emerges as a model for multi-stakeholder engagement in conservation."*

Goal	Objectives	Actions
Goal 1: Maintaining the ecological and hydrological integrity of the wetland	Objective 1: Securing the zone of influence of the wetlands	• Zone of influence and buffer zones of the wetland area to be notified, along with activities to be regulated, prohibited and banned
		• Springsheds in the wetland catchments are mapped and spring shed management plans developed and implemented
		• Establish and maintain the flow regimes needed for the hydrological integrity of the wetlands
		• Enhancing capacity of local community for adoption of sustainable agriculture
		• Establishing a hydrological monitoring system in the wetlands and the Hanle river
	Objective 2: Conservation of key habitats and wetland species	High conservation value areas in the four wetlands in the complex to be notified and conservation action initiated
		A plan for conservation of snow trout to be developed and implementation initiated
		Action plans for protecting the nesting sites of BNC and managing the feral dog threat to be agreed upon and implementation initiated with key stakeholders
	Objective 3: Hanle wetland complex becomes a model for community based eco-tourism	Sustainable eco-tourism roadmap is prepared and implemented
		Decentralized solid and liquid waste management is implemented
Goal 2: Multi-stakeholder institutional arrangement and cross-sectoral synergies established to ensure the effectiveness of the conservation plan of Hanle Wetland Complex	Objective 1: A multi-stakeholder institutional arrangement and CEPA programme lead to active stakeholder engagement and cross-sectoral coordination to ensure the effectiveness of the conservation plan of the Hanle Wetland Complex	A multi-stakeholder Hanle Wetland Complex conservation committee (as a mechanism for coordination and integrated management) is constituted and functional
		Establish synergies/linkages with ongoing programmes (TSP, Organic farming, and so on) to ensure integration of wetland conservation in sectoral plans
		A Communication, Education, Participation and Awareness (CEPA) programme is implemented for enhancing multi-stakeholder engagement and ownership in wetland conservation

An action plan with budget and timelines for implementation of various activities is also presented. Total budgetary requirement for carrying out the activities amounts to **INR 39,925,000/-** for a period of five years.

The plan also presents activity phasing for the implementation period under the coordination and management of Department of Wildlife Protection, Ladakh UT. Additionally, to promote collaboration and cross-sectoral synergies mapping of various schemes of different Government Departments was undertaken.

Realizing the significance of a multi-stakeholder approach for effective wetland management, the plan also proposes constitution of Hanle Wetland Complex Conservation Committee to ensure the participation of all the stakeholders in effective management of the wetland complex.

The proposed management plan is a dynamic one and suggests monitoring mechanisms to assess the changes in the wetland ecosystems with provisions for adaptive management.

Chapter 1: Introduction

Wetlands are one of the most productive ecosystems, performing many ecological and economic roles. Wetlands provide essential ecosystem services and contribute to people's livelihoods. They are a source of water; protect us from floods, droughts and other disasters; provide food and livelihoods to millions of people; support rich biodiversity, and store more carbon than any other ecosystem.

High-altitude wetlands (HAWs) are typically classified as wetlands occurring above elevations of 3,000 meters, nestled between permafrost regions and the tree line. They play an important role in the hydrological regime of key rivers and act as a buffer to store glacial meltwaters.

Additionally, HAWs sustain distinct biological diversity, including crucial habitats to various species, like migratory birds, which depend on these ecosystems to complete their annual migration cycles between the tropic and temperate regions.

Wetlands in Changthang:

The region is bestowed with rich aquatic resources, including, notably the Indus River and its tributaries, including Shyok, Nubra and Suru. The wetlands form a significant hydrological feature in this vast region. These high-altitude wetlands are habitat to diverse flora and fauna, including the resident and migratory waterbirds. The area is mostly frozen in winter from November to April, with many migratory birds visiting from April to October. Species such as the Black-necked Crane *(Grus nigricollis),* the Bar-headed Goose *(Anser indicus)*, the Great Crested Grebe *(Podiceps cristatus)*, and the Ruddy Shelduck *(Tadorna ferruginea)*, common Redshank (*Tringa tetanus*), Brown-headed Gull (*Larus brunicephallus*) use these wetlands as their breeding grounds. Hussain and Pandav, 2008 have reported breeding of at least 44 species of waterfowl in the high-altitude wetlands of Changthang cold desert Sanctuary (Hussain & Pandav, 2008). Key mammal species supported by the wetlands include Tibetan Argali *(Ovis amon hodgsoni),* Snow Leopard (*Panthera uncial*), Eurasian Lynx *(Lynx isabellina)* and Tibetan Wild Ass *(Equus kiang).* The vegetation can be broadly classified into scrub formations, desert steppe and marsh meadows. The major plant communities include *Caragana-Eurotia, Artemesia-Tenacetum, Stipa-Oxytropis-Alyssum,* and *Carex melanantha-Leymus secalinus.* Vegetation is mostly found along the riverine wetlands and marshes. The growing season is confined to a short period (June−August) in summer, and alpine steppe communities mostly characterize vegetation with medium to sparse cover (20%) (Tsewang Namgail, 2007). There are 24 major high-altitude wetlands in the Changthang region. The Hanle Wetland Complex is one of the most significant wetland

complexes of the landscape, which provides vast ecosystem services to the local communities besides supporting key biodiversity.

Hanle village is a little-known Changpa settlement in the eastern Hanle valley bordering China. Hanle valley is an important area for wildlife conservation. The Hanle Wetland Complex, which ranges from 4000 to 4400 meters above mean sea level, is a unique and significant, biodiversity-rich area of Changthang, Ladakh, within the Trans-Himalayan region.

Figure 1. Raar Wetland in the Hanle Wetland complex

Over 310 bird species belonging to 148 genera and 40 families have been recorded from wetlands in this region. Owing to the rich biodiversity the wetland complex supports, the area has been identified as an Important Bird Area by the Bird Life International[1] and Key Biodiversity Area.[2] The relative remoteness, unique hydrology and geomorphological characteristics of HAWs demands a differentiated approach to the management, considering their value as an ecological network rather than individual sites. This need is further underscored by rapidly changing land use and land cover patterns in these areas, and climatic stressors like increased rate of glacial melt. The effective management of the wetland complex requires a deeper understanding of the

[1] http://datazone.birdlife.org/site/factsheet/hanle-plains-(hanle-river-marshes)-iba-india
[2] http://www.keybiodiversityareas.org

climatic, hydrological and biological processes in these wetlands and devising management strategies based on this knowledge.

Under the UNDP SECURE Himalayas project, WWF India has developed an integrated management plan for the wetland complex based on field studies and stakeholder consultations.

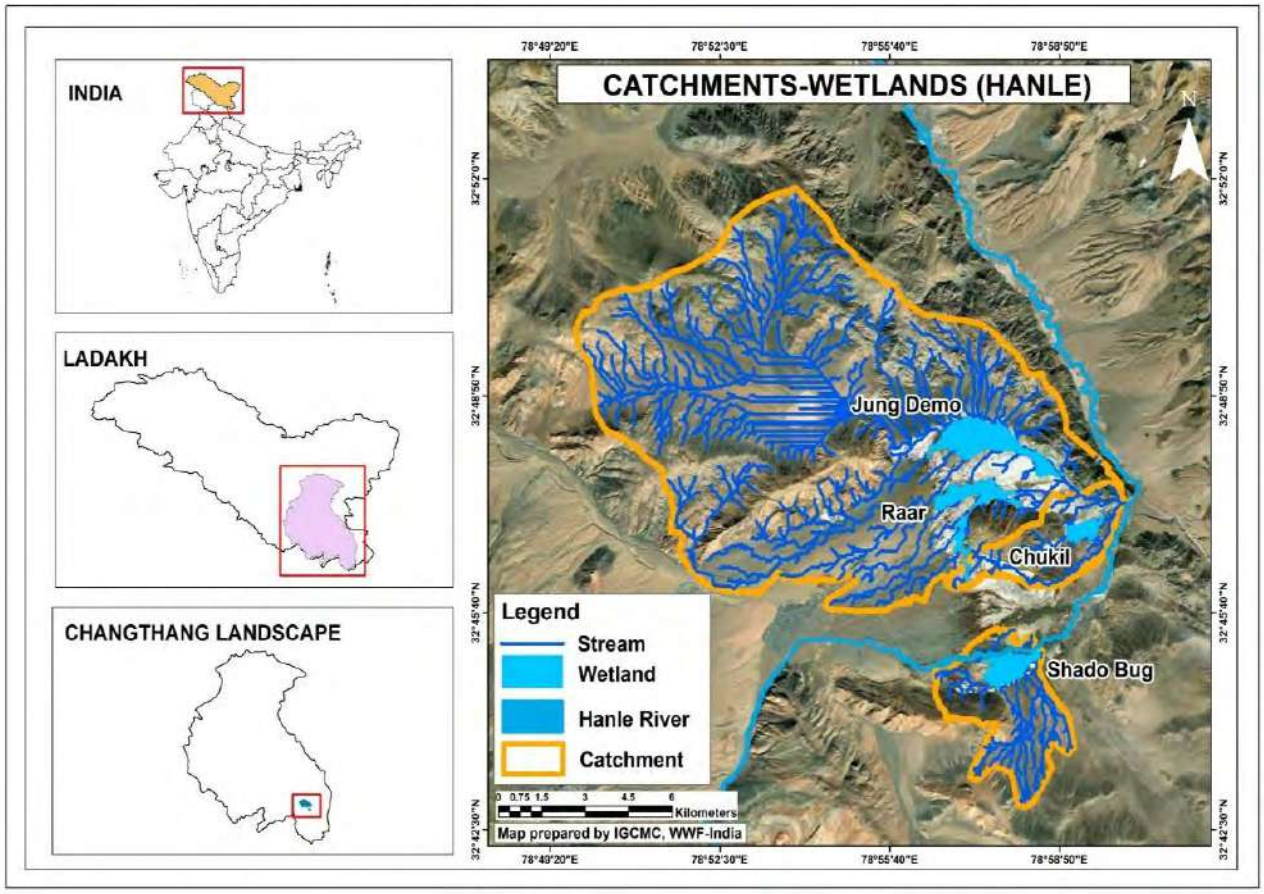
Chapter 2: Description of Wetland Features

Physical Regime

2.1 Location and Extent

Hanle Wetland Complex lies on the west and north of Hanle village, located about 275 kilometers from Leh. Hanle village is one of the high-altitude villages in Ladakh, perched at a staggering altitude of close to 4300 meters.

The habitat is a complex of fast-flowing streams, stagnant pools, marshes, seasonally flooded marshes, and bogs along the Hanle river, 45km south of its confluence with the Indus river. The wetlands are frozen from November to April and are fed by snowmelt in summer. The freshwater pools shelter species such as *Hydrilla, Myriophyllum, Potamogeton,* and an edible aquatic lichen[3]. The Hanle Wetland complex comprises four wetlands, out of which three wetlands, namely Jung Demo, Raar and Chukil, are part of the same hydroshed, while Shado Bug is a part of a separate



Map 1. Catchment Area and drainages of wetlands in Hanle Complex

[3] http://www.keybiodiversityareas.org/site/factsheet/18185

hydrological system, a little downstream. All the four wetlands feed into the Hanle River, an important tributary of River Indus. The wetland system has been identified as an Important Bird Area by the Bird Life International.

The salient features of the existing wetlands located in the wetland complex are as below:

- **Name of the District(s) in which the wetland complex is located**: Leh, Changthang Landscape, Ladakh UT
- **Name of the Village**: Hanle
- **Name of the Tehsil**: Nyoma

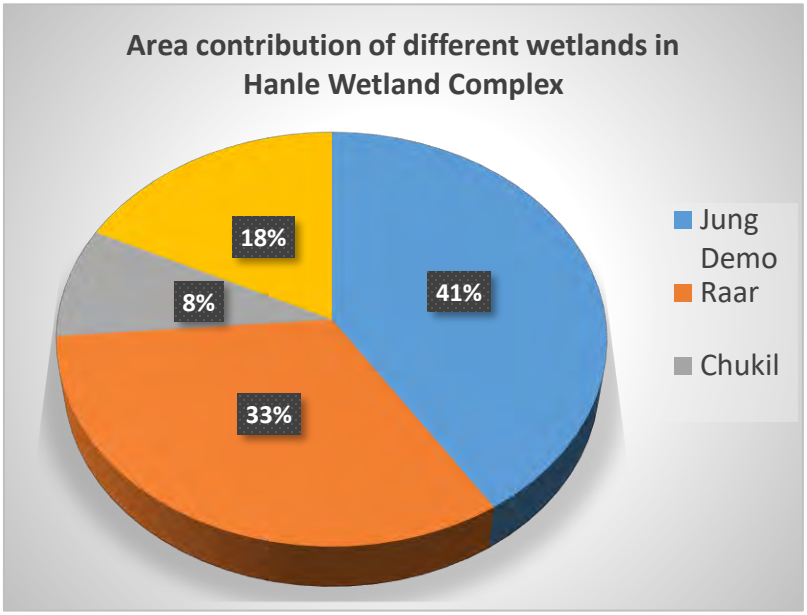
Table 1. Salient features of Wetlands in Hanle Complex

Name of the Wetland	Elevation(m) above mean sea level)	Latitude	Longitude	Area of Wetland (ha)	Zone of Influence (sq km)	Major Source of Water
Jung Demo Wetland	4305	32°48'07.6" N	78°57'41.6" E	224	109.75	Glacial Melting
Raar Wetland	4326	32°46'47.3" N	78°57'02.0" E	180		Glacial melting
Chukil Wetland	4276	32°46'53.9" N	78°59'20.9" E	47	7.05	Glacial melting
Shado Bug Wetland	4298	32°44'42.3" N	78°58'25.3" E	97	10.47	Glacial melting

The wetland area has been calculated based on the geospatial analysis as well as the ground-truthing survey. Similarly, the zone of influence has been delineated based on geospatial analysis. The details of the methodology used to delineate the zone of influence are mentioned in **Annexure 1.**

Map 2. Hanle Wetland Complex

The area receives less than 100mm of precipitation annually as rainfall and snow, and hence is recognized as a cold desert. Most of the wetland and streams of Ladakh are of glacial origin and remain frozen during the period from November to April.[4]



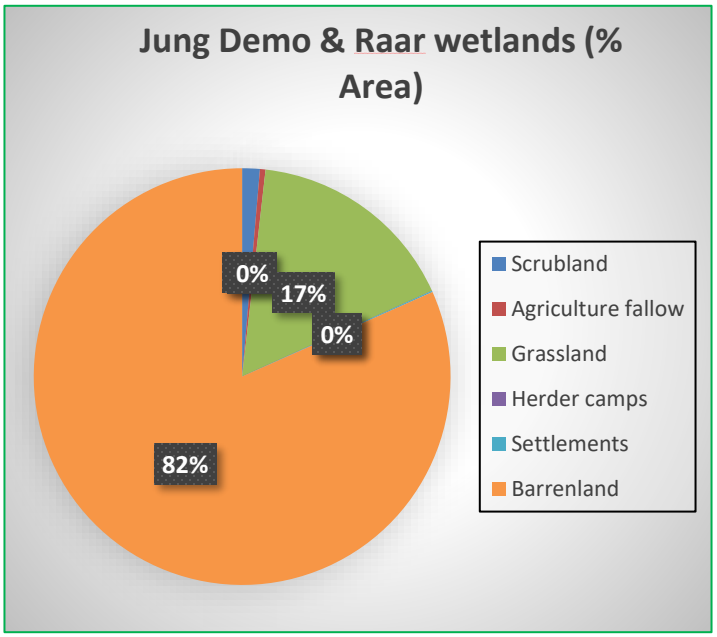
Graph 1: Area contribution of different wetlands in the Hanle Complex

[4] Hussain, S. A., Singh, R. K., & Badola, R. Unified ecosystem management plan for the Changthang wilderness area, Ladakh

2.2 Wetland Catchment:

The catchment area of the wetland complex is spread across 12727ha. The catchment area has been delineated on the digital elevation model, followed by the ground-truthing survey of the field. Assessment of the land use and land cover classes have been done based on the geo-spatial analysis. The details of existing land use and land cover in the catchment area are tabulated as below:

Jung Demo and Raar Wetlands: The land use-land cover analysis reveals that the major land use in Jung Demo and Raar wetlands is barren land and scrubland, which forms 41.26% and 41.76% of the area respectively, followed by grassland, which forms 16.19% of the area. Settlements cover 0.12% of the total area.

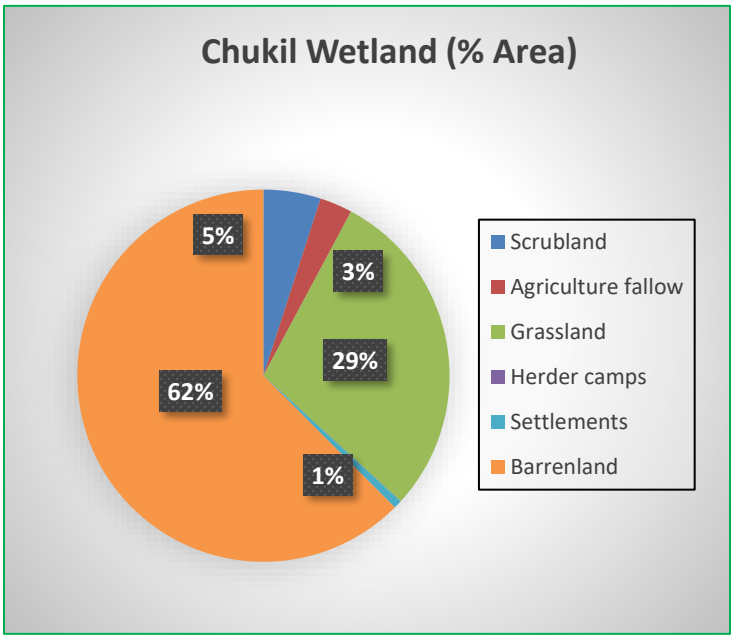


Graph 2. Land Use Land Cover in Zone of Influence of Jung Demo and Raar

Table 2. Land Use Land cover in Zone of Influence of Jung Demo and Raar wetlands

Class name	Area (in sq.km)	Area (%)
Agriculture fallow	0.785	0.72
Grassland	17.769	16.19
Waterbodies	0	0
Settlements	0.1367	0.12
Barren land	45.286	41.26
Scrubland	45.775	41.71
Total	109.75	100

Chukil Wetland: The land use land cover analysis reveals that the major land use in Chukil Wetland is barren land and grassland which forms 62.51% and 29%, respectively, followed by scrubland which forms 4.94 % of the area.



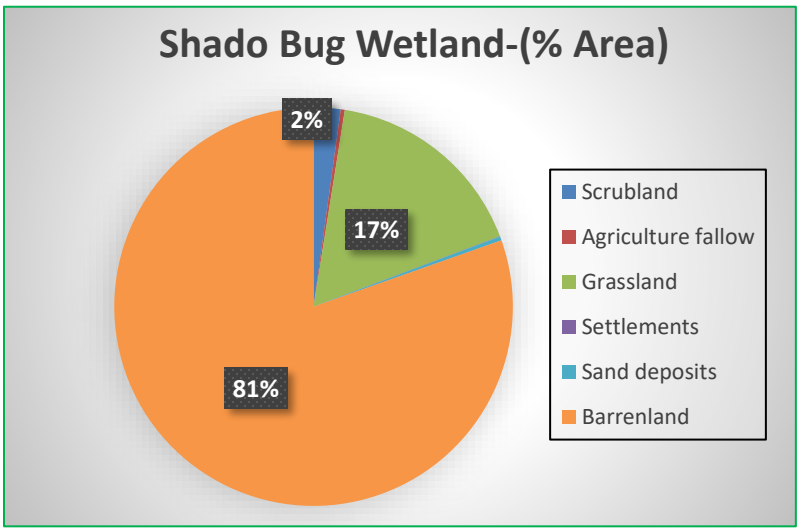
Graph 3. Land Use Land Cover in Zone of Influence of Chukil Wetland

Table 3. Land Use Land Cover in zone of influence of Chukil Wetland

Class	Area (in sq.km)	Area (%)
Agriculture fallow	0.20	2.83
Grassland	2.05	29.00
Waterbodies	0	0
Settlements	0.051	0.72
Barren land	4.43	62.51
Scrubland	0.35	4.94
Total	7.09	100

Shado Bug Wetland:

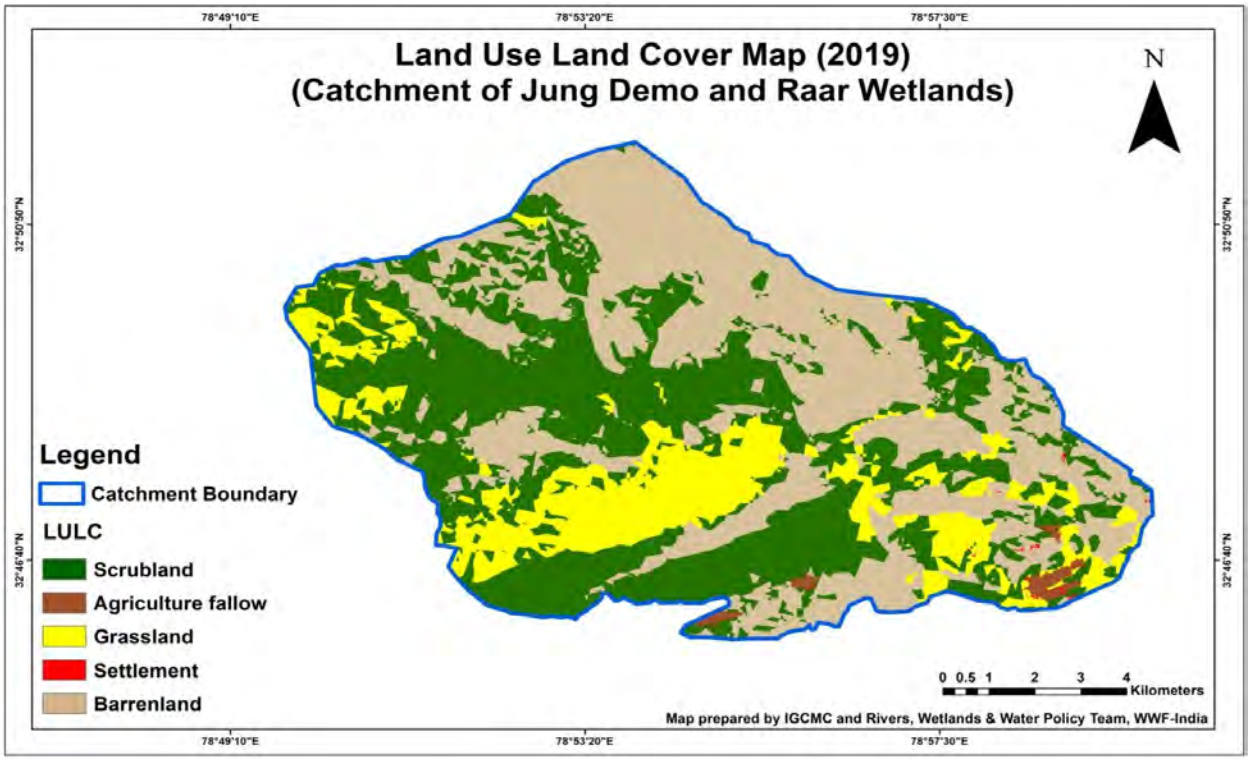
The land use land cover analysis reveals that the major land use in the Shado Bug wetland is scrubland which forms 57.21%, followed by barren land, which forms 25.61% of the area, closely followed by grassland, which forms 16.5% of the area in the zone of influence.



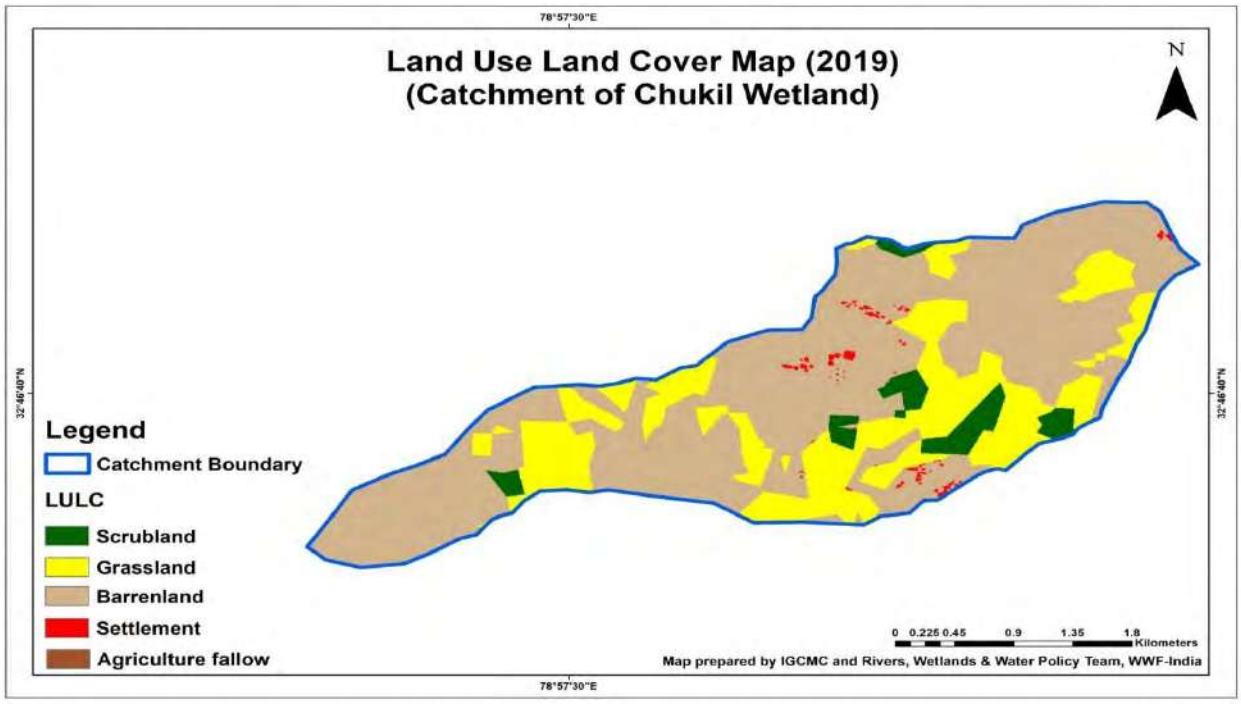
Graph 4. Land Use Land Cover in Zone of Influence of Shado Bug

Table 4. Land Use Land Cover in Zone of Influence of Shado Bug

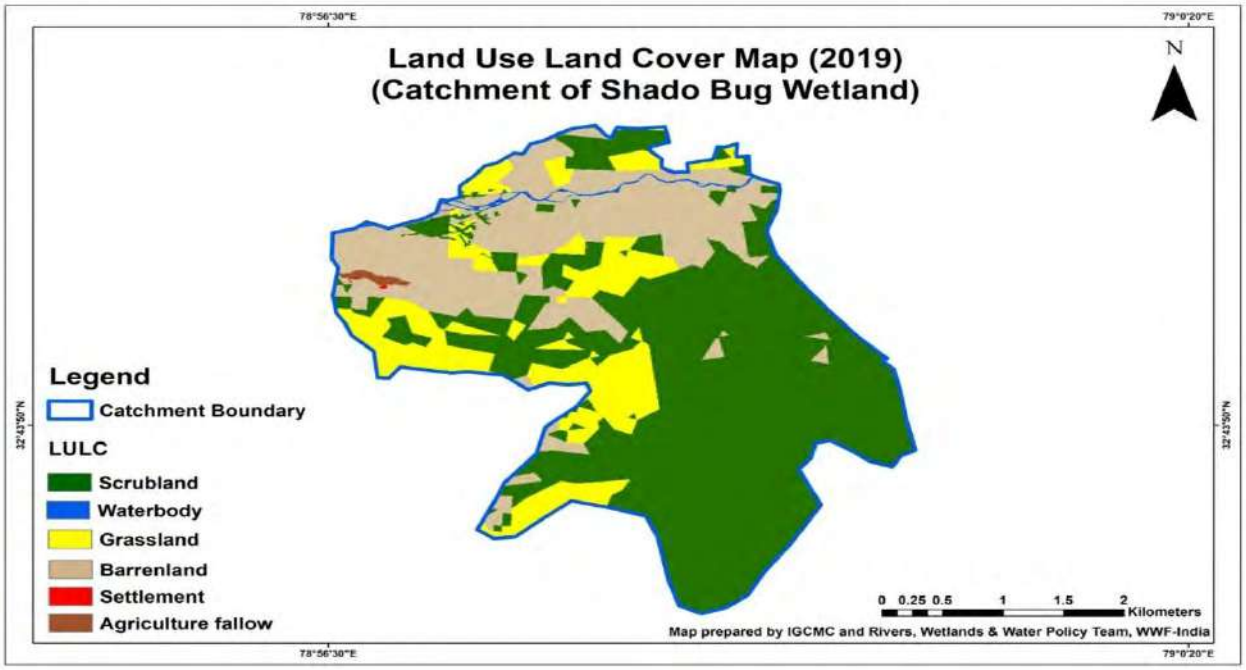
Class name	Area (in sq.km)	Area (%)
Agriculture fallow	0.034	0.32
Grassland	1.732	16.50
Waterbodies	0.053	0.50
Settlements	0.003	0.029
Barren land	2.689	25.61
Scrubland	6.007	57.21
Total	10.50	100



Map 3. Land Use Land Cover map of Jung Demo and Raar Wetlands



Map 4. Land Use Land Cover map of Chukil Wetland



Map 5. Land Use Land Cover map of Shado Bug Wetland

2.3 Hydrological Regimes

The hydrology of the Hanle Wetland Complex is governed by the inflows received from snowmelt and precipitation as rainfall and snowfall, which averages less than 100mm annually. The temperatures in the region vary between -21°C to 17°C. The rainfall peaks in July-August while the snowfall peaks between December-February. An analysis shows that in last ten years, the precipitation has decreased.

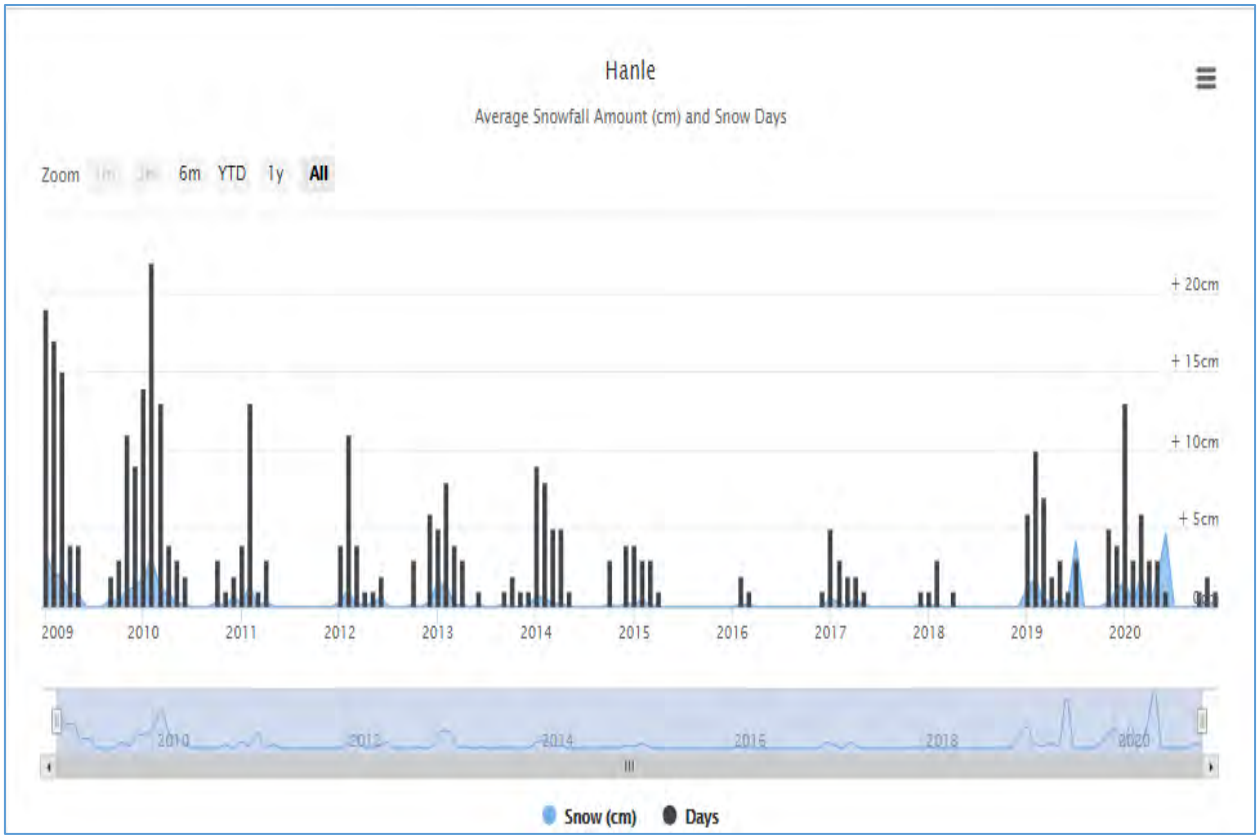
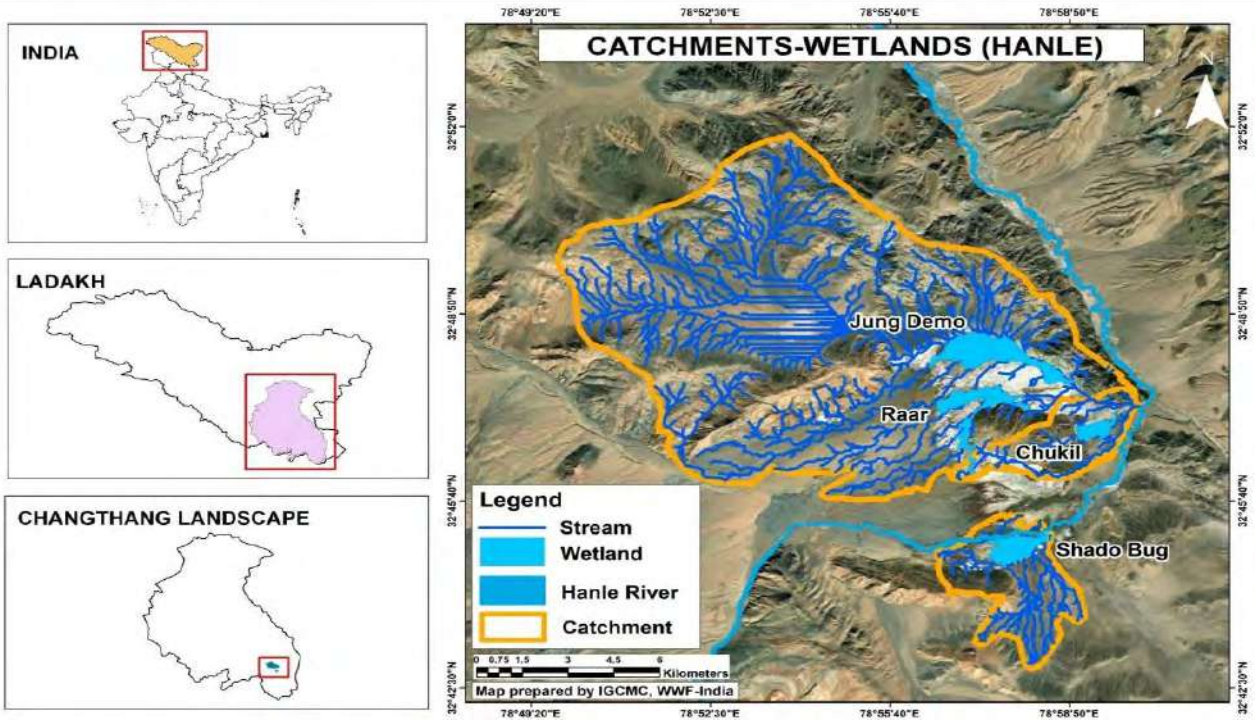


Figure 2. Decadal variation in the precipitation in Zone of Influence of Hanle Wetland Complex

Details on the hydrology of the wetlands are as below:

- **Jung Demo:** Micro drainages generated through SWAT model for assessment of hydrology suggest that there are around 15 inlets to the wetland, out of which two are the major ones which carry the majority of water into the wetland while 13 others are minor ones which contribute relatively less amount of water into the wetlands owing to smaller catchments. There is only one designated outlet from the wetland, which is intact.
- **Raar:** Four main inlets feed the wetland. Some of these inlets are partially impacted due to the construction of linear infrastructure in the upstream village of Punguk. There is one outlet from this wetland.
- **Chukil:** Micro drainages generated through the SWAT model suggest that there are three main inlets to Chukhil, out of which two inlets are impacted by construction of road from Khaldo village northwards (in the year 2013-14) cutting across two main drainages, while there is one outlet from the wetland, which is in good shape.

- **Shado Bug**: There are two main inlets to Shado bug, while only one outlet drains the wetland.



Map 6. Hydrology of Hanle Wetland Complex

2.4 Biodiversity: Important Flora and Fauna

The Changthang region lies at 4000m and above. The soil is sandy or sandy loam. Borax deposits in the dried marshy areas and around wetlands are a common feature. Strong and unpredictable winds make the area suitable for only well-adapted life forms. The single most characteristic feature of the region is the dryness (Sapru and Kachrroo, 1976)[5]. This region has numerous wetlands − brackish as well as freshwater. Apart from their hydrological importance, the wetlands are home to a wide variety of flora and fauna.

The vast open plains of Hanle are known nesting sites of the Black-necked Cranes (BNC) in Ladakh. In addition to the BNC, many other migratory birds also breed and feed in these wetlands.

The common birds which breed in and around the wetlands of Hanle are Upland Buzzard, Bar-headed Geese, Brahminy Ducks, Gargany, Northern Pintail, Northern Shoveller and the Common Teal. Within the Hanle plains, Jung Demo has been a traditional Black-necked Crane nesting area

(Chacko 1996; Pfi ster 1997). Shado Bug is also a known nesting site for Black-necked Crane (Chacko 1995; Pfi ster 1997).[6] WWF India, in its survey during October-November 2020, recorded species like the Upland Buzzard (*Buteo hemilasius),* Black-necked Crane (*Grus nigricollis)*, Pallas's Gull *Ichthyaetus,* Bar-headed Goose (*Anser indicus),* Ruff (*Philomachus pugnax)* and Plover (*Charadrius mongolus)*.

Several species of mammals are found in the region, which includes the Blue Sheep (*Pseudois nayaur*), Ladakh Urial (*Ovis orientalis vignii*), Tibetan Argali (*Ovis ammon hodgsoni*), Tibetan Wild Ass (*Equus kiang*), Himalayan Marmot (*Marmota himalayana*), Red Fox (*Vulpes vulpes*), Tibetan Gazelle (*Procarpa picticaudata*), Snow Leopard (*Uncia uncia*), Wild Dog (*Cuon alpinus laniger*), Tibetan Wolf (*Canis lupus chanko*) and the Lynx (*Lynx isabellin*).

Table 5. Notable animal species recorded in the Hanle wetland complex

Name of the species (Mammals)	Common Name	Jung Demo	Raar	Chukil	Shado bug
Ovis ammon hodgsoni	Tibetan Argali	√	√	√	√
Panthera uncia	Snow Leopard	√	√	√	√
Equus kiang	Tibetan Kiang	√	√	√	√
Lynx lynx	Tibetan Lynx	√	√	√	√
Pseudois nayaur	Blue Sheep	√	√	√	√
Vulpes vulpes	Red Fox	√	√	√	√
Canis himalayensis	Himalayan Wolf	√	√	√	√
Mustela altaica	Mountain Weasel	√	√	√	√
Alticola stoliczkanus	Stoliczka's Mountain Vole	√	√	√	√
Lepus oiostolus	Woolly Hare/ Tibetan Hare/ Highland Hare	√	√	√	√
Ochotona ladacensis	Ladakh Pika/ Ladakh Mouse Hare/ Stoliczka's Pika	√	√	√	√
Ochotona roylei	Royle's Pika/ Himalayan Mouse Hare/ Indian Pika	√	√	√	√

[6] http://www.rainwaterharvesting.org/tso_moririlake/black-necked.pdf

Table 6. Notable species of birds recorded in Hanle Wetland Complex

Name of the species (Birds)	Common Name	Jung Demo	Raar	Chukil	Shado bug
Buteo hemilasius	Upland Buzzard	√	√	√	√
Grus nigricollis	Black-necked crane	√	√	√	√
Ichthyaetus ichthyaetus	Pallas's Gull	√	√	√	√
Anser indicus	Bar-headed Goose	√	√	√	√
Philomachus pugnax	Ruff	√		√	√
Charadrius mongolus	Plover	√		√	√
Limosa limosa	Black-tailed Godwit	√		√	√
Sterna hirundo	Tern	√		√	√
Gypaetus barbatus	Bearded Vulture	√		√	√
Haliaeetus leucoryphus	Pallas's Fish Eagle	√		√	√
Pandion haliaetus	Osprey	√		√	√
Plegadis falcinellus	Glossy Ibis	√		√	√
Ibidorhyncha struthersii	Ibis Bill	√		√	√
Bubo bubo	Eagle Owl	√		√	√
Athene noctua	Little Owl	√		√	√
Syrrhaptes tibetanus	Tibetan Sandgrouse	√		√	√
Perdix hodgsoniae	Tibetan Partridge	√	√	√	√
Phoenicurus erythrogaster	White-winged Redstart	√	√	√	√
Tadorna ferrugine	Ruddy Shelduck	√	√	√	√
Motacilla alba	White Wagtail	√	√	√	√

Table 7. Species with high conservation significance recorded in Hanle Wetland Complex

Mammals		Jung Demo	Raar	Chukil	Shado bug
Species	Conservation Status	√	√	√	√
Snow Leopard *(Panthera uncia)*	Vulnerable	√	√	√	√
Mountain Weasel (*Mustela altaica)*	Near Threatened	√	√	√	√
Tibetan Argali (*Ovis ammon hodgsoni)*	Near Threatened	√	√	√	√
Birds					
Black-necked Crane (*Grus nigricollis)*	Vulnerable	√	√	√	√
Pallas's Fish Eagle (*Haliaeetus leucoryphus)*	*Endangered*	√		√	√
Bearded Vulture (*Gypaetus barbatus)*	Near Threatened	√		√	√

Assessment of Fish Species: As a part of the this assignment, an assessment of the fish species was carried out in all the wetlands of the complex and their associated streams. For this, experimental fishing was done using nets of different mesh sizes as per the standard protocol. The details of fish species recorded in the wetlands are tabulated below:

Table 8. Occurrence of snow trout in Hanle wetland complex

S. No	Wetland	Species Recorded
1	Jung Demo	Snow trout (*Schizothorax* sp)
2	Chukil	None
3	Raar	Snow trout (*Schizothorax* sp)
4	Shado Bug	Snow trout (*Schizothorax* sp)

Figure 3. Snow Trout observed in Jung Demo

2.5 Water Quality

During the present investigation, the team collected water samples from different locations in the three wetlands. In Jung Demo, the samples were collected from the spring and outlet, while from Raar, samples were collected from the spring, inlet and outlet while from Shado Bug, samples were collected from the centre of the wetland and outlet.

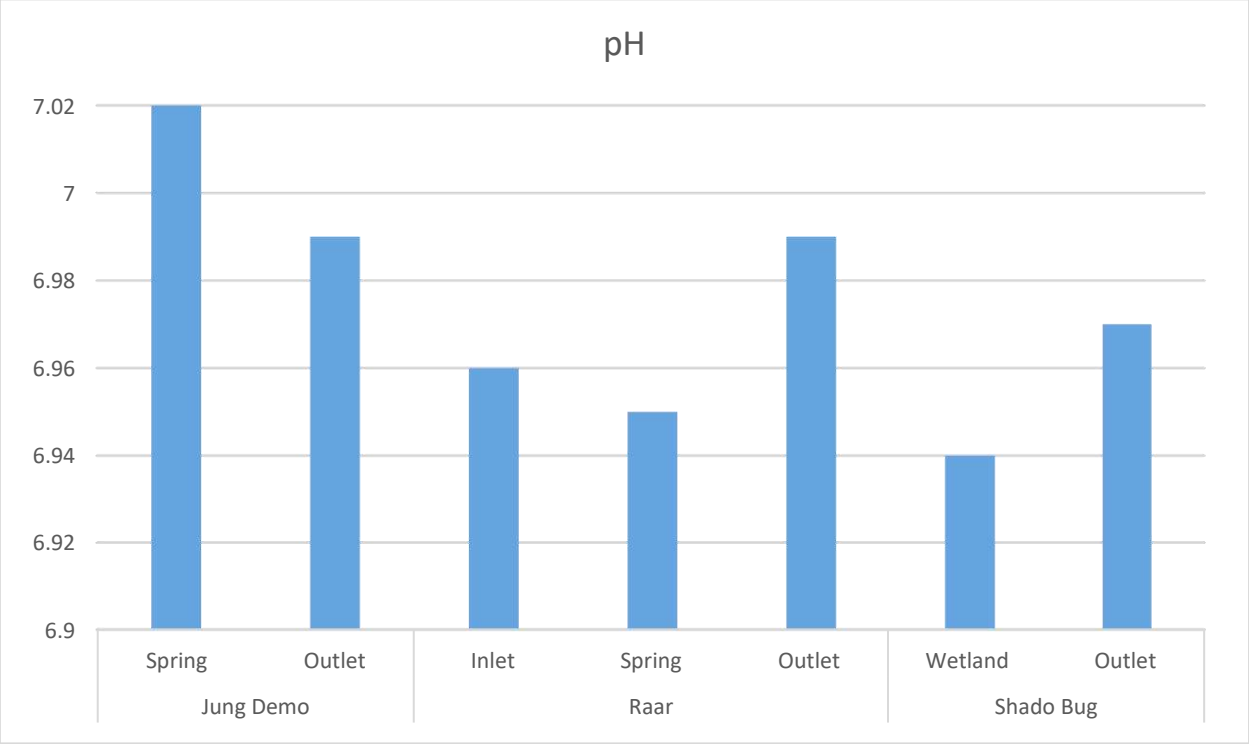
The water quality analysis carried out in the wetland reveals satisfactory water quality. During the present investigations**,** the pH has been recorded in near-neutral range (6.94-7.02), indicating that the wetlands are not very productive. Low values of turbidity and colour indicate the absence of any physical impurities in the wetland. Moderate concentrations of dissolved oxygen ranging from 4.2 mg/l to 5.4 mg/l indicate low levels of primary productivity in the wetlands. Similarly, low values of BOD ranging from 0.6 mg/l to 1.2 mg/l and COD ranging from 3 mg/l to 6.5 mg/l indicate good water quality. Pesticide residues in all the wetlands have been recorded below the detectable limit, which indicates that there is no negative impact of agriculture residues on the wetlands. However, the only cause of concern in terms of water quality is the presence of a coliform group of bacteria in some samples (outlet of Jung Demo, outlet of Raar, and both the samples, from (wetland and outlet) Shado Bug), which could be on account of animal wastes flowing into the wetlands. The details of water quality analysis are tabulated below:

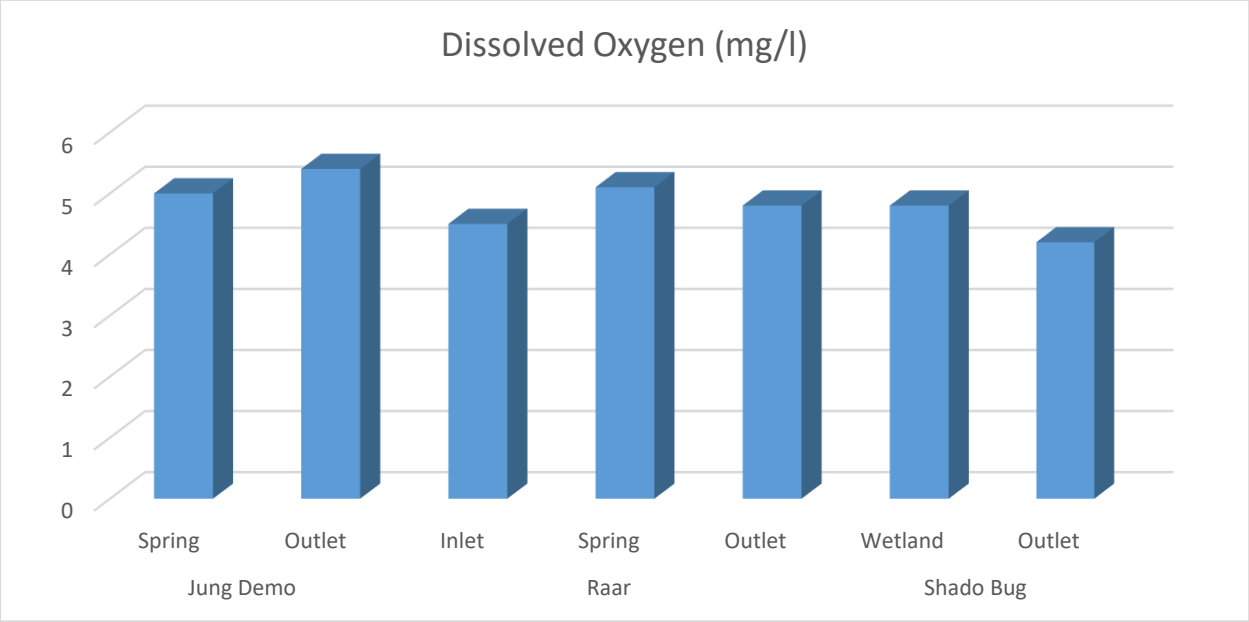
Figure 4. Collection of Water samples and field testing

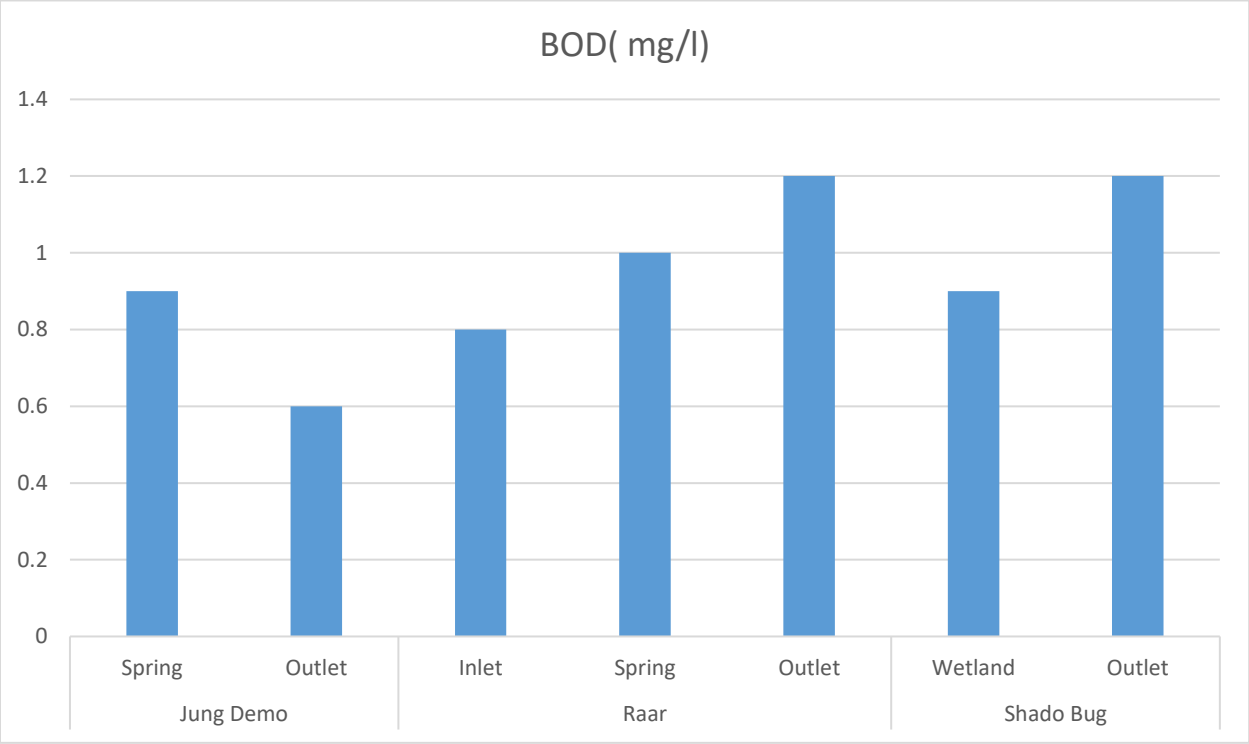
Table 9. Water Quality Analysis of wetlands in the complex

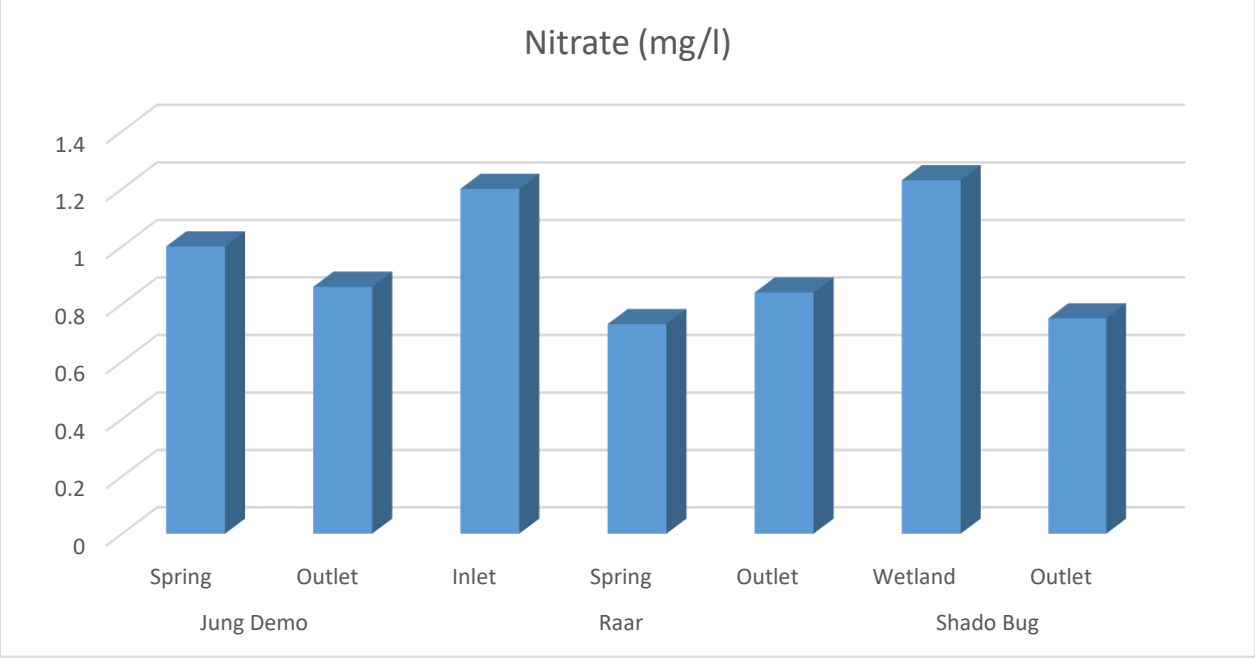
Parameter	Jung Demo		Raar			Shado Bug		Desirable Values (IS-10500)
	Spring	Outlet	Inlet	Spring	Outlet	Wetland	Outlet	
pH	7.02	6.99	6.96	6.95	6.99	6.94	6.97	6.5-8.5
Electrical Conductivity	226	209	254	273	247	340	259	-
TDS (mg/L)	153	141	173	189	168	234	177	500-2000
Color (Hazen)	<1	<1	<1	<1	<1	<1	<1	5-15
Turbidity (NTU)	<5	<5	<5	<5	<5	<5	<5	1-5
Salinity (mg/l)	0.289	0.267	0.332	0.356	0.314	0.433	0.34	-
Total suspended solids (mg/l)	3.7	5.2	4.8	39.0	5.4	5.0	6.1	-
BOD $^{3\ days}$ (mg/l)	0.9	0.6	0.8	1.0	1.2	0.9	1.2	-
COD (mg/l)	4.2	3.0	4.8	4.2	5.9	4.2	6.5	-
TOC (mg/l)	1.1	1.2	1.1	1.2	1.7	1.3	1.9	-
Dissolved Oxygen (mg/l)	5.0	5.4	4.5	5.1	4.8	4.8	4.2	-
Total Hardness (mg/l)	60	56	62	72	58	74	52	200-600
Total Alkalinity (mg/l)	56	50	52	64	52	62	44	200-600
Orthophosphate (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Total Phosphorus (mg/l)	0.04	0.08	0.06	0.05	0.04	0.03	0.10	-
Nitrate (mg/l)	1.00	0.86	1.20	0.73	0.84	1.23	0.75	45
Total Nitrogen (mg/l)	1.1	1.0	1.3	0.9	0.9	1.4	1.1	-
Pesticides Residues	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
Total Coliform (CFU/100 ml)	ND	8.0	ND	ND	8.0	9.0	7.0	0
Fecal Coliform (CFU/100 ml)	ND	2.0	ND	ND	5.0	5.0	4.0	0

Graph 5. Variation in important water quality parameters






BOD(mg/l)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Spring
Outlet
Inlet
Spring
Outlet
Wetland
Outlet
Jung Demo
Raar
Shado Bug


Nitrate (mg/l)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Spring
Outlet
Inlet
Spring
Outlet
Wetland
Outlet
Jung Demo
Raar
Shado Bug

2.6 Ecosystem Services/ Socioeconomic and livelihoods

For the assessment of ecosystem services and community dependence on wetlands Rapid Assessment of Wetland Ecosystem Services (RAWES), as prescribed by the Ramsar convention was used. The RAWES approach is a simple, systemic and cost-effective approach designed to carry out rapid, qualitative assessments of a comprehensive range of wetland ecosystem services. It was developed specifically within the context of the Ramsar Convention to support a variety of Ramsar-related purposes. This includes:

- Describing the ecological character of a wetland for Ramsar Site designation;
- Updating the Ramsar Site Information Sheet (RIS);
- Ramsar Site management planning;
- Formulating and implementing Ramsar National Policies;
- Providing information for national wetland inventories;
- Conducting wetland impact assessments; and
- Developing CEPA (communication, capacity building, education, participation and awareness) materials.

[7]The assessment tool developed for the consultations was based on the RAWES tool provided by the Ramsar Convention. The RAWES form, used for the discussions with stakeholders is placed in **Annexure 2**.

Tools for Primary Data Collection and Methodology for Analysis

The following tools were applied for primary data collection:

- **Survey:** The survey schedule was designed as a structured set of open-ended and close-ended questions to record quantifiable information pertaining to various dimensions of dependency of the community on wetland's ecosystem services and the sensitivity of such dependencies on the vulnerability of the wetland's health.

[7] The RAWES approach can be used by Ramsar Site and wetland managers across a range of scales, from whole wetlands to localized zones of large and complex wetlands. At the 13th Meeting of the Conference of the Contracting Parties to the Ramsar Convention (Ramsar COP13) held in Dubai in October 2018, the Contracting Parties officially recognized the RAWES approach by adopting Resolution XIII.17 on Rapid Assessment of Wetland Ecosystem Services.

- **Participatory Rural Appraisal (PRA):** Participatory Rural Appraisal (PRA) was applied to primarily collect historical changes in the community's dependencies on wetland's various ecosystem services; the emerging trend of threats, changes in land use and land cover in and around the wetland and the overall change in the perception of the community with regard to the status of the wetland.
- **Focused Group Discussion (FGD):** One FGD was conducted with a group comprising the Village Pradhan, members of other institutions, and farmers to record their responses to a set of predefined questions. These were essentially on livelihood aspects, biodiversity, conservation initiatives, rights and privileges.

The results of the assessment of ecosystem services are as follows:

a) **Provisioning services**

i. Freshwater − The Hanle river and the wetlands are sources of water to the livestock and people. While the wetland and nearby areas are sources of water to the livestock, spring water is used by local communities for drinking purposes.

ii. Food − The wetland supports grazing of livestock. On an average, kiang removes only 3% to 4% of the total forage consumed in the Hanle Valley, with the greater part being consumed by goats (45% to 47%) followed by yaks (20% to 21%) and sheep (20%).

iii. Fiber − Pashmina, sheep's wool, and yak's wool are sourced from the animals fed on the wetland. Changra (Pashmina goat of the Changthang region) is known to be among the best in the world, while the Merino sheep wool is unique to the landscape. Changra has been introduced into other parts of Ladakh to encourage Pashmina products.

iv. Natural Medicines − Out of the four wetlands, medicinal plants are only found in the Shado Bug wetland.

b) **Regulatory services**

i. Flood hazard regulation − The marshes act as a sponge and retain water in case of floods.

ii. Water regulation − The wetland holds water during high flow and recharges groundwater.

iii. Erosion regulation − The wetland's wide pasture cover protects the top soil from wind erosion and runoff from rainfall.

iv. Local climate regulation − Evapotranspiration from the vegetation regulates the micro-climate of the region.

All wetlands assist in local climate regulation. Water regulation is a common service offered by all the wetlands. Four wetlands also assist in flood regulation or guarding communities against floods. None of the wetlands offer the service of water purification.

c) Cultural Services

All the four wetlands in the Hanle complex have spiritual and religious value mainly associated with Buddhism. This suggests the pivotal role monasteries could play in wetland management. Many wetlands are also study sites for educational research or are frequently visited by wetland experts and others associated with the study of wetland and biodiversity.

i. Cultural heritage −The wetland has been used as community grazing land for generations by people of Shado Bug and Khaldo, as well as Saasoma Tibetan refugees.
ii. Recreation and tourism − The wetlands attract a good number of bird-watching and wildlife enthusiasts. Hanle, with the world's highest observatory, attracts nature and adventure tourists. The wetland is an area of interest in the research of Black-necked Cranes and other birds.
iii. Aesthetic Value − The aesthetic beauty of nature here and the wildlife dependent on it attracts tourists and local communities likewise.
iv. Spiritual and religious value – The Skang-sol annual religious event is confined to individual houses. Decorated barley dough is offered in the wetlands.

d) Supporting Services

i. Primary production − Grasses are the primary producers present in the area. The wetland also supports the primary productivity of the area
ii. Nutrient cycling − The wetland recycles the nutrients by facilitating the decomposition of organic matter.
iii. Provision of habitat − Provides habitat for wild as well as domestic animals. Black-necked Cranes, White Wagtail, Kiang, Blue sheep, Cattle, Sheep, Goat, Yaks, etc. are the significant faunal species that depend on these wetlands for habitat.

The service of nutrient cycling is being provided by four wetlands. Local communities also reported that the four wetlands are provide habitat for biodiversity.

Table 10. Summary of Ecosystem Services offered by wetlands in Hanle Complex

Provisional Services			
Indicator	Jung Demo	Chukil	Shado Bug
Fresh water	√	√	√
Food	√	√	√
Fuel	X	X	X
Fibre	√	√	√
Ornamental resources	X	X	X
Natural medicines	X	X	√
Regulatory Services			
Indicator	Jung Demo	Chukil	Shado Bug
Local climate regulation	√	√	√
Water regulation	√	√	√
Flood hazard regulation	√	√	√
Storm hazard regulation	X	X	X
Erosion regulation	√	√	√
Water purification	X	X	X
Cultural Services			
Indicator	Jung Demo	Chukil	Shado Bug
Cultural heritage	√	√	√
Recreation and tourism	√	√	√
Aesthetic value	√	√	√
Spiritual and religious value	√	√	√
Inspirational value	√	√	√
Educational and research	X	√	√
Supporting Services			
Indicator	Jung Demo	Chukil	Shado Bug
Primary production	√	√	√
Nutrient cycling	√	√	√
Water recycling	√	√	√
Provision of habitat	√	√	√

Table 11. Eco-system services provided by wetlands and their periodicity

Ecosystem Services	Duration of Ecosystem Services												Dependency as perceived by the community
	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	
Irrigation water for agriculture.(March ending till mid-September)													
Jung Demo													Low. Dependency has decreased in the past few years. Agriculture land is now used for other purposes like building tourist-related infrastructure.
Chukil													Low. Dependency has decreased in the past 2-3 years. Few Tibetan refugees who used to cultivate land have moved to Leh/other places.
Raar													Medium. 48-50 households have their agriculture land here.
Shadobug													Medium. Around 40 households have agriculture land.
Grazing in wetland and nearby area.													
Jung Demo													Low. 24 households use the wetland for grazing. Livestock of both Jung Demo and Punguk use the pastures supported by the wetland.
Chukil													Low
Raar													Low
Shado Bug													Low
Drinking water source for livestock.													
Jung Demo													Medium. Approx. 600-800 cattle rely on water from the wetland area.
Chukil													Medium
Raar													Medium
Shado Bug													Medium
Drinking Water: Hand-pumps available around all the wetlands. People use both the hand-pumps and spring water (if available) for drinking.													
Jung demo													Low. Eight Households only. Will rise with increasing number of tourists.

Chukil													None. People use hand-pumps.
Raar													High. People of Jungdemo (8 Households), Naga (Around 30 Households) + Nunnery (48 nuns).
Shado Bug													High. 40-50 Households.
Tourism													
Jungdemo													Low footfall at present. This might increase.
Chukil													Medium. However, a rapid increase has been recorded in the past few years. Among all the four wetlands, this has the largest infrastructure to support tourists.
Raar													Low. No tourist-related infrastructure. Occasional local tourist in summers.
Shado Bug													None.
Religious events - The Skang-sol annual religious event where offerings are made to the wetlands is observed in all the wetlands.													
Jung Demo													Low (Skang sol event once a year)
Chukil													
Raar													
Shado Bug													
Village economy (Livestock + Agriculture) Grazing in the wetland and surrounding area. Agriculture land in the catchment.													
Jung Demo													High. Agriculture and Livestock are primary livelihood sources for the community.
Chukil													High
Raar													High
Shado Bug													High

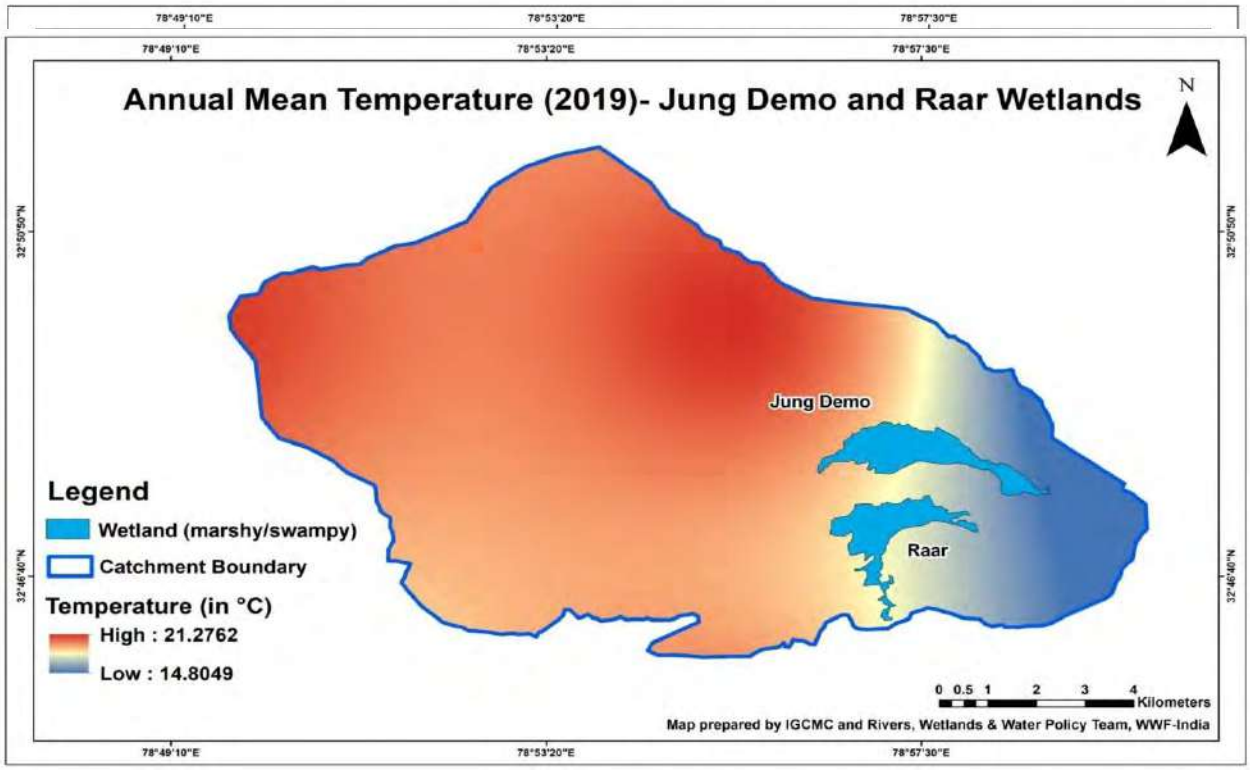
Chapter 3: Evaluation of Wetland Features

3.1 Priority wetland features:

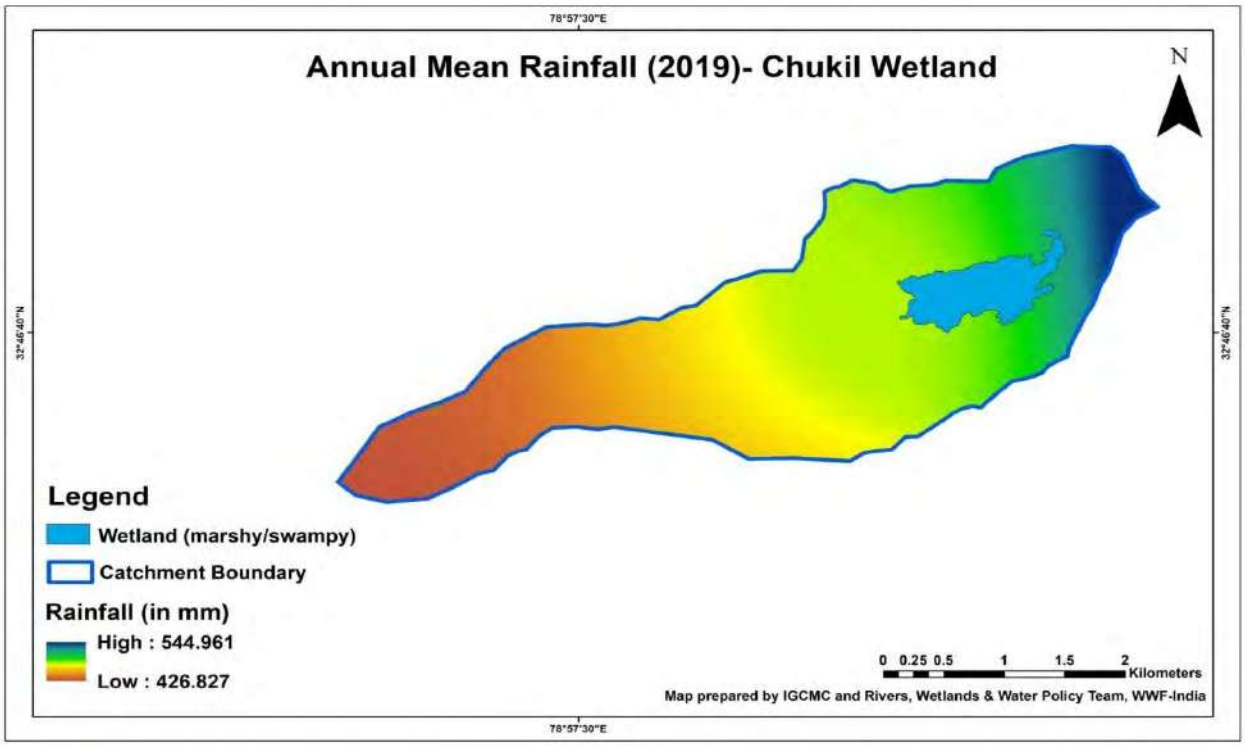
The Hanle wetland complex plays significant role in the hydrology of Hanle River, which is one of the important tributaries of the River Indus. Apart from being key to the local water security, the hydrological system sustained by these wetlands is also key to the biodiversity in the region. Some of the priority wetland features that need to be maintained to maintain the health of the wetland areas are as below:

Hydrology: The wetlands in the Hanle complex are a very significant feature of the larger hydrological system of the region and is also the key to the water security for local communities. Therefore, maintaining the hydrology of the wetlands is critical as the wetland play a very significant role in the hydrological processes of the region. . The original hydrology of the wetland complex enabled the flow of water from the glacier to the River Hanle after some retention in the wetlands, which provided an ideal habitat for the key aquatic fauna. This retention of water contributes to the base flows of River Hanle during the lean season.

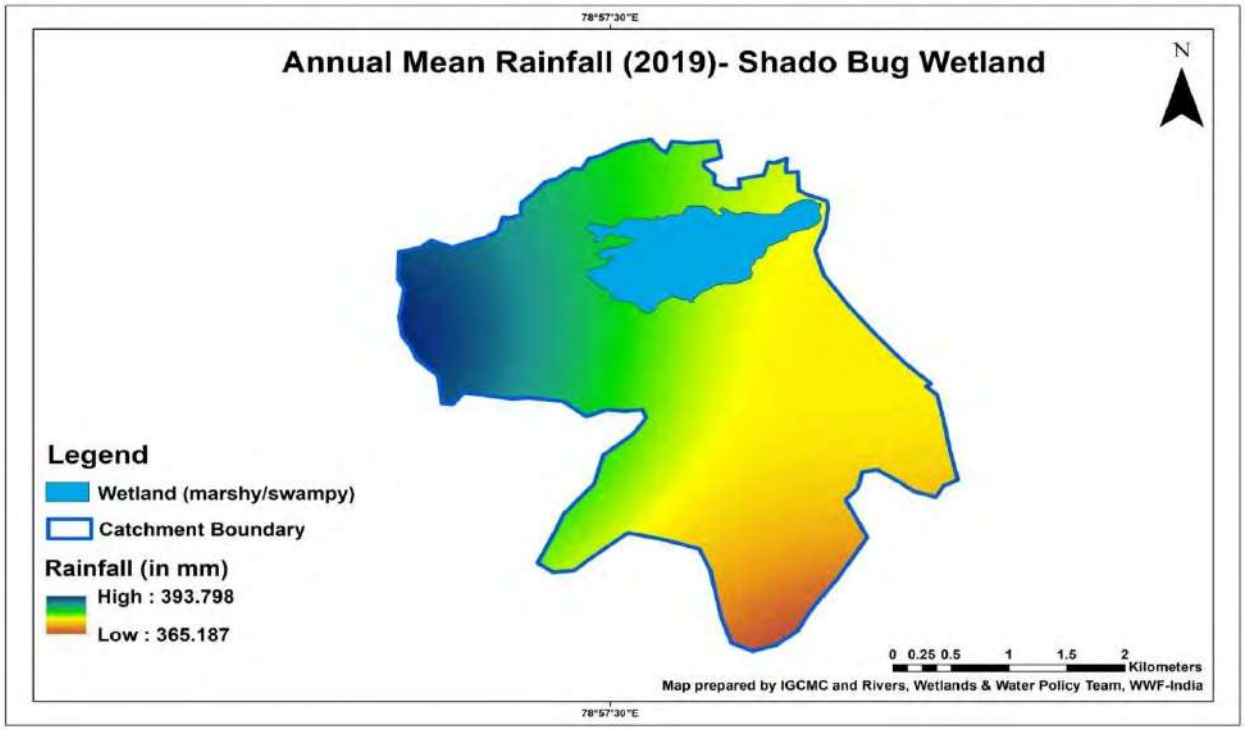
The zone of influence receives very little precipitation and hence the wetlands become even more important in maintaining the base flows of the rivers, the water security for the communities, and biodiversity. The annual mean rainfall recorded in 2019 in the zone of influence of the wetlands is mapped below:



Map 7. Annual mean rainfall in catchments of Jung Demo and Raar



Map 8. Annual mean rainfall in catchments of Chukil wetland



Map 9. Annual mean rainfall in the catchments of Shado Bug Wetland

Aquatic Biodiversity: The Hanle marshes provide a wonderful mosaic of ecosystems that are the ideal habitat for many threatened, endangered and endemic species. With the human interventions increasing in the region, Hanle wetlands are one of the few pristine habitats left for this fauna and flora. The wetlands are also one of the most significant wetland complexes in the Central Asian Flyway. Therefore, the biodiversity of this wetland complex is one of the most significant features that needs to be maintained to conserve the ecosystem services of the wetlands in the complex.

3.2 Major Threats

a) Changes in land use/land cover within the zone of influence:

Modified Normalized Difference Water Index (MNDWI) was used to extract the water and non-water areas in the study area. Areas of permanent wetland water were delineated using pre-and post-monsoon images.

This index is useful in mapping the water areas, displaying the differences in turbidity and vegetal content of the water, erratic soil or measuring the water content of the vegetation. This index uses green spectral bands and near infrared (increases the spectral feedback of the soil humidity of the rocks and plants and the water begins to absorb radiation from the surface layer). The dark colour (values close to -1) represent the water crystal, the light colour (values close to +1) represent dry land and intermediate colours (values close to 0) represent lands with intermediate humidity content.

Preparation of Wetland extent map

After the Modified Normalized Difference Water Index (MNDWI), a threshold was identified for each season to differentiate the water and non-water areas in a particular season. Raster reclassification techniques were used to extract the water extent areas in different seasons. Raster calculator was used to extracting through raster to vector process in Arc GIS software. Average of rate (AOR) methods are used to smoothing the raster pixels surface. The Net areal change was analyzed by superimposing vector layers of each water extent areas in different seasons during 1992 and 2019 in ArcGIS spatial analytical tool.

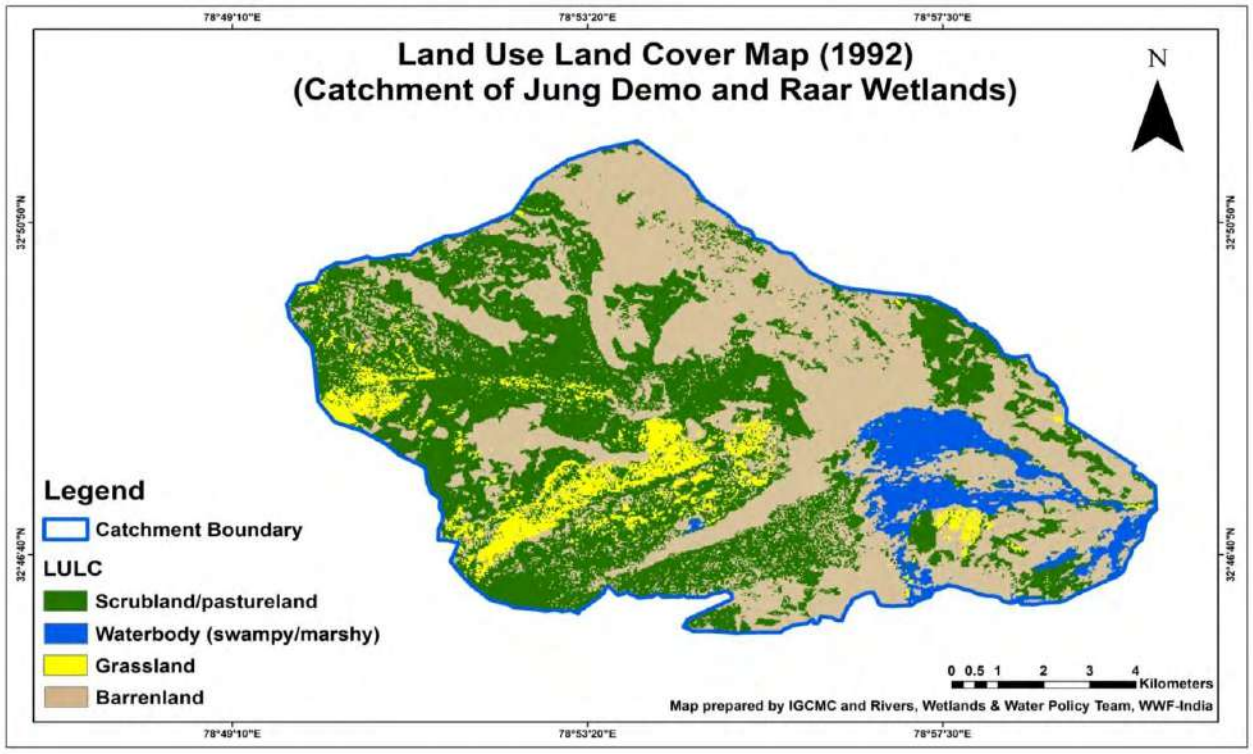
The results of the analysis are as below:

i. **Jung Demo and Raar:** The land use and land cover analysis of the wetland complex reveals that 20% of the area of the zone of influence has undergone land use

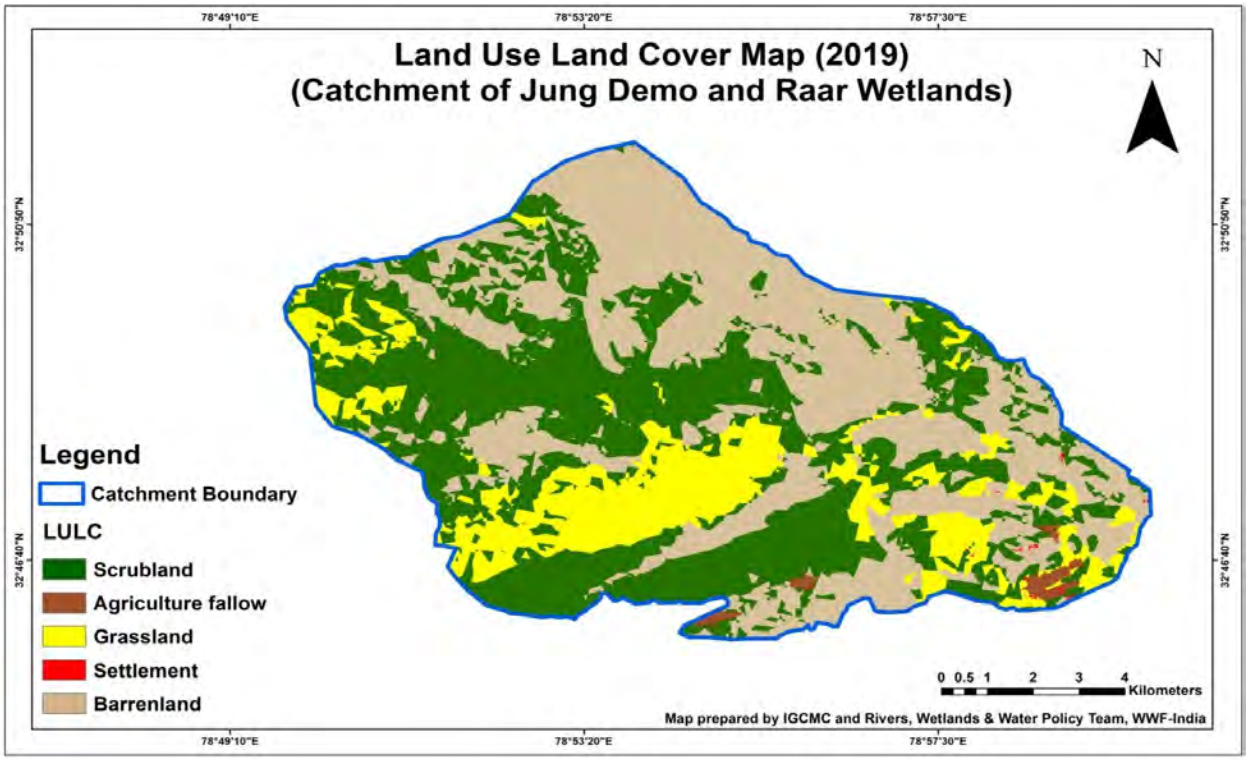
conversion. The majority of land-use change (74%) has been observed from barren land to other classes (grassland 72% and vegetation 2%), while 4% of agriculture land and 5% of grass/pasture land were converted into barren land.

Table 12. Land Use Land Cover changes in Jung Demo- Raar catchment

Class name	1992	1992	2019	2019	Change	
	Area (in sq.km)	Area (%)	Area (in sq.km)	Area (%)	Area (in sq.km)	Area (%)
Agriculture fallow	0	0	0.785	0.72	0.785	0.72
Grassland	7.12	6.49	17.769	16.19	10.65	9.70
Waterbodies	5.75	5.24	0	0	-5.75	5.24
Settlements	0.00	0.00	0.1367	0.12	0.14	0.12
Barren land	50.45	45.99	45.286	41.26	-5.16	4.73
Scrubland	46.383	42.28	45.775	41.71	-0.608	0.57
Total	109.70	100	109.75	100		



Map 10. Land Use Land Cover Map (1992) Catchment of Jung Demo and Raar Wetlands

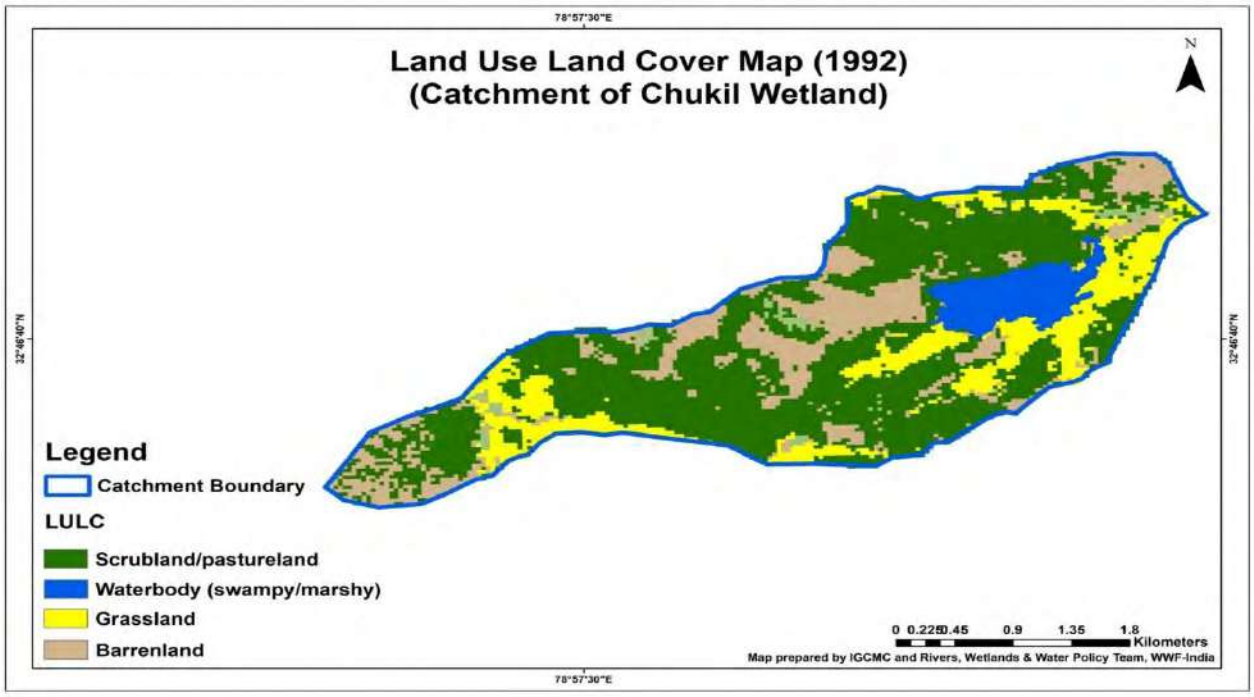


Map 11. Land Use Land Cover Map (2019) Catchment of Jung Demo and Raar Wetlands

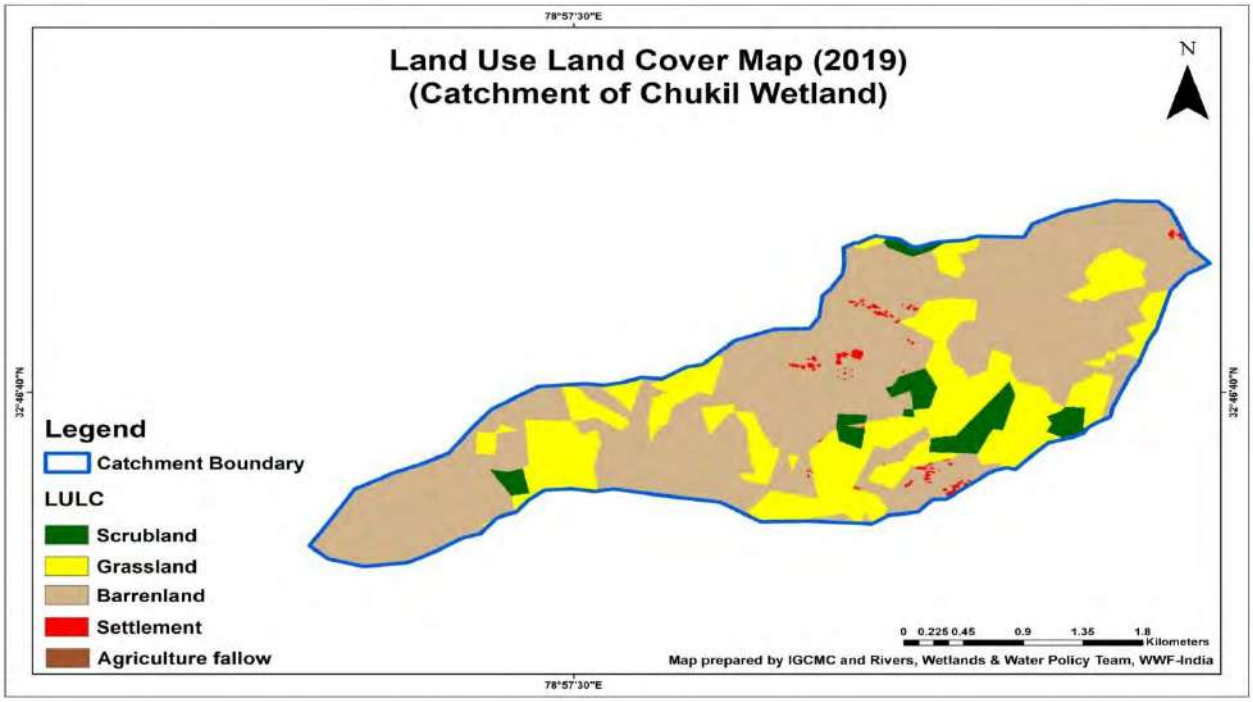
ii. **Chukil:** LULC change analysis of catchment suggests some change in contributing catchment (inter land-use conversions, 36% of total area, 2.5 sq km). The area under grassland has increased while barren land has decreased. Among the LULC change spatial units, the majority of land use change (72%) has been observed from barren land to other classes (grassland 53% and vegetation 17%, 2% Built-up), 32% of agriculture land and 5% of grassland have been converted to the barren land.

Table 13. Land Use Land Cover changes in Chukil catchment

Class Name	1992	1992	2019	2019	Change	
	Area (in sq.km)	Area (%)	Area (in sq.km)	Area (%)	Area (in sq.km)	Area (%)
Agriculture fallow	0	0	0.20	2.83	0.20	2.83
Grassland	0.23	3.26	2.05	29.00	1.82	25.73
Waterbodies	0.04	0.57	0	0	0.04	0.57
Settlements	0	0	0.051	0.72	0.051	0.72
Barrenland	5.38	76.31	4.43	62.51	0.95	13.80
Scrubland	1.4	19.858	0.35	4.94	1.05	14.919
Total	7.05	100	7.09	100		



Map 12. Land Use Land Cover Map (1992) Catchment of Chukil Wetland)



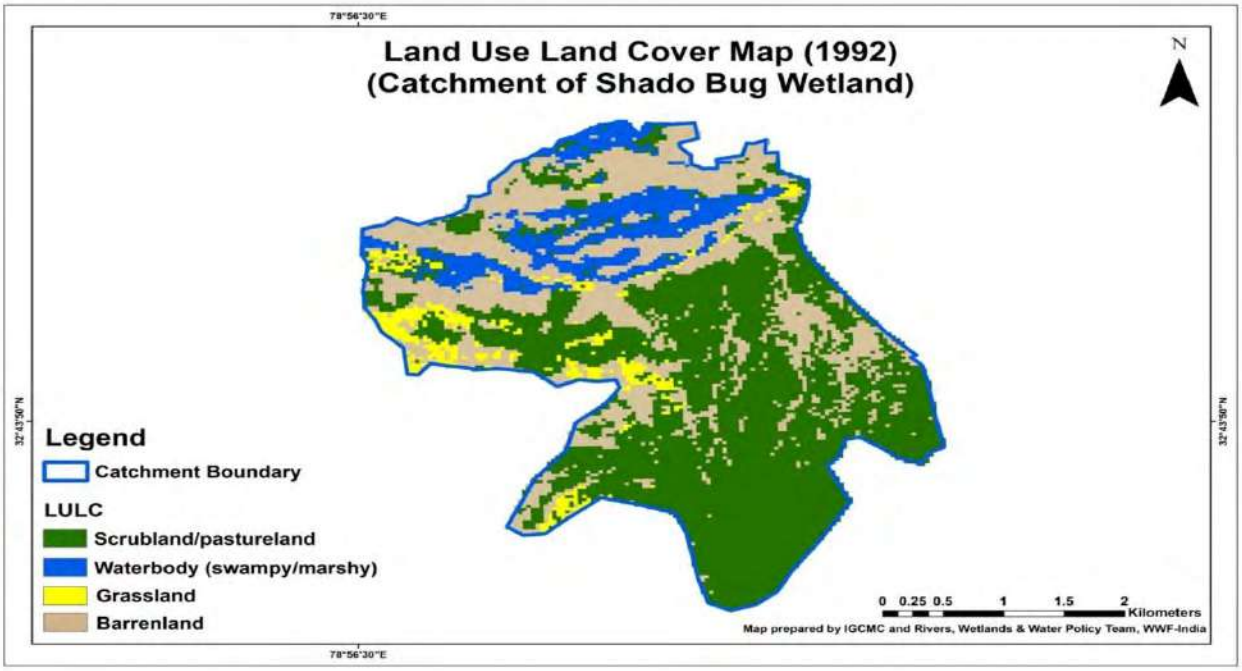
Map 13. Land Use Land Cover Map (2019) Catchment of Chukil Wetlands

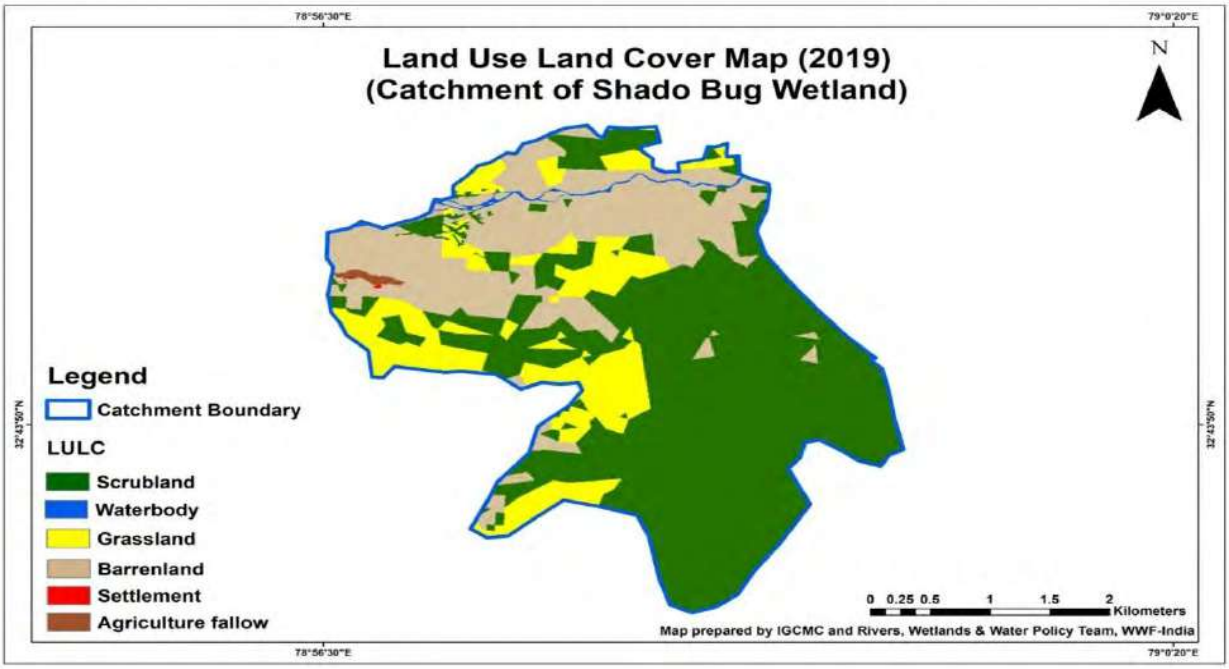
iii. **Shado Bug:** The analysis suggests that out of the total catchment area, interclass land use conversions have occurred in 30% of its area (in 3 sq km). Among the LULC change spatial units, the majority of land use change (51%) has been observed from barren land to other classes (grassland, 49.8% and vegetation 1.3%), 39% of agriculture land and 4.6 % of grass/pastureland had been converted into barren land.

Table 14. Land Use Land Cover changes in Shado Bug wetland catchment

Class name	1992	1992	2019	2019	Change	
	Area (in sq.km)	Area (%)	Area (in sq.km)	Area (%)	Area (in sq.km)	Area (%)
Agriculture fallow	0	0	0.034	0.32	0.034	0.32
Grassland	0.55	5.25	1.732	16.50	1.18	11.24
Waterbody	1.10	10.53	0.053	0.50	-1.05	-10.03
Settlements	0.00	0.00	0.003	0.029	0.00	0.03
Barren land	3.20	30.55	2.689	25.61	0.51	4.95
Scrubland	5.62	53.66	6.007	57.21	0.387	3.55
Total	10.47	100	10.50	100		

Map 14. Land Use Land Cover Map 1992 and 2019 Catchment of Shado Bug Wetlands





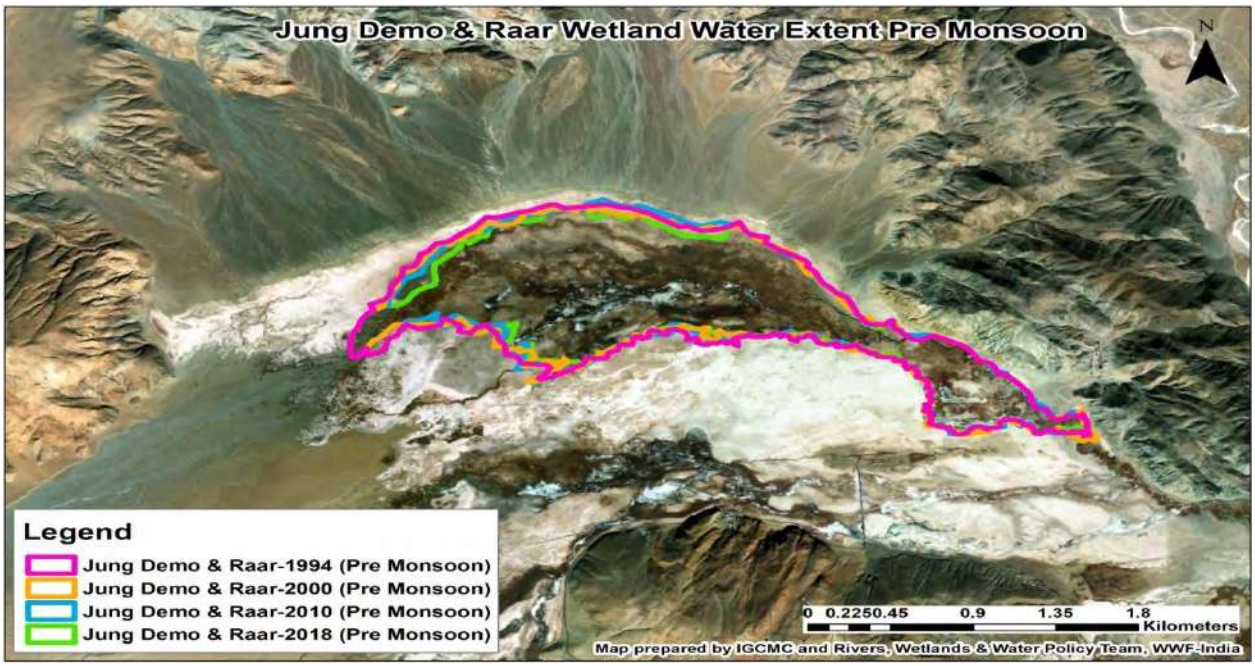
Note: The absence of visible swampy area in the maps of 2019 is due to the failure to capture signature of water in the imagery of 2019.

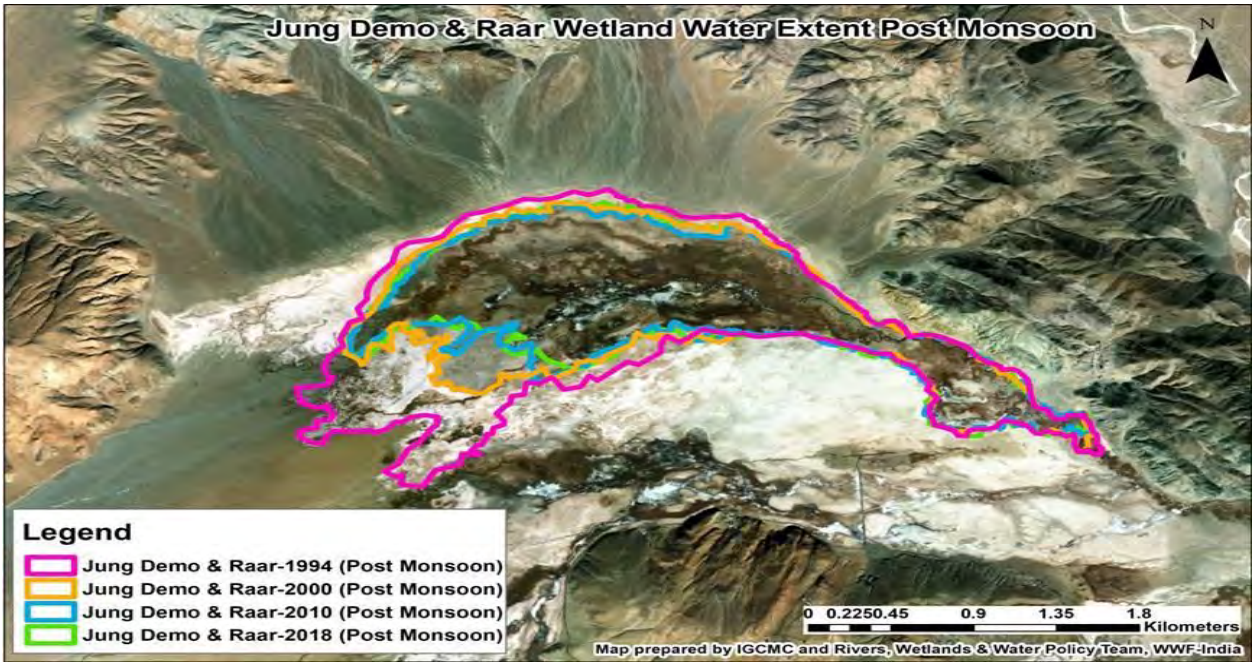
b) **Reduction in water spread area:**

A reduction in the water spread area of all the wetlands was recorded in the MWDI analysis. The details of the reduction in the wetlands are as follows:

i. Jung Demo and Raar: A reduction in water spread area from 254.36ha in pre-monsoon in 1994 to 224.6ha in 2018 has been observed, while during the post monsoon, reduction was from 372.9ha in 1994 to 249.92ha in 2018. This is in accordance with the reduction in precipitation.

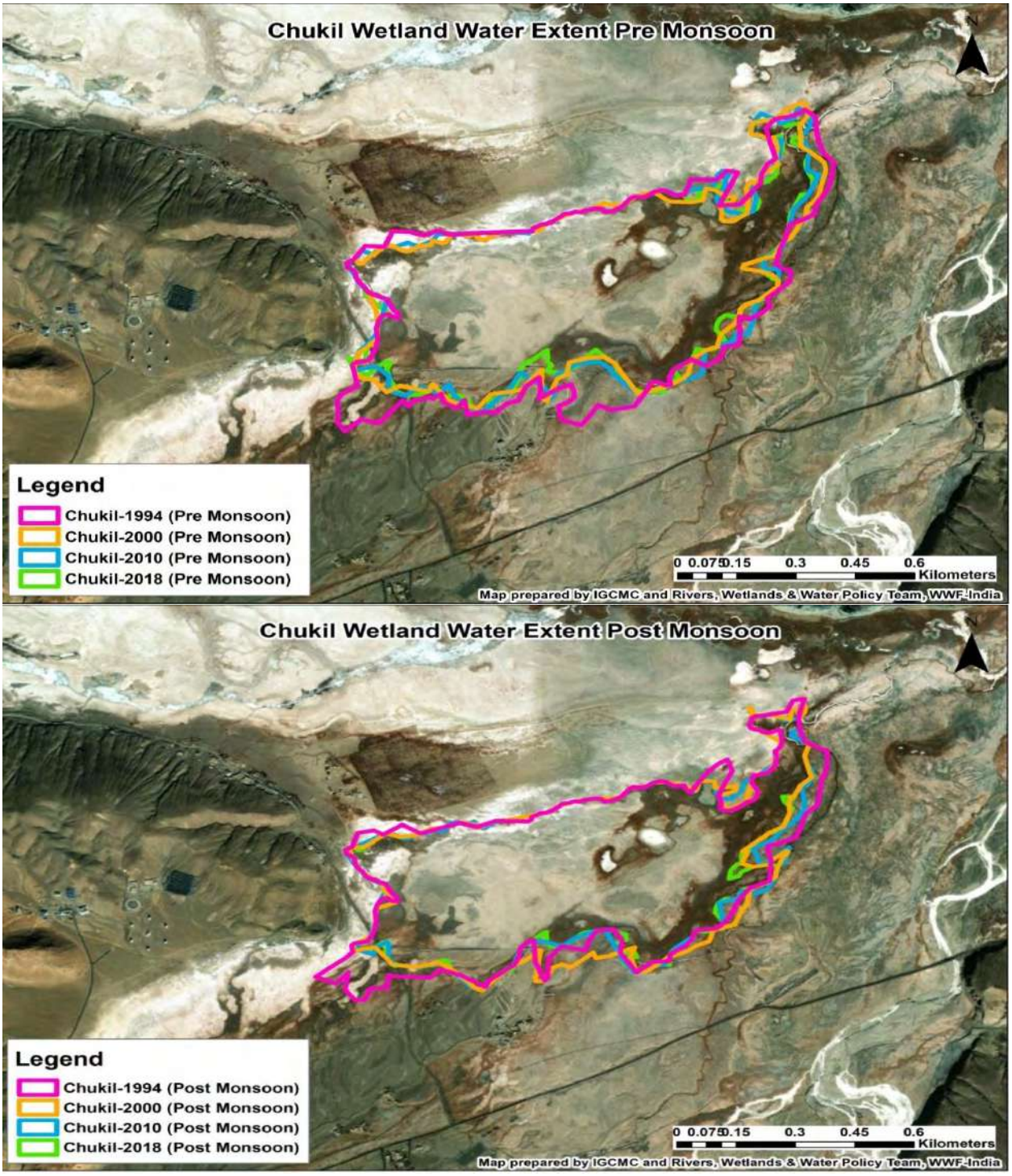
Map 15. Jung Demo and Raar Wetland Water Extent Pre and Post Monsoon





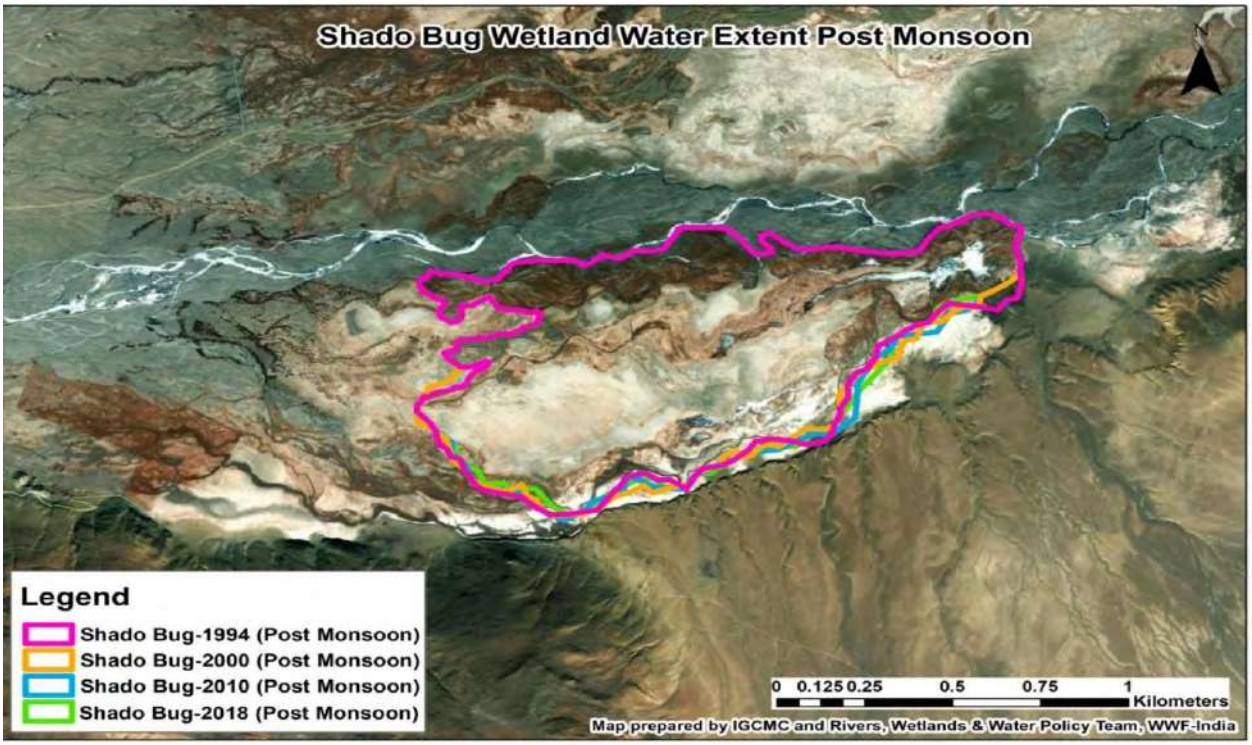
ii. Chukil: The reduction in water spread area from 60.63ha in pre-monsoon in 1994 to 49.86ha in 2018 has been observed. During the post monsoon, reduction was from 54.07ha in 1994 to 47.47ha in 2018. This is in accordance with the reduction in precipitation.

Map 16. Chukil Wetland Water Extent Pre and Post Monsoon



iii. Shado Bug: A reduction in water spread area from 99.93ha in pre-monsoon in 1994 to 97.75ha in 2018 has been observed. During post monsoon, reduction was from 101.75ha in 1994 to 100.85ha in 2018. This is in accordance with the reduction in precipitation.

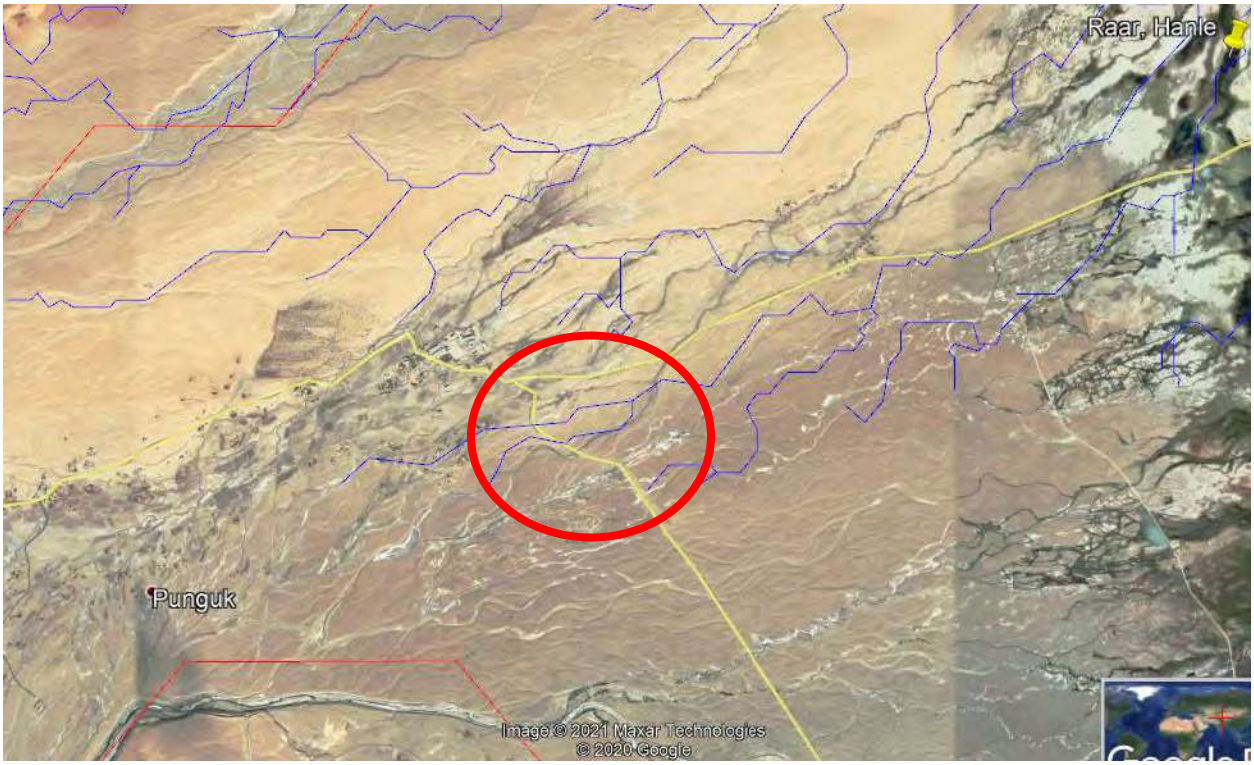
Map 17. Shado Bug Wetland Water Extent Pre and Post Monsoon



Degradation of catchment and blockages in inflow and outflow channels

c. Loss of hydrological connectivity between Jung Demo and Raar:

According to the satellite images of 2013-14, linear infrastructure resulted in the loss of connectivity between the two wetlands. The road constructed by PWD, seems to have resulted in the partial obstruction of connectivity between the two marshes, resulting in drying of patches in Raar wetland. Some parts of the marshes have been reported to be drying up as compared to earlier years by the local community members.



Map 18. Loss of Hydrological connectivity between Jung Demo and Raar

d. Tourism Infrastructure:

In Jung Demo, one large hotel with a capacity of 30-40 rooms is being constructed in the immediate periphery. In addition, many homestays and smaller hotels are also becoming operational in the area. This will pose the following challenges to the wetland:

- Increased water abstraction/use
- Increase in the generation of solid and liquid waste
- Littering of food waste leading to an increase in the population of feral dogs.
- Disturbance to wildlife

Figure. 5. Construction in Jung Demo

e. Erection of electric poles in Raar: A large number of electric poles have been erected in the Raar wetland. Though this does not directly impact the health of the wetland, this poses an indirect threat of mortality of large birds like BNC due to accidental electrocution.

Figure 6. Electric poles in Raar

f. Feral dogs:

Studies indicate that there are more than 3500 dogs in the Changthang region.[8] Local communities and stakeholders perceive, as well as report, this as an increasing and a major threat. Dogs prey on the chicks, eggs, fledglings and even adult birds, especially of key species, including the Black-necked Crane. Littering of food waste near Jung Demo wetland attracts feral dogs. However, during the seasons when food waste is not available, feral dogs attack the wildlife. There have been reported instances of feral dogs attacking the key wildlife in the region.

Figure 7. Feral dogs in Changthang region

[8] https://www.downtoearth.org.in/blog/wildlife-biodiversity/india-s-wildlife-is-under-threat-from-free-roaming-dogs-70648#:~:text=The%20Changthang%20Wildlife%20Sanctuary%20in,every%20one%20of%20these%20species.

g. Solid waste disposal:

Littering of solid waste has been observed in Chukil and Raar. Tourists and local communities are equally responsible for the littering of solid waste into the wetland. The littering of solid wastes increases during the tourist seasons and religious events. Though a scientific characterization of the solid waste has not been carried out, visual observation shows that it mostly comprises plastic from packaging waste.

Figure 8. Solid waste littering around wetlands

h. Mining:

The wetland sediments have traditionally been used in the making of houses and buildings. Since the linear and tourism infrastructure around the wetlands, especially Jung Demo, has been increasing, instances of mining from the wetland have also amplified. Mining not only disturbs the

Figure 9. Mining around Jung Demo

local biodiversity but also degrades the bed structure of the wetland, changing the bed morphology. This has impacts on the floral and faunal diversity supported by the wetland. Additionally, the seed bank of native macrophytic vegetation is also lost due to mining, which could result in changes in the floral and faunal assemblage. This will, in turn, have a direct bearing on the health of the wetland and the biodiversity it supports.

i. Increased consumption of water due to water-intensive crop:

The community survey in the Hanle complex recorded the cultivation of Fodder oats *(Avena sativa),* locally known as Yukpa, a newly introduced fodder variety. Respondents during the survey informed that they were trained on Yukpa cultivation by the Krishi Vigyan Kendre (KVK), Nyoma, almost three years ago. Respondents perceived Yukpa to be a water-intensive crop. Stall feeding is being promoted in the region by the Government to avoid human and animal conflict during grazing seasons. Discussion with KVK, Nyoma on technical details pertaining to the

cultivation of Yukpa revealed that cultivation of Yukpa is purely organic and that they are distributing seeds under Tribal Sub Plan (TSP) scheme. KVK is still in the process of developing a 'Package of Practices' (PoP) on Yukpa cultivation and a systematic study on Yukpa cultivation is likely to be carried out in the coming years. The irrigation schedule of Yukpa cultivation is similar to that of traditional crops. Since there is no Package of Practice developed for the cultivation of oats in the region (as informed by the KVK), community's perception of Yukpa being a water-intensive crop is important. Hence, the impacts of the cultivation of this crop on the wetlands need to be studied in detail.

Figure 10. Development of pasture (Yupka cultivation) in the Zone of Influence of Hanle Wetland Complex

Table 15: Cropping pattern in Zone of influence of Hanle Wetland Complex

Wetland	Months	Number of households dependent on wetland for agriculture	Crops
Jung Demo	May to September	8	Barley, Potato, Local Peas, Turnip and Yukpa (Fodder)
Raagar	June to August	45	Barley, Peas, Potatoes, Yukpa
Chukil	May to September	50	Barley, Potato, Local Peas, and Yukpa (Fodder)

j. Wetland health: The wetland health assessment of all the four wetlands indicates moderate to good health. The health assessment is carried out based on the methodology and format issued by the Wetland Division of the Ministry of Environment, Forests and Climate Change. The wetland health cards of the wetlands are as follows:

Wetland Health Assessment: Jung Demo

Wetland Health Score: 0.82 **Wetland Health Category: B**

Table 16. Wetland Health Assessment Card: Jung Demo

Wetland Health indicator	Score	Category	Area forimprovement	Inferences
% wetland converted to non-wetland use since 2000	B	Good	Clear demarcation of area, regular monitoring to prevent further wetland area conversion	There are some changes in catchment land cover, but the core wetland/ marshy area remains intact with negligible change in its spread area.
Ratio of number of natural inlets choked and diverted to total number of natural inlets.	A	Good	Catchment/ channel rejuvenation, regular monitoring for any obstructions	There are 15 small and big inlets (two major, 13 smaller) to Jung Demo marshy area which remains intact.
Ratio of number of natural outlets choked and diverted to total number of natural outlets	A	Good	Regular monitoring for any obstructions	There is one outlet from the wetland and it is intact.
Biological Oxygen Demand		Unknown	Regular Water quality monitoring	Regular water analysis of the wetland needed to plan conservation initiatives.
% wetland area covered by invasive macrophytes	A	Good	Regular monitoring for any invasive macrophytes	At present not an issue

Annual waterbird count as a proportion of average count of last 5 years		Unknown	Regular survey and bird checklist for biodiversity monitoring	Bird checklist/ Biodiversity checklist would help in developing a strategy the for ecosystem improvement.
Clearly demarcated wetlands map	C	Average	Map prepared should be approved by the State Wetland Authority	Maps needed for wetland demarcation is prepared
Wetland Management plan	D	Bad	Wetland Management plan needs to be developed for proper conservation	Wetland management plan would ensure future conservation initiatives.
Wetland notification	A	Good		Wetland notified by the Department of Wildlife Protection

Wetland Health Assessment: Raar, Hanle

Wetland Health Score: 0.85 **Wetland Health Category: B- (Good)**

Table 17. Wetland Health Assessment Card: Raar

Wetland Health indicator	Scores	Category	Area of improvement	Inferences
% wetland converted to non-wetland use since 2000	A	Good	Clear demarcation of area, regular monitoring to prevent further wetland area conversion	The core wetland/ marshy area is intact, with negligible change in its water spread area.
Ratio of number of natural inlets choked and diverted, to total number of natural inlets.	A	Good	Catchment/ channel rejuvenation, regular monitoring for any obstructions	There are four main inlets to this marshy area and none of them is choked.
Ratio of number of natural outlets choked and diverted to total number of natural outlets	A	Good	Regular monitoring for any obstructions	There is one outlet from these marshes and it is slightly impacted due to construction of linear infrastructure
Biological Oxygen Demand		Unknown	Regular Water-quality monitoring	Regular water analysis needed for the wetland to plan conservation initiatives.
% wetland area covered by invasive macrophytes	A	Good	Regular monitoring for any invasive macrophytes required	Not an issue at present

Annual waterbird count as a proportion of average count of last 5 years		Unknown	Regular survey and developing bird checklist required for biodiversity monitoring	Bird checklist/ Biodiversity checklist would help in developing the strategy for ecosystem improvement.
Clearly demarcated wetlands map	C	Average	Map prepared should be approved by the State Authority	Maps needed for wetland demarcation is prepared
Wetland Management plan	D	Bad	Wetland Management plan needs to be developed for proper conservation	Wetland management plan would ensure future conservation initiatives.
Wetland notification	A	Good		Wetland notified by the Wildlife Protection department.

Wetland Health Assessment: Chukil, Hanle

Wetland Health Score: 0.74 **Wetland Health Category: C- (Moderate)**

Table 18. Wetland Health Assessment Card: Chukil

Wetland Health indicator	Score	Category	Area of improvement	Inferences
% wetland converted to non-wetland use since 2000	B	Good	Clear demarcation of area, regular monitoring required to prevent further wetland area conversion	Catchment (inter-land-use conversions, 36% of total area) conversion has happened but the core wetland /marshy area remains intact with negligible change in its spread area.
Ratio of number of natural inlets choked and diverted to total number of natural inlets.	D	Bad	Catchment/ channel rejuvenation required, regular monitoring for any obstructions	There are three main inlets to Chukil, out of which two inlets are impacted by construction of road from Khaldo habitation northwards (in year 2013-14), cutting across two main drainage points.
Ratio of number of natural outlets choked and diverted to total number of natural outlets	A	Good	Regular monitoring for any obstructions	There is one outlet from the wetland and it is intact.

Biological Oxygen Demand		Unknown	Water quality monitoring data is being collected for wetland health assessment	Regular water analysis for the wetland needed to plan conservation initiatives.
% wetland area covered by invasive macrophytes.	A	Good	Regular monitoring required for any invasive macrophytes	Not an issue at present
Annual waterbird count as a proportion of average count of last 5 years		Unknown	Regular bird checklist required for biodiversity monitoring	Bird checklist/ Biodiversity checklist would help in developing the strategy for ecosystem improvement.
Clearly demarcated wetlands map	C	Average	Map prepared should be approved by the State Authority	Maps needed for wetland demarcation is prepared.
Wetland Management plan	D	Bad	Wetland Management plan needs to be developed for proper conservation	Wetland management plan would ensure future conservation initiatives.
Wetland notification	A	Good		Wetland notified by the Wildlife Protection department.

Wetland Health Assessment: Shadobug, Hanle

Wetland Health Score: 0.85 **Wetland Health Category: B- (Good)**

Table 19. Wetland Health Assessment Card Shado Bug

Wetland Health indicator	Scores	Category	Area of improvement	Inferences
% wetland converted to non-wetland use since 2000	A	Good	Clear demarcation of area, regular monitoring to prevent further wetland area conversion	The core wetland/ marshy area is intact with negligible change in its water spread area.
Ratio of number of natural inlets choked and diverted to total number of natural inlets.	A	Good	Catchment/ channel rejuvenation, regular monitoring for any obstructions	There are two main inlets to this wetland and they remain intact.
Ratio of number of natural outlets choked and diverted to total number of natural outlets	A	Good	Regular monitoring for any obstructions required	There is one outlet from the wetland and it is intact.

Biological Oxygen Demand		Unknown	Regular Water quality monitoring needed.	Regular water analysis needed for the wetland to plan conservation initiatives.
% wetland area covered by invasive macrophytes.	A	Good	Regular monitoring for any invasive macrophytes required	Not an issue at present
Annual waterbird count as a proportion of average count of last 5 years		Unknown	Regular bird surveys and updation of checklist required.	Bird checklist/ Biodiversity checklist would help in developing the strategy for ecosystem improvement.
Clearly demarcated wetlands map	C	Average	Map prepared should be approved by the State Authority	Maps needed for wetland demarcation.
Wetland Management plan	D	Bad	Wetland Management plan needs to be developed for proper conservation	Wetland management plan would ensure future conservation initiatives.
Wetland notification	A	Good		Wetland notified by the Wildlife Protection department.

Chapter 4: Institutional Arrangement

The Department of Wildlife Protection, Ladakh, has been actively engaged in the protection of wetlands and associated wildlife. However, long-term management of the wetland will require the active participation of all the stakeholder groups.

As seen in the earlier chapters, there are several stakeholders, including traditional institutions and Government agencies, who are actively engaged in various types of activities in the wetland and its zone of influence. Some of them have a positive influence, while the decisions/ actions of others may be counterproductive. The role played by the key stakeholders in the Hanle Wetland Complex and their alignment/intent are given below.

4.1 Key Institutions

Table 20. Stakeholder Mapping

Stakeholder	Interest/stake	Alignment/Interest	Influence 1: Low 2: Medium 3: High
District Rural Development Department	Holds high influence on urban development/ can work for improving water savings in urban areas	Implementation of conservation activities like clearing inflow channels	2
Department of Science & Technology	Indian Institute of Astrophysics Research activities.	Regulation of activities in zone of influence	3
Department of Wildlife Protection	Owners of the wetland and zone of influence.	Planning and Implementation of conservation activities for wetlands	3
District Irrigation Department	Irrigation and water diversion	Regulation of water diversions and overall hydrological monitoring	2
District Agriculture Department	Agriculture planning and extension	Influence cropping pattern in the zone of influence and package of practices in agriculture to save water	3
Indo-Tibetan Border Police	Land use/ camp installation/waste management	Regulate littering of waste and management of leftover food	3
Indian Army	Land use/camp installation/waste management	Siting of camps Regulate waste (including food) disposal	3
District Electricity Department	Power supply	Proper alignment and insulation of electric cables	3
Sarpanch and elected members of Panchayat	Highly influential people who facilitate development in their respective villages	Planning and implementation of conservation activities	2

District Sheep Husbandry Department	Develops enclosures for pasture development	Regulation of grazing/pasture development	2
District Animal Husbandry Department	Develops enclosures for pasture development	Regulation of feral dogs and management of other livestock	2
District Soil Conservation Department	Constructs bandhs near Hanle river	Implementation of soil /springshed conservation measures	2
Local NGOs	LeDEG and Leh Nutrition Project (LNP) watershed development projects	Implementation of conservation activities, behavior change stakeholder mobilization	2
Border Road Organization and PWD	Infrastructure and Road Projects	Regulation of construction of roads within wetlands and key drainage channels	3
Religious Institutions	Hanle Monastery and Tashi Choling Gompa	Influence behaviour of local community	3
Local community members	Land and water intensive behaviour/practices.	Planning and execution of wetland conservation activities	3
GOBA (Traditional village heads)	Deciding upon traditional grazing calendar	Regulate grazing	3
Ladakh Autonomous Hill Development Council (LAHDC)	Overall management of the Ladakh region	Planning and implementation of conservation measures Tourism policy, organic farming	3
Defense Institute of High-Altitude Research (DIHAR)	Research on High-Altitude ecology	Research inputs for better management of the zone of influence, monitoring of wetland	2
All Ladakh Tour Operators Association (ALTOA)	Tourism activities in the region	Regulation of solid waste littering and protection of key areas, sensitization of tourists	2

The stakeholder mapping and focused group discussions revealed diverse stakeholders of the wetland and its zone of influence. However, the Focused Group Discussions with the key stakeholders, including LAHDC, ALTOA, Department of Tourism, other line departments and village Sarpanchs clearly indicated the need to synergise and integrate wetland conservation in sectoral plans. There is also an opportunity for convergence of many schemes and plans for integrated management of wetlands.

The analysis also revealed that there are four distinct groups of stakeholders, who can play significant roles in the management of the wetland. The details of the same are tabulated below:

Table 21. Assessment of roles of key stakeholders in management of Wetlands

Policy Makers/Decision makers	Implementers	Influencers	Users
MoEFCC	Department of Wildlife Protection	Indo-Tibetan Border Police	Local community members/Community Institutions
Department of Wildlife Protection UT	District Rural Development Department	Indian Army	Religious Institutions
Revenue Department	District Irrigation Department	District Electricity Department	
LAHDC	District Agriculture Department	Sarpanch and elected members of Panchayat	
Forest Department	Goba	Religious Institutions	
Indian Army		District Sheep Husbandry Department	
Indo-Tibetan Border Police		District Animal Husbandry Department	
		Local NGOs/ SHGs/ Youth Associations	
		Hanle Monastery	
		Tashi Choling Monastery	

4.2 Traditional Institutions

In addition to the formal management setup, the wetlands in the Hanle complex also have an informal set of practices, which contribute to wetland management. The details of community institutions contributing and their respective roles and responsibilities are tabulated below:

Table 22. Role of traditional institutions in wetland management in Hanle Complex

S. No.	Wetland	Institutions	Roles and Responsibilities
1	Jung Demo	Goba (Traditional Village Head)	Develop grazing calendar
		Hanle Monastery	Organizing and managing footprint of religious events on wetlands for village communities of Punguk, Kungje, Khaldo, Shado Bug and Sasoma
2	Raar	Tashi Choling Monastery	Annual de-weeding in the wetland

		Goba (Traditional Village Head)	Develop grazing calendar
3	Chukil	Goba (Traditional Village Head)	Develop grazing calendar
		Ama Tsogspa (Women Self Help Groups)	Occasional clean-up drives in the wetlands
		Djunu Tsogpa (Youth Association)	Occasional clean-up drives in the wetlands, helping the Monastery in collecting funds for the restoration and organizing prayers.
4	Shado Bug	Goba (Traditional Village Head)	Develop grazing calendar
		Community	Providing access to medicinal plants to community
			Water withdrawal from wetland
		Sarpanch	Has the powers to intervene and stop any adverse activities on the wetland as well as plan for conservation-related activities

Ongoing Schemes and Plans

Various government schemes being implemented in the zone of influence were also mapped to understand synergies with wetland conservation. The details of the government schemes are tabulated below:

Table 23. Ongoing government schemes and plans in the wetlands

S. No.	Scheme	Implementing Department	Focus Area of work of work	Geographical area
1	Development of pasture	Department of Soil Conservation	Development of pasture and fodder	In zone of influence of all wetlands
2	Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)	Department of Rural Development	Channel expansion for irrigation in Shado Bug, *Lera* (shed for cattle) and a glass room for the grazers for all settlements in Hanle. (Around 1-2 provided each year)	Shado Bug
3	Promotion of sheep husbandry	Department of Animal husbandry	Fodder for winter, construction of *Lera* (shed for cattle) and a glass room for the grazers. Tents in every village, fencing for protection of plantation	In zone of influence of all wetlands (Immediate periphery)

4	Microfinance for purchase of livestock	Department of Animal husbandry	Interest free loan provided	In Hanle, Khaldo and Kunji villages
5	Agriculture extension programme	Department of Agriculture	Subsidy for greenhouse, seeds and agriculture equipment. Training on organic farming and cropping practices	In Hanle, Khaldo and Kunji villages
6	Mission Organic Development Initiatives (MODI)	Ladakh Autonomous Hill Development Council	Making all agriculture produce in Ladakh organic by 2025.	Promotion of organic farming, training and outreach events in Hanle, Khaldo villages
7	Protection of livestock and agriculture produce	Krishi Vigyan Kendra, Nyoma	Training on livestock care and protection of crops	In Hanle, Khaldo and Kunji villages
8	Pradhan Mantri Gram Sadak Yojna	Public Works Department	Construction of road	Within wetland area in Raar, zone of influence

Chapter 5: Setting Management Objectives

Based on the recognition of the full range of ecosystem services, hydrological, ecological characteristics and the present threats, an integrated management plan has been prepared following the guidelines of the National Programme for Conservation of Aquatic Ecosystems. The following chapter presents the management goals, objectives, activity and monitoring framework.

Based on the assessments and stakeholder inputs, the management objectives for planning for the Hanle Wetland Complex is as follows:

5.1 Vision and Management Goals

"A well-protected and healthy wetland complex, rich in biodiversity, which retains the flow of ecosystem services and emerges as a model for multi-stakeholder engagement in conservation."

Goals

1. Maintaining the ecological and hydrological integrity of the wetland complex.
2. Multi-stakeholder institutional arrangement and cross-sectoral synergies established to ensure the effectiveness of the conservation plan of Hanle Wetland Complex

The details of objectives and actions required to achieve the goals are presented below:

Goal 1: Maintaining the ecological and hydrological integrity of the wetland

Objectives	Actions
Objective 1: Securing the zone of influence of the wetlands	. Zone of influence and buffer zones of the wetland area to be notified, along with activities to be regulated, prohibited and banned
	. Springsheds in the wetland catchments are mapped and spring shed management plans developed and implemented
	. Establish and maintain the flow regimes needed for the hydrological integrity of the wetlands
	. Enhancing capacity of local community for adoption of sustainable agriculture
	. Establishing a hydrological monitoring system in the wetlands and the Hanle river
Objective 2: Conservation of key habitats and wetland species	High conservation value areas in the four wetlands in the complex to be notified and conservation action initiated
	A plan for conservation of snow trout to be developed and implementation initiated

	Action plans for protecting the nesting sites of BNC and managing the feral dog threat to be agreed upon and implementation initiated with key stakeholders
Objective 3: Hanle wetland complex becomes a model for community based eco-tourism	Sustainable eco-tourism roadmap is prepared and implemented
	Decentralized solid and liquid waste management is implemented

Goal 2: Multi-stakeholder institutional arrangement and cross-sectoral synergies established to ensure the effectiveness of the conservation plan of Hanle Wetland Complex

Objective 1: A multi-stakeholder institutional arrangement and CEPA programme lead to active stakeholder engagement and cross-sectoral coordination to ensure the effectiveness of the conservation plan of the Hanle Wetland Complex	A multi-stakeholder Hanle Wetland Complex conservation committee (as a mechanism for coordination and integrated management) is constituted and functional
	Establish synergies/linkages with ongoing programmes (TSP, Organic farming, and so on) to ensure integration of wetland conservation in sectoral plans
	A Communication, Education, Participation and Awareness (CEPA) programme is implemented for enhancing multi-stakeholder engagement and ownership in wetland conservation

Chapter 6: Monitoring and Evaluation Plan

The wetland in its current situation is highly sensitive to changes in the zone of influence. The wetland complex is being impacted due to a large number of anthropogenic activities in the zone of influence and the wetland. Any further degradation in the health of the wetland will result in the loss of highly significant ecosystem services offered by the wetland. In order to ensure that the wetland is retained in its best health, it is important to monitor the wetland at periodic intervals. This monitoring of the wetland health needs to be carried out by the multi-stakeholder committee. This will help detect early signs of degradation in wetland health and support informed decisions for implementing conservation actions. The monitoring plan for the wetland is below:

Table 24. Monitoring plan for the Wetlands

Wetland feature	Management objective	Performance Indicator	Means of measurement	Frequency	Responsible Agency
Area (Objective 1)	Maintenance of the ecological and hydrological integrity of the wetland complex	No loss in wetland area	Remote sensing and ground-truthing	Once a year	Department of Wildlife Protection and DIHAR, Leh
	Notification of zone of influence and buffer zones of the wetland area, (along with activities to be regulated, prohibited and prohibited),	Notification of buffers and activities to be regulated, prohibited and permitted. Assessment of changes in land use and land cover	Remote sensing and ground truthing	Once in three years	Department of Wildlife Protection and DIHAR, Leh
Catchment	Notification of High Conservation Area	Extent of area under HCV	Notification	Once a year	Department of Wildlife Protection
Hydrological regimes (Objective 2)	Enhancement of hydrological connectivity within wetlands complex	Area inundated during various seasons	Analysis of remote sensing data, and hydrological surveys	Once a year	Department of Wildlife Protection Preservation, NIH Jammu and DIHAR, Leh
	Maintenance of water quality	BOD, nutrients (Nitrate and phosphate)	Seasonal water quality monitoring		SKAUST, Department of Wildlife Protection
	Assessment of E-flows for all the four wetlands and establishment of baselines	Environmental flows (E-flows) for four wetlands and Hanle arrived at and agreed upon by stakeholders	E-flows assessment	Once	

Biodiversity (Objective 1,2)	Maintenance and enhancement of habitat of waterbirds	Population and diversity of wetland dependent species	Winter and summer avian surveys	Twice a year	Department of Wildlife Protection and individual birders
		Migratory birds		Once a year	Department of Wildlife Protection and individual birders
	Development and implementation of Snow trout conservation plan	Baselines of population estimates of snow trout, assessment of habitat requirements completed	Survey reports	Once	Department of Wildlife Protection, Department of Fisheries
	Preparation and implementation of plan for protection of BNC	Baselines of population estimates of BNC, assessment of habitat requirements completed	Survey reports	Four seasons in two consecutive years	Department of Wildlife Protection
Ecosystem services	Maintenance of ecosystem services	Change in ecosystem services and dependencies	RAWES	Once in two years	Department of Wildlife Protection
		Tourism	Number of tourists	Monthly aggregated to annual	Department of Tourism, LAHDC, Department of Wildlife Protection, and ALTOA
Governance (Objective 3)	Enhancement of Institutional capacity	Functional and active wetland committee	Number of meetings and decisions/ actions taken		Multi-stakeholder committee and Department of Wildlife Protection
		Implementation of integrated plan	Resources mobilized and utilized	Once	Department of Wildlife Protection
	Declaration of Hanle Wetland Complex as conservation reserve		Notification, formation of conservation reserve committee	Once	Department of Wildlife Protection
	Plan for CEPA prepared and implemented	Extended outreach and change in level of engagement of stakeholders	Stakeholder surveys	Once in two years	Ladakh Autonomous Hill Development Council

Chapter 7: Development of Action Plan

Action Plan: The studies carried out by WWF India under this assignment, along with an analysis of the perception of the communities, officials of the Department of Wildlife Protection and the key stakeholders including the Ladakh Autonomous Hill Development Council Tour Operators, LAHDC and department of tourism reveal that the wetland provides a large number of ecosystem services. The health assessment of the wetlands indicates moderate to good health. However, there are emerging threats that may interfere with the integrity of the wetlands. Therefore, active management of these wetlands is essential to protect the ecosystem services offered by the wetlands and the biodiversity that this wetland supports. The details of the management action required for achieving the envisioned goals are given below:

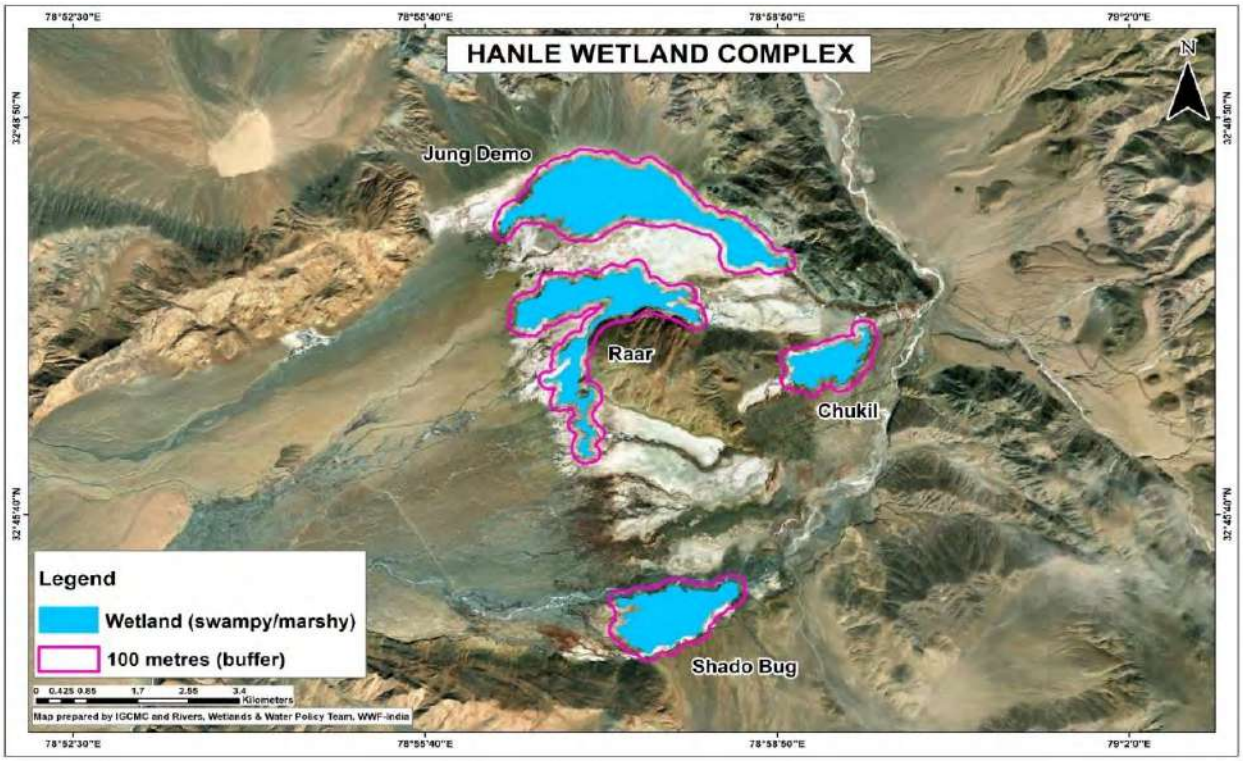
Goal 1: Maintaining the ecological and hydrological integrity of the wetland complex

Objective 1: Securing the zone of influence of the wetlands

Action 1: Notification of Zone of influence and buffer zones of the wetland area along with activities to be regulated, prohibited and banned

The immediate periphery of the wetlands is the zone with maximum biological activities. There is a constant exchange of life, matter and energy from and to the wetland from this immediate periphery. However, due to increased anthropogenic pressures, mainly because of agriculture, water abstraction and tourist activities, this area is impacted. It hence needs to be protected by prohibiting, regulating and promoting appropriate activities within the zone. Following options for buffers are proposed for further discussions and necessary action:

Option 1: 100-m buffer from maximum observed water level



Map 19. 100 meters buffer area of Hanle Wetland Complex

Advantages:

- Protection of immediate periphery
- Littoral zones of wetland protected, providing protection to species like amphibians and reptiles dependent on the wetland

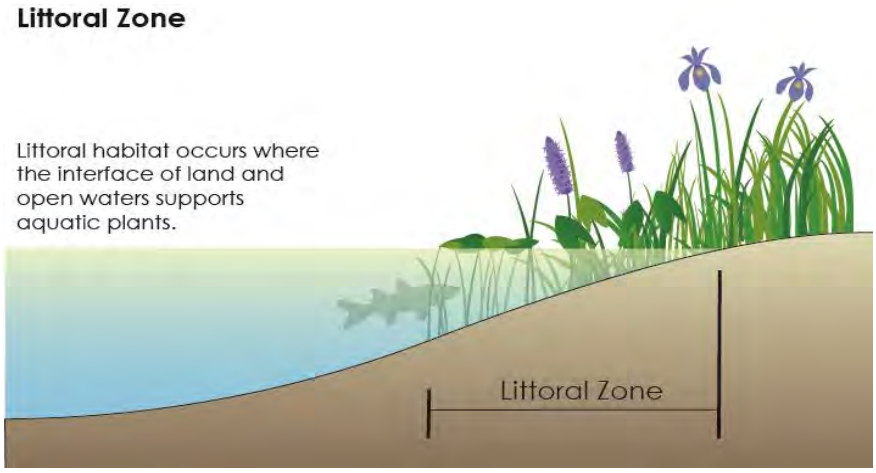
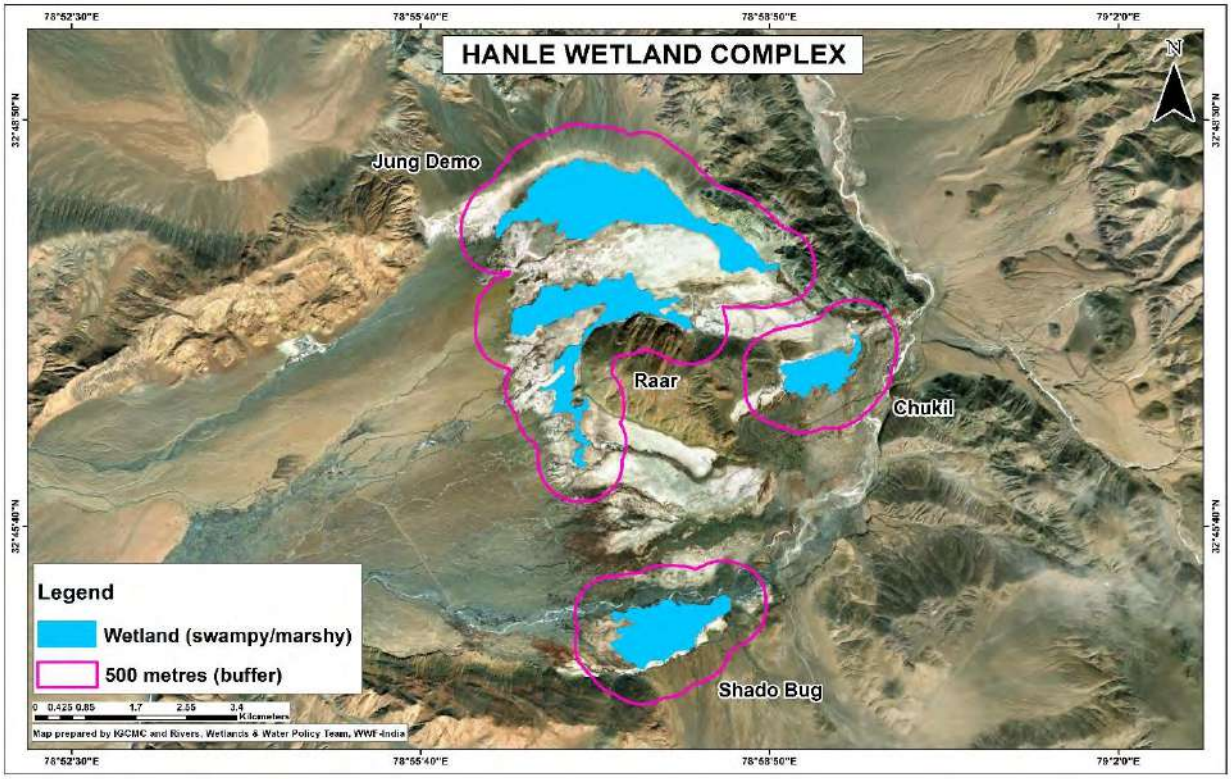


Figure 11. Littoral zone of the wetland (Representative image)
Source: Limnology: Lakes and River Ecosystems by Robert G Wetzel, Third Edition.

Option 2: 500-m buffer from maximum observed water level

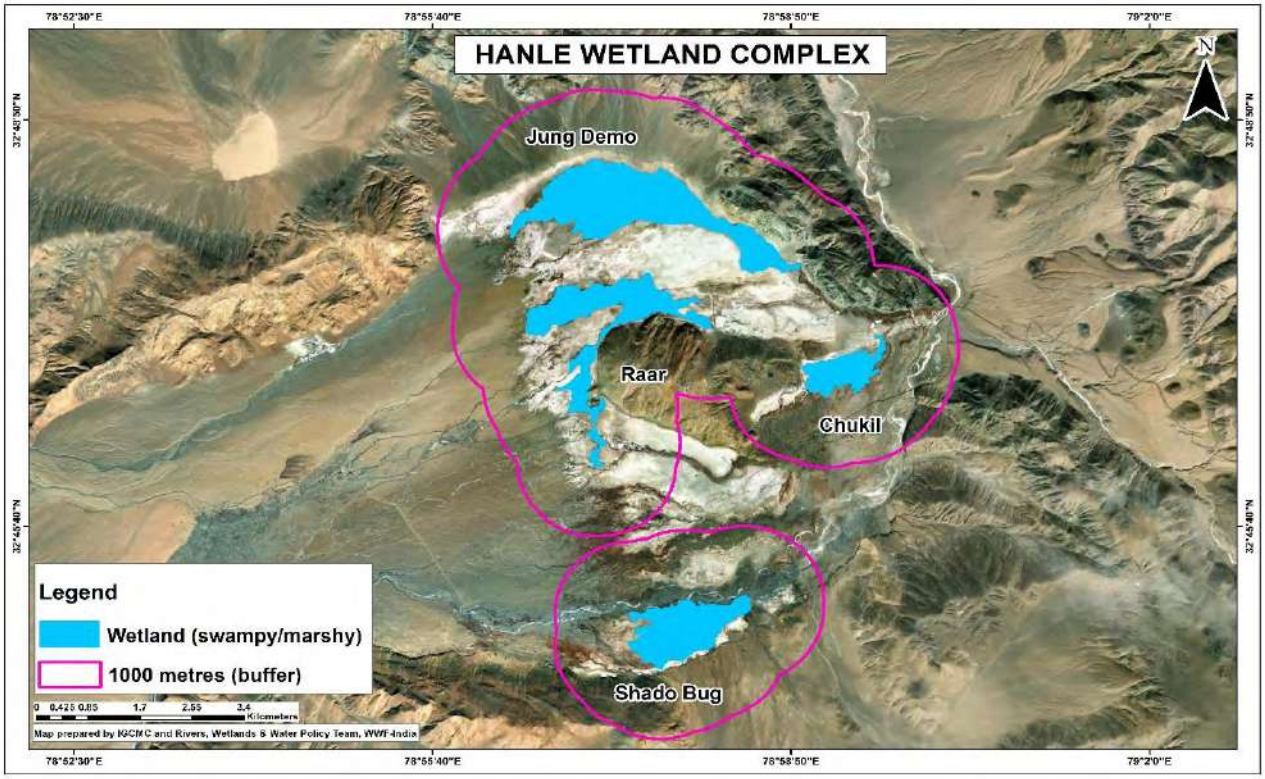


Map 20. 500 meters buffer area of Hanle Wetland Complex

Advantages:

- Protection of riparian vegetation
- Protection of greater ecological perimeter of the Hanle wetland
- Buffer Zone to provide protection of entire area between Jung Demo and Raar wetlands to ensure hydrological connectivity

Option 3: 1000-m buffer from maximum observed water level



Map 21. 1000 meters buffer area of Hanle Wetland Complex

Advantages:

a. Will provide protection to most of the wetland-dependent species and their habitats and the larger zone of influence.

b. Entire area under Jung Demo, Raar and Chukil will be provided enhanced protection, ensuring ecological and hydrological continuum.

The details of the activities that are proposed to be prohibited, regulated and permitted in the proposed buffer zone is tabulated below:

Table 25: Activities to be prohibited, regulated and permitted

Proposed Activity	Jung Demo	Chukil	Raar/ Raagar	Shado Bug
Reclamation/ filling up				
Single-use plastic				
Food waste disposal				
Mining Activities				
Infrastructure in buffer zone				
Largescale water diversions/abstractions				

Introduction of non-native fish species				
Solid/liquid waste disposal				
Grazing				
Infrastructure in Zone of influence				
Agriculture activities within the wetland boundaries/ buffer areas				
Springshed conservation				
Environmental awareness among stakeholders				
Promotion of sustainable agriculture				
Wetland Research				

	To be prohibited
	To be regulated
	To be permitted

The notification of the buffer zone and the activities to be prohibited/regulated/promoted could be made under the provisions of Wetland (Conservation and Management) Rules 2017.

Action 2: Springsheds in the wetland catchments are mapped and springshed management plans developed, implemented

The springs that support and are supported by the wetlands in the Hanle complex are key to the water security of the region, and the principal source of water to the wetlands. However, these springs are getting degraded due to the varied stressors and need to be conserved on priority to protect the hydrology of the wetlands.

The details of steps involved in the development of the springshed development plan are given below:[9]

Step 1: Studying the geological map of the area: Geological maps (published or unpublished) of the area of interest can be used for reference purposes and to gain a first-hand idea about the regional geology. Generally geological maps obtained from Geological Survey of India provide information such as the types of rocks distributed in the region, their orientation and broad geological structures.

[9] A Handbook on Springshed Management Developed by People's Science Institute

Step 2: Geological observations during a transect walk: Geological traverses are to be carried out in a springshed to collect information on spring location, rock type, strike and dip values. This information collected at every location of interest is supplemented with values of latitude, longitude and elevation.m Geological map and geological cross section are prepared based on the above information which are essential for the development of conceptual hydrogeological layout and to identify the recharge area or protection zone.

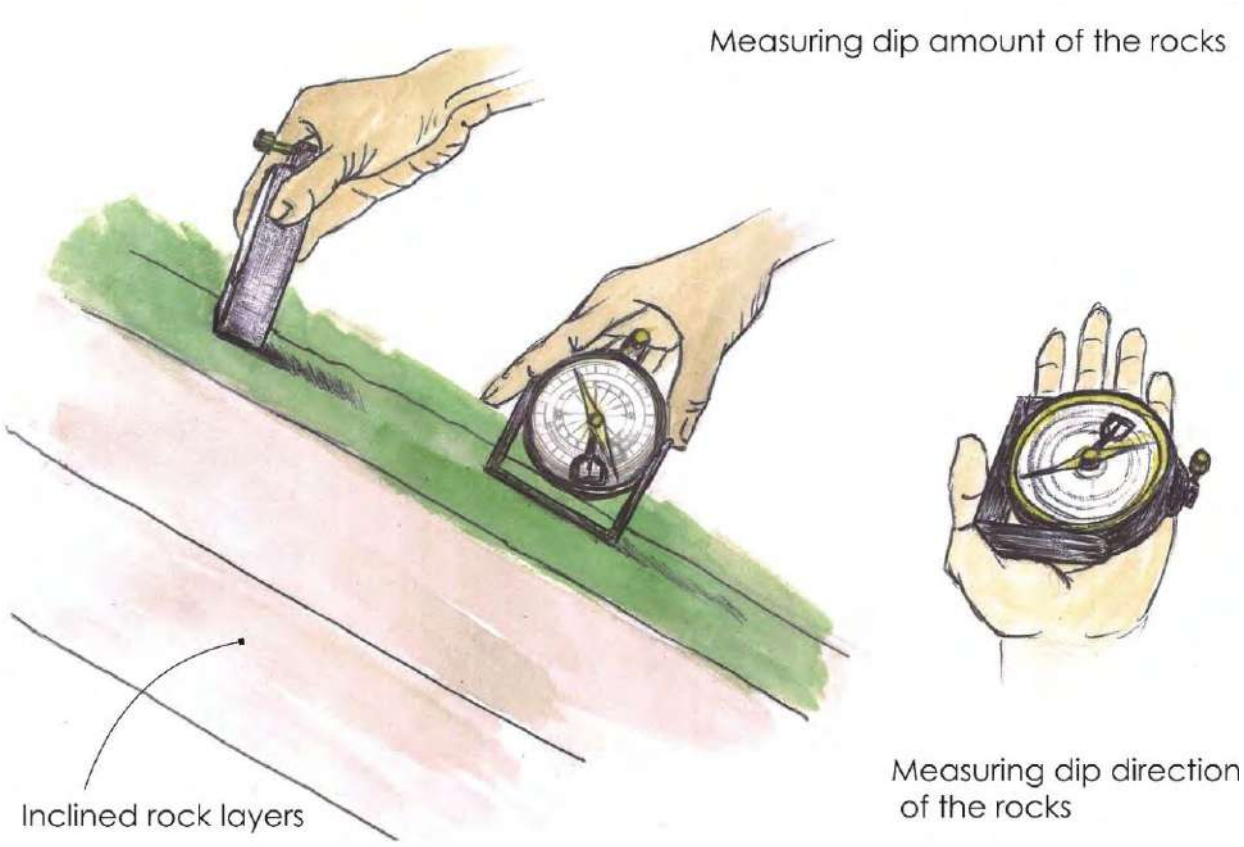


Figure 12: Measurement of dip for streams

Step 3: Creating a geological map (using Google Earth)

A geological map shows the distribution of different types of rocks and their structural relationship with each other in the area of interest. It can be prepared using the following steps:

- Data compilation in MS Excel
- Converting Excel data into Google Earth file (.kml)
- Plotting strike and dip of lithology and fracture/joints in Google Earth
- Connecting lithology and structural data to produce a map

Step 4: Creating a conceptual hydrogeological layout of the springshed: A hydrogeological layout of the springshed is a cross-section depicting springs and its relation with the surrounding

geology viewed in 3-dimension. To prepare a hydrogeological layout, a cross-section is first prepared from the geological map and projected into a 3-dimensional image. The location of the spring is then positioned in the 3-D layout to form a conceptual layout. Base maps/geological maps, prepared on the basis of data collected in the field, are used to create a hydrogeological layout, including a cross-sectional view of spring and springshed.

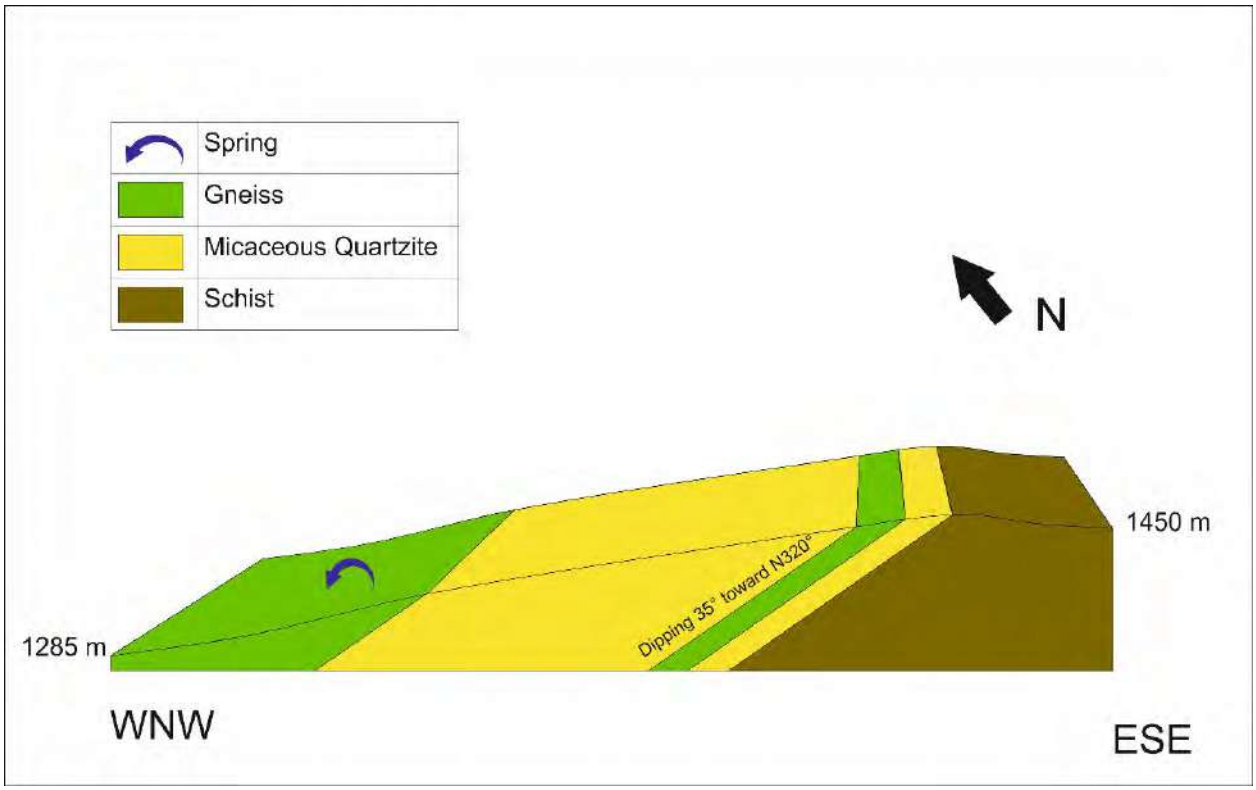


Figure 13: Sample Conceptual Hydrological layout

Step 5: Classification of spring type and broad identification of the aquifer

Hydrogeological layout of a springshed helps in identifying the aquifer and recognize the type of spring being studied. It also helps demarcate the recharge area for the spring as part of the springshed management activities.

Step 6: Delineating recharge areas: Identifying and delineating the recharge area(s) is the most crucial step in springshed management. Whether for the purpose of increasing the recharge to aquifers feeding springs or managing the aquifers and springs through the protection of such recharge areas, this step is crucial in augmenting or restoring spring discharge quality. The steps

involved in the process include the identification of the areas based on the hydrogeological layout and google earth images.

Step 7: Identifying springshed treatment: Once the recharge area is identified, engineering and vegetative measures can be detailed out to achieve the following:

1. Reducing the velocity of surface runoff: This can be attained by making bunds or trenches across the flow of water. This reduces the velocity of the surface run-off and enhances infiltration into the soil.

2. Increase the length of flow: If water is allowed to travel a longer distance in the recharge area, it will have more time to infiltrate the soil.

3. Storing the surface run-off: If the surface run-off, which usually dies off after the rains, is stored on the ground by means of recharge pits, ponds, etc., it will infiltrate into the ground and recharge the spring. Therefore, the basic concept for recharge of the springs is, to make 'Kuchha' (mostly earthen) structures in the recharge area with some storage so that the water collects, infiltrates down, feeds the aquifer and increases the discharge.

Additionally, the SOP suggested by the Ministry of Jal Shakti, Government of India [10] could be also be referred to for the development of the springshed development plan. The step-wise process of springshed development as provided in the SOP, is as below:

Table 26: Steps in springshed development

Steps	Activity	Objective	Equipment	Outcome
Step 1	Spring Mapping	To locate spring emergence point/geo-tagging	GPS device/ Android phone	Spring Atlas/ Inventory
Step 2	Spring Discharge measurement	To measure spring discharge	A bucket whose volume is known, stop watch	Spring Hydrograph
Step 3	Rainfall	To measure rainfall	Rain Gauge	Spring Hydrograph
Step 4	Water Quality	Water Quality Monitoring	Tracer, on spot water quality testing kit	Water Quality Report
Step 5	Baseline (Socio-Economic)	Base line survey	Formats, Structured Questionnaire	Village water resource map, demand and supply status, vulnerable springs
Step 6	Hydro-geological mapping	To collect Hydrological and Hydrogeological data from the field survey	GPS, Bruton, Clinometer, Hammer, Google earth and Sketch (Software)	Hydrogeological conceptual layout and spring site cross section

[10] https://jalshakti-ddws.gov.in/

Step 7	Designing recharge interventions and management protocols	Physical and biological measures, social fencing Behavior change	Tools for community mobilization experts, such as SARAR kit	Spring recharge and protocols for springshed management
Step 8	Impact Assessment of Springshed works	Measurements of benefits from springshed works with other socio-economic aspects	A bucket whose volume is known, Stop Watch, Tracer on spot water quality testing kit, Formats, Structured Questionnaire	Improvement in water availability and quality

The development of the springshed rejuvenation plan for the region need to be based on the field assessments and requirements.

Action 3: Development and implementation of Package of Practices to reduce water consumption by Yupka

The Ladakh Autonomous Hill Development Council (LAHDC) has been promoting schemes to make Leh district organic by 2025. Since the zone of influence of the wetlands is ecologically fragile, it is important to promote sustainable agriculture practices that take into account organic farming and focus on development of crop-specific Package of Practices with an emphasis on increasing agriculture water-use efficiency.

The Pradhan Mantri Krishi Sinchai Yojna (PMKSY) of the Ministry of Jal Shakti has been implementing various schemes to increase the water use efficiency across the country. Some schemes that are highly relevant in already water-stressed areas like Ladakh, need to be promoted to reduce the impact of agriculture on the Hanle wetlands. Some of the schemes that could be implemented with the support of the Department of Agriculture and Krishi Vigyan Kendra Nyoma in the region are detailed out below:

1. **More crop per drop (Micro Irrigation):** The more crop per drop scheme stresses the need to increase the agricultural water-use efficiency. Implementation of the scheme in the Hanle Wetland Complex and its zone of influence can reduce the agriculture footprint of the region.
The Krishi Vigyan Kendra at Nyoma has been implementing the agriculture extension programme in the region, thereby addressing the issue of water diversion. There is a need to develop PoPs according to the agro-climatic conditions.
The details of the crops in the zone of influence are as follows:

2. **Reduction of water footprint of cultivation of fodder crop:** The community survey in Hanle complex recorded cultivation of Shalimar Fodder Oats (*Avena sativa*) locally known as Yupka in the periphery of wetland complex under the Tribal Sub-plan Scheme (TSP).

Table 27: Details of crops in Zone of Influence of wetlands in Hanle complex

Wetland	Months	Number of households dependent on wetland for agriculture	Crops
Jung Demo	May to September	8	Barley, Potato, Local Peas, Turnip and Yukpa (Fodder)
Raagar	June to August	45	Barley, Peas, Potatoes, Yukpa
Chukil	May to September	50	Barley, Potato, Local Peas, and Yukpa (Fodder)

3. Respondents informed that they were trained on Yukpa cultivation by Krishi Vigyan Kendra (KVK), Nyoma, almost three years ago. The local community perceived Yukpa to be a water-intensive crop. Focused discussions with Ms. Jigmet, Head of the Department, KVK, Nyoma on technical details pertaining to the cultivation of Yukpa informed that the cultivation of Yukpa is purely organic and KVK till now has carried out the distribution of seeds under the TSP scheme. The KVK is yet to develop a Package of Practices (PoP) on Yukpa cultivation and that a systematic study on Yukpa cultivation is likely to be carried out in the coming years. The irrigation schedule of Yukpa cultivation is similar to traditional crops. Farmers irrigate the crop based on their experience-driven assessment and perceive that the Yukpa is water intensive crop.

4. **Mission Organic Development Initiative of Ladakh:** This initiative aims at converting Ladakh into a fully organic UT by 2025. According to Action plan[11] for developing the initiatives prepared by LAHDC in 2019, Nyoma blocks have very little uptake of pesticides and even the use of chemical fertilizers is on a decline. The promotion and implementation of the scheme will further strengthen the sustainable agricultural activities in the region. However there is a need to develop, field test and implement package of practices suitable for Yupka.

[11] Mission Organic Development Initiative of Ladakh, Policy, Strategy and Action Plan, LAHDC 2019.

Action 4: Establish and maintain the flow regimes needed for the hydrological integrity of the wetlands

Definition: Environmental Flows (E-Flows) are the quality, quantity and timing of flows required for the maintenance of the ecological integrity of rivers and wetlands, their associated ecosystems and the goods & services provided by them.

The environmental flows is the amount of water that the wetland requires to carry out the basic ecological functions. Since the wetlands are an essential part of the hydrological system that feeds the Hanle River and vice versa, it is important to assess the E-flows required for the wetlands as well as the Hanle River. The study carried out under this assignment shows that the water spread area of the wetlands is decreasing, which may be due to the decreased flow of water into the wetlands. Since these wetlands are important both for the communities and biodiversity, it is important to assess the E-flows requirement of the wetlands and Hanle River. This will also help in future basin planning.

The need to ensure Environmental Flows in the wetlands has been stressed upon by the Ramsar convention as well. The Ramsar convention vide its resolution VIII.1 provides guidelines for the allocation and management of water to maintain the ecological functions of wetlands.[12]

[12] https://www.ramsar.org/sites/default/files/documents/pdf/res/key_res_viii_01_e.pdf

Policy Recommendations prescribed by the Ramsar Convention

- Implementation of Environmental Flows requires cross-sectoral policy, legislative, regulatory and financial frameworks for water resources management at the local and basin levels, engaging stakeholders and respecting different cultures and values.
- Wetland managers should be engaged in water management processes.
- Effective implementation of environmental flows should be ensured to meet the SDGs, especially SDG 6, “Ensure availability and sustainable management of water and sanitation for all”.
- The environmental flows of wetlands can be met through careful water infrastructure planning and development; releases of water from dams; removal of dams; dam construction planning; limitations on groundwater and surface water diversions; and management of land use practices.
- Commitment to long-term monitoring of surface and groundwater flow patterns and the ecological and societal responses to changing patterns is essential to improve water management strategies and develop effective regulations. Public participation in the monitoring, evaluation and adaptive management of environmental flows can lead to broader acceptance of the need for water to meet the ecological functions of wetlands, depending on location, increased community capacity, shared ownership of purpose and better outcomes for rivers, wetlands and estuaries.

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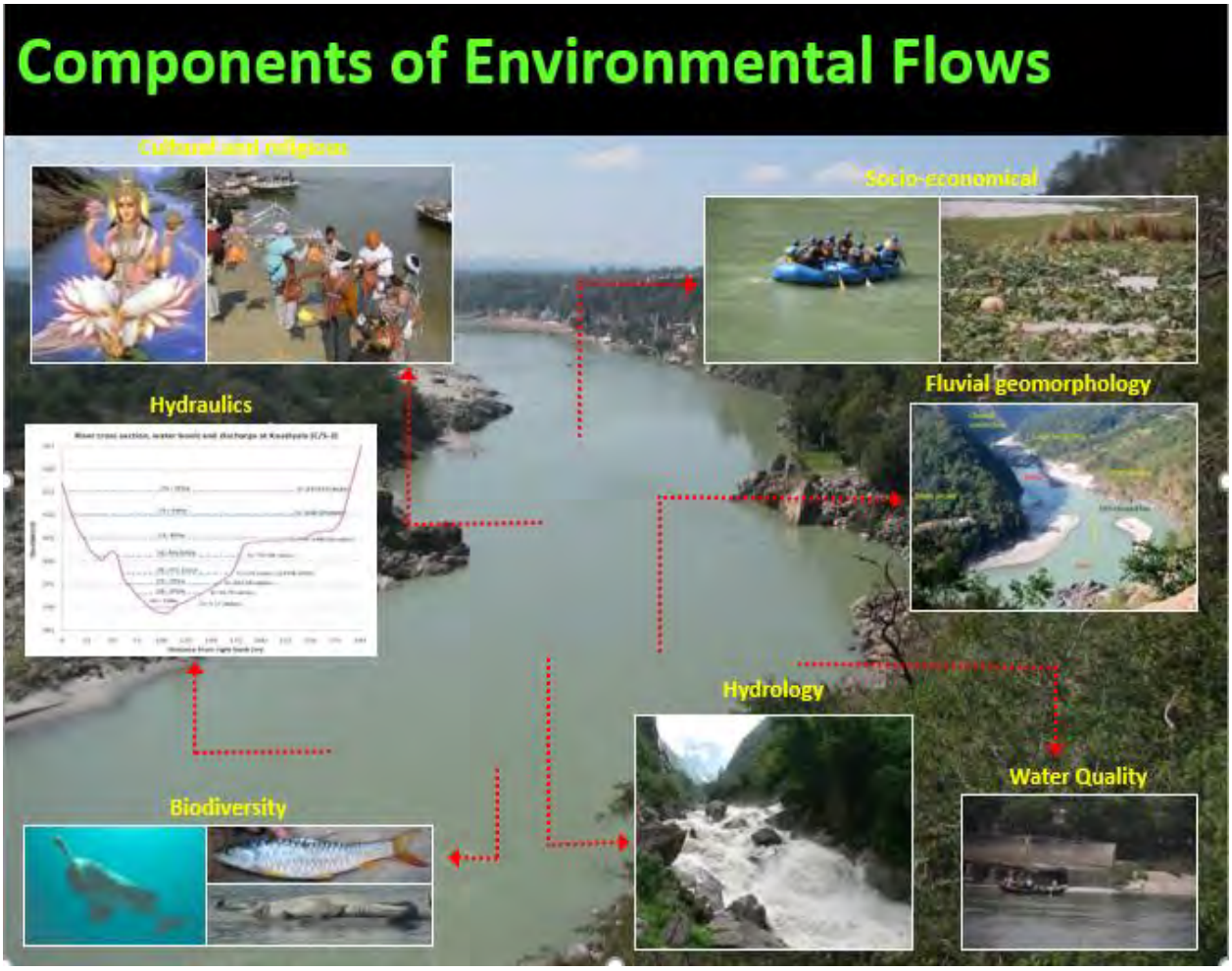


Figure 14: Components of E-flows assessment

Components of E-flows: The components of E-flows include the hydraulics, fluvial geomorphology, hydrology, biodiversity, water quality, socio-economic and cultural- religious components. The E-flows assessments are based on any of these/combination of these components.

The thematic terms of reference for the E-Flows assessment of river and wetlands are provided herewith. These terms of references provide high level guidance for the E-Flows assessment for rivers and wetlands in the Hanle complex.

Homogenous Zonation – is a scoping study through which the stretches of a river or wetlands is divided into homogenous zones from the perspective of elevation, tributary confluence, locations of towns/settlements, gauge and discharge monitoring locations, other anthropogenic features etc. Afterwards, in each of the zones, the representative E-Flows sites are identified. The joint multidisciplinary team visits these identified sites and shortlist the sites for E-Flows assessment.

For all the identified E-Flows locations, following tasks are taken up as a part of E-Flows Assessment – for these activities, primary surveys and review of secondary information is necessary:

Table 28: Thematic Terms of Reference for Environmental Flows

S. No.	Homogenous Zonation	Hydrology	Hydraulics	Fluvial Geomorphology	Biodiversity	Socio-cultural	Livelihoods	River/ Wetland Health
1	Assessment of Homogenous Zones, from the perspective of elevation, tributaries confluences, settlements, monitoring stations	Identify and review previous hydrological modeling studies and assessment of their usability	Generate Cross Section and Longitudinal Profiles Generate cross section & longitudinal profile of identified sites for hydraulic modeling	Analysis of sediments in the river, and the assessment of the effects that will result from different flow regimes	Conduct all season surveys (avian fauna, fishes, other organisms and life-forms dependent on water from the river/wetland) with an objective to assess the present condition in terms of the difference between the reference/desired condition	Assess the representation of the river in mythology, folklore, folk art and popular literature and art	Assess subsistence and non-consumptive livelihood activities that has dependency over water in the river/wetland	Assess the River/Wetland health Category with the help of (i) bio-monitoring, (ii) physico-chemical water quality parameters, (iii) basic hydraulics parameters (depth, width, connectivity)
2	Identification of locations in each Zone for E-Flows Assessment	Set up hydrological model and calibrate under existing conditions of land and water use	Conduct hydraulic modelling exercise	Analyse the channel and floodplain morphology in terms of the geomorphic features, and their stability	Describe measured depths, average velocities and substratum types most commonly associated with sensitive species and families, and/or with maximum biodiversity	Historical evidence of civilizations along the river, and its influence on society	Assess the implications on varying flows/depths onto these livelihood	Review of secondary literature to develop clear understanding on River Health
3	Homogenous Zonation Report	Examine the feasibility of different ways of modeling the past 'natural' and present-day flows, using observed flow data	Validate & calibrate the hydraulics model with hydrological information	Assess conducive flows regimes to support conducive sediments transport	Thorough review of present and past literature in regard to species dependence onto the river flows/depth and wetland depths at different seasons	Cultural importance of the river and wetlands, with focus on rituals and festivals, if any	Develop clearing understanding on present and reference/desired condition to sustain these livelihoods while maintaining the riverine or wetland ecosystem	Validate primary information through secondary information
4		Hydrology Report	Hydraulics Report	Starter Document – Fluvial Geomorphology	Starter Document – Biodiversity	Starter Document – Socio-cultural aspects	Starter Document – Livelihood aspects	Starter Document – River Health

Socio economic dependency and wetland health information has been generated under the UNDP SECURE Himalayas project. Same assessments for Hanle River needs to be done.

A roadmap for E-flows assessment is presented below:

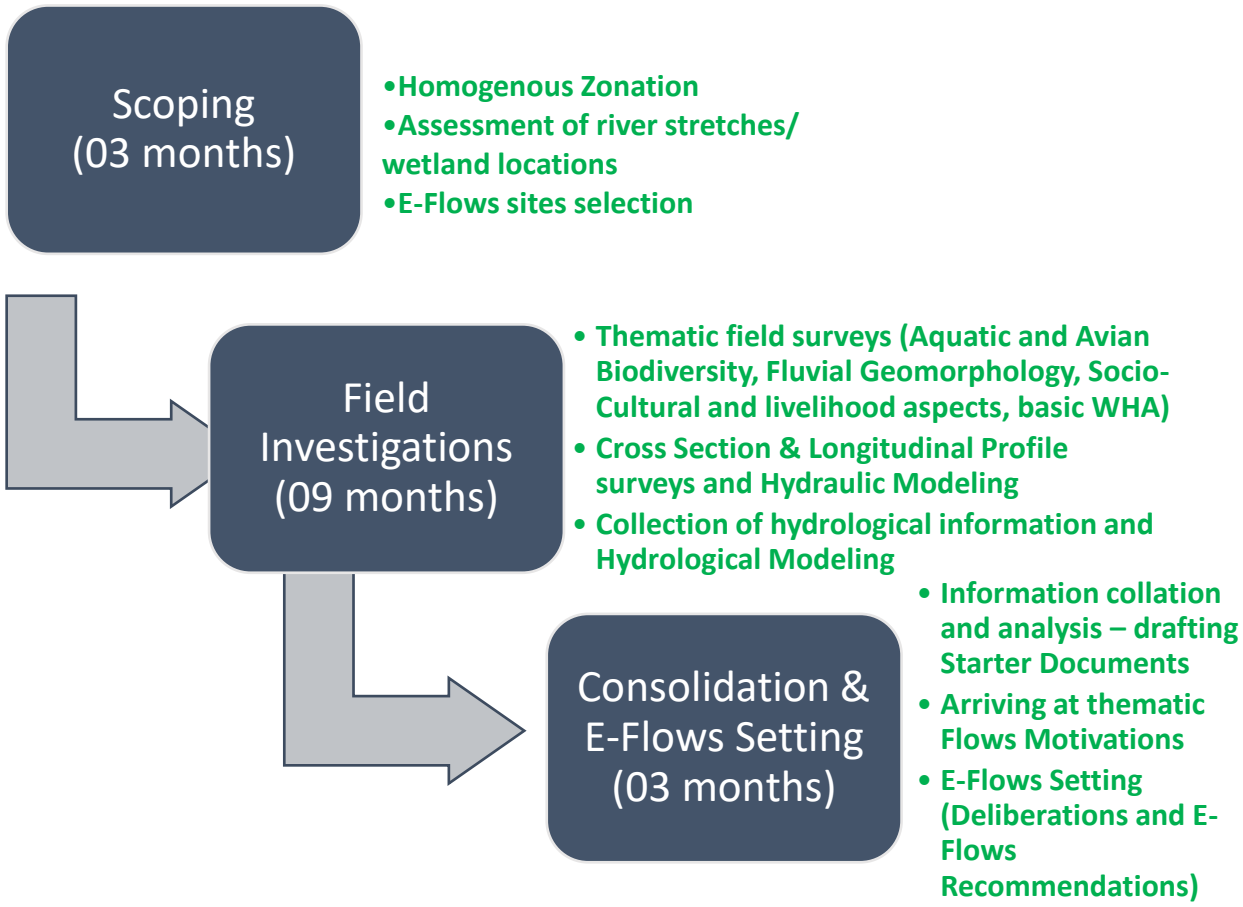


Figure 15: Roadmap for E-flows assessment

Action 5: Establishing a hydrological monitoring system in the wetlands and the Hanle River

With the threats to the wetlands on a constant rise, such as changes in hydrology, reduction in water spread area and changes in the land-use and land cover in the zone of influence, it is imperative that a robust wetland monitoring system is set up. This will help develop baselines and monitor future temporal changes in wetland health, hydrology and water availability and most importantly the impacts of management interventions. Therefore, it is proposed to set up a Regional Wetland Monitoring Station at Hanle that can regularly monitor the health of the wetlands in the complex and cater to nearby wetlands in the region. The long-term monitoring of the wetland complex would require the following:

Hydrological Assessments: In order to assess the hydrology of the wetland and associated inlets and outlets of the wetland, it is important to set up a mechanism to monitor the temporal changes in wetland storage/inundation and flows in and out of the systems. The requirements for monitoring the hydrological parameters are as below:

a. **Staff Gauges/ Automatic water level recorders**: The staff gauges are to be installed at ecologically and hydrologically significant points and at the deepest points of the wetlands to periodically monitor the water levels in the wetlands. Similar gauges should be installed in all the major inlets and outlets of the wetlands to monitor the water inflow and outflow from the wetlands. (Please see box for comparison of manual and automatic gauges)
b. **Velocity meters**: This will help record the flow velocity in the inlet and outlet channels for calculating discharges.
c. **Automated weather monitoring station:** An automated weather monitoring station is required to record the climatic data, including temperature, precipitation, wind velocity, humidity, etc., which have a direct bearing on the biophysical characters of the wetland. This will also be help correlate wetland hydrology vis a vis climatic changes.

The process of setting up of the hydrological monitoring systems is as follows:

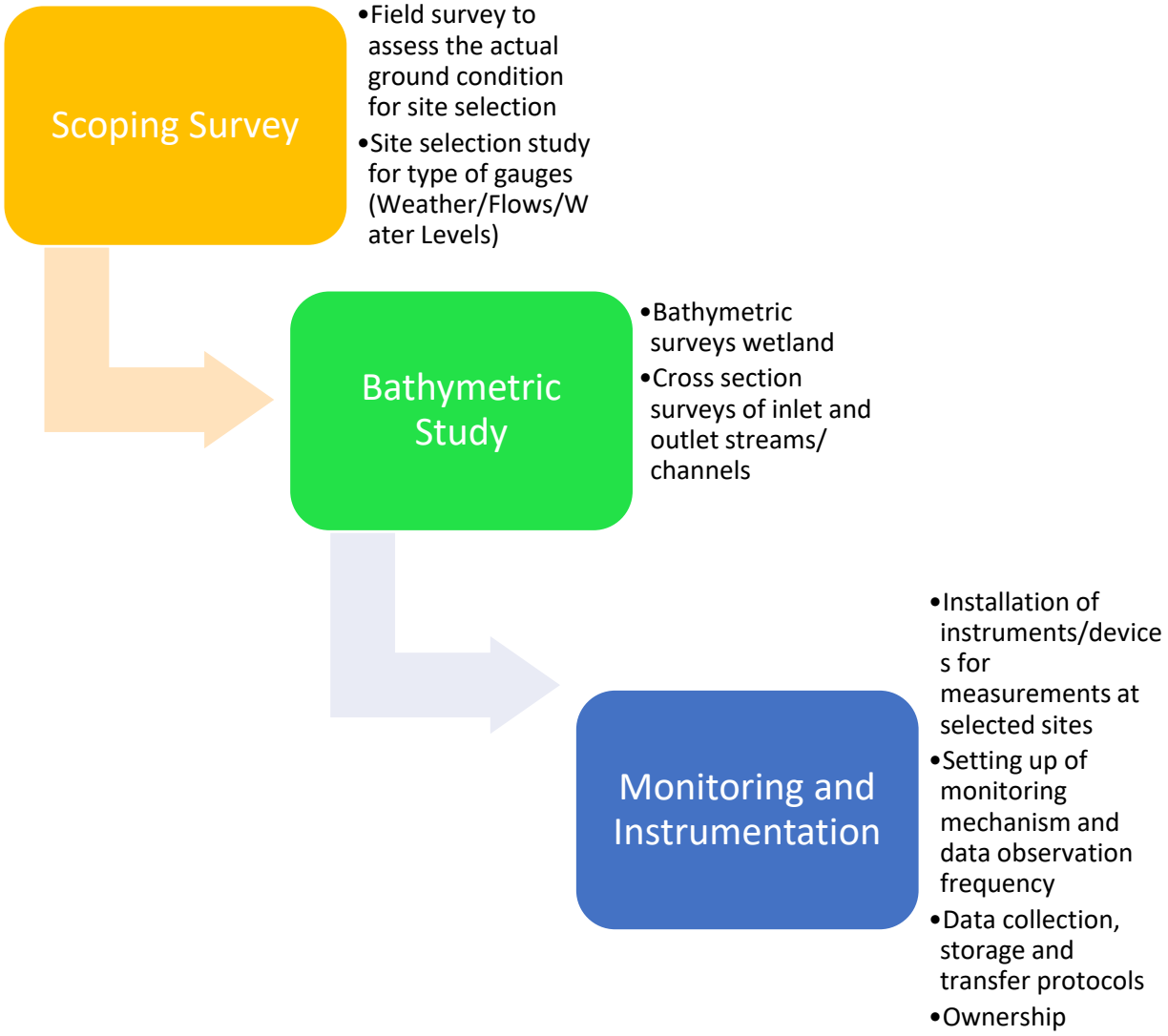


Figure 16: Process of setting up hydrological monitoring systems

Detailed plan for each of the wetlands is given below:

A. Jung Demo and Raar

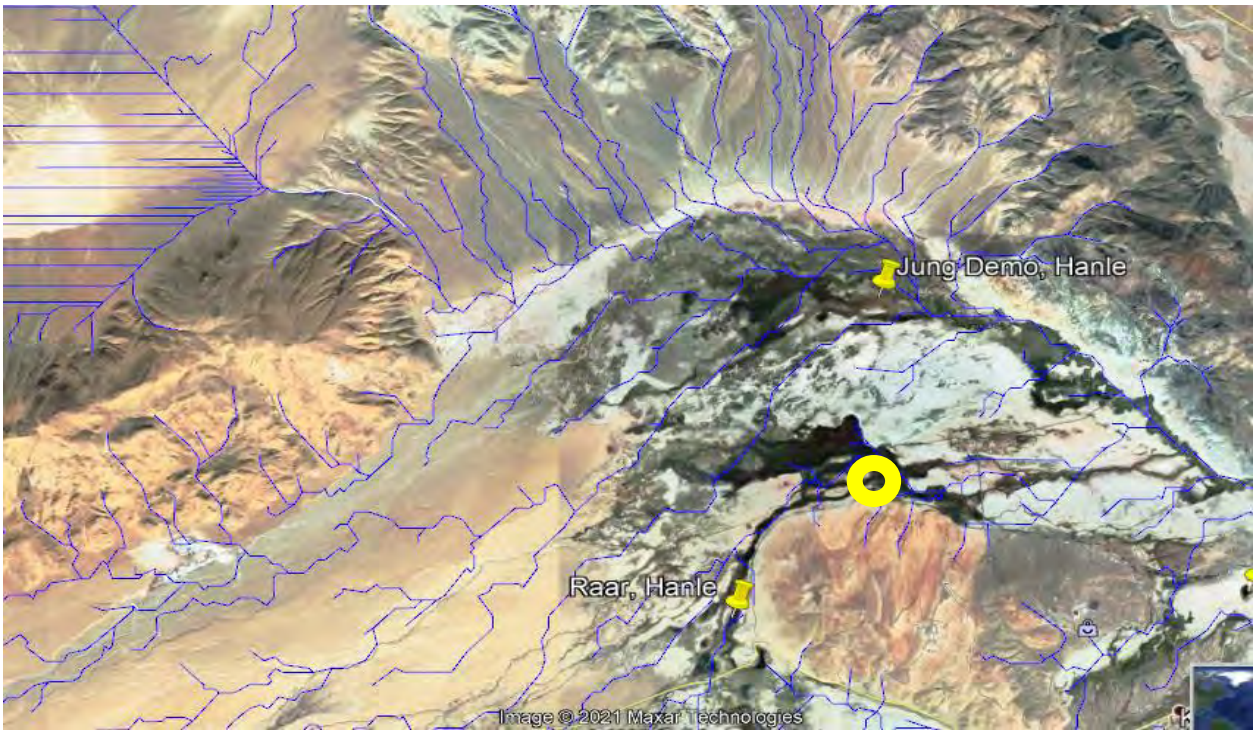
Raar

- Manual gauge staff /or automatic depth sensor could be installed at the deepest point to monitor water-level fluctuation. In Raar, the deepest point is towards the center of the marshy area, however the same could be ascertained based on the bathymetric studies.

- Raar has four main inlet channels, of which two are prominent inlet channels; and one outlet. A cross-section profile of channels at these two locations needs to be developed.
- Manual/Automatic water level gauge to be installed. Velocity of water in the channels needs to be monitored with velocity meter. Gauge-Discharge curves to be developed for reference**.** (Please see box: Gauge discharge curve)

Jung Demo

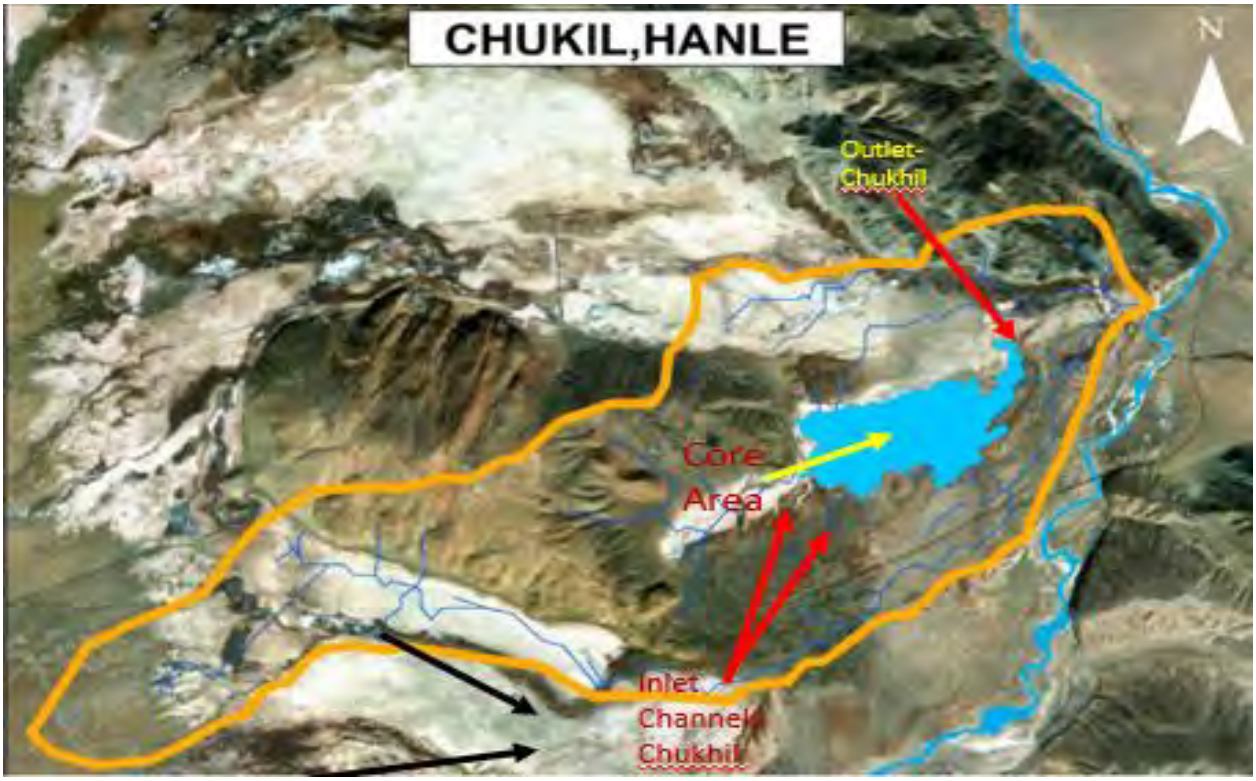
- Manual/Automatic water level instrument to be placed at the deepest location of core area, which is towards the center of the wetland.
- Cross section surveys to be conducted at two main inlet channels and one outlet channel of Jung demo and manual/automatic depth monitoring gauge to be installed
- Velocity of water in the channels needs to be monitored with velocity meter. Gauge-Discharge curves to be developed for reference.



Map 22. Map showing location for installation of staff gauges in Jung Demo and Raar wetland

B. Chukil

- Chukhil has three main inlet channels and one outlet channel. Cross-section profile at two main inlets and one outlet needs to be generated.
- Manual/ automatic water level gauge to be installed at two main inlets and one outlet and in the centre of the wetland for assessment of changes in the water level.
- Velocity of channels need to be monitored with velocity meter. Gauge-Discharge curves for reference to be developed.

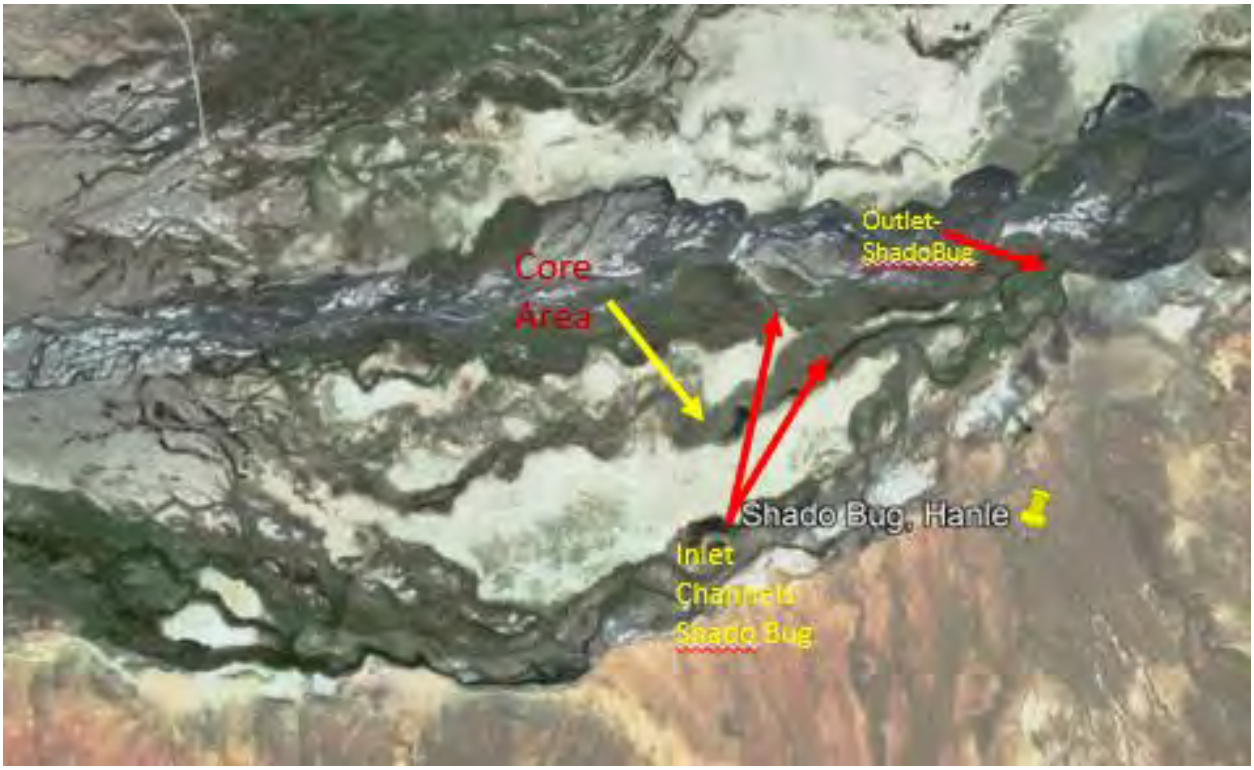


Map 23. Map showing location for installation of staff gauges in Chukil wetland

C. Shado Bug

- The wetland has two main inlet channels and one outlet channel, cross section profile at these sites needs to be carried out.
- Manual/ automatic water level gauge to be installed at two inlets and one outlet and center of the wetland for assessment of changes in the water levels.

- Velocity of channels needs to be monitored with velocity meter. Gauge-Discharge curves for reference to be developed.



Map 24. Proposed location for staff gauges in Shado Bug.

Figure 17. Staff Gauge (Representational Image)

Box 1. Comparison of manual Vs automatic water level monitors

Manual gauge
Advantages

- Easy to manufacture/develop even through locally available material like cement pole or bamboo or a wood.
- Easy to install
- Cheaper in cost
- Minimal risk of rusting and damage
- Needs little maintenance

Disadvantages

- Needs a separate observer to monitor and record gauge values.
- No facility of storing the data
- Remote installation and can be inconvenient in a harsh weather scenario
- Analysis demands manual input into computer storage

Automatic Water Level Monitor
Advantages

- Gives complete run-off record: duration, peak flows, flow recession, volumes
- Most suitable for remote sites, needs no reader at site
- Data can often be downloaded directly into the computer for analysis with a great saving of time.
- Data can be linked well to rainfall data (from intensity gauges)

Disadvantages

- Water level controls need to be replaced every 3 years.
- Electronics are usually built separately
- Quite expensive to install, operate and maintain as compared to manual gauge
- Need regular calibration and maintenance.
- Need trained manpower.

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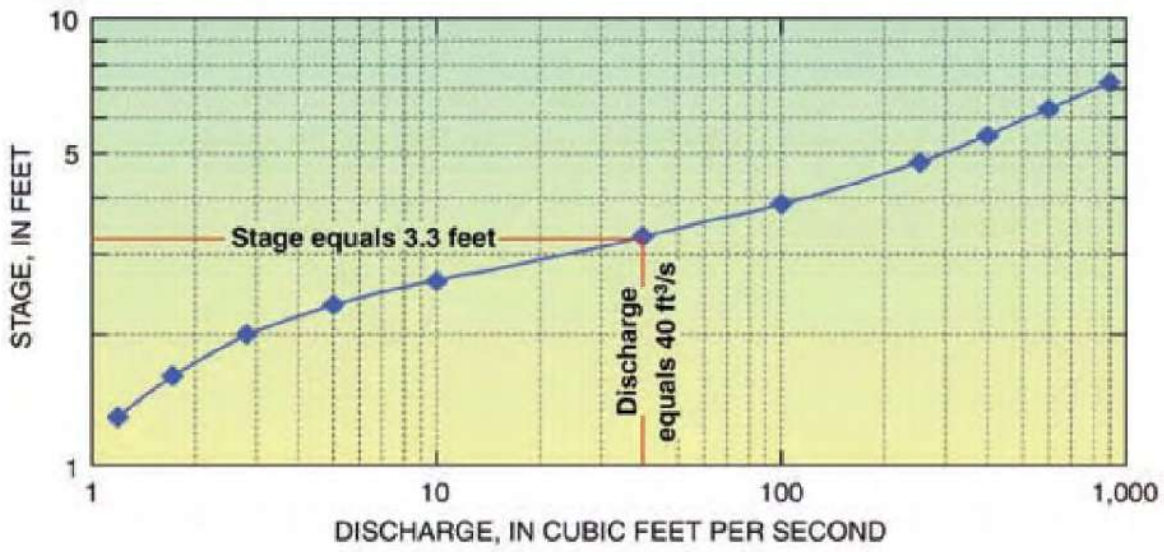
Box 2: Sample Gauge Discharge Curve

Gauge Discharge Curve

Stream gauges helps recording the water levels or stage at a defined frequency of observation. These stage values are translated to river discharge by applying the stage-discharge relation (also called rating curve). Stream discharge is measured indirectly from variables that can be measured directly, such as stream depth (stage), stream width, and streamflow velocity. Discharge in small streams is measured by measuring a cross-section profile of the river, breaking the river into subsections, and measuring the velocity of water in each subsection. The cross-section of each subsection multiplied by the velocity of the water gives the discharge rate (cubic feet per second) for a given subsection. The discharge for all subsections is summed to calculate the discharge for the entire stream or river. Stage-discharge relations are developed for various water levels at the hydro observation location and a standard Stage-Discharge curve is developed which is further used to calculate the discharges just by referring to the recorded water level.



Water quality monitoring station: Long-term water quality data is required to assess the health of the wetlands (List of parameters and methodology for testing is given in table 27). Automated/manual water quality monitoring test kits could be used in all the wetlands to collect the data on vital parameters including dissolved oxygen, salinity, pH, total dissolved solids, nitrate, phosphate and sulphate. Additionally, a field testing is required to carry out analysis of parameters like BOD, COD, coliform and biological parameters, including phytoplankton, zooplankton, macro-zoobenthos and macrophytic assemblage in the wetlands. These tests could also be done by engaging National Accreditation Board for Testing and Calibration Laboratories (NABL)/ Central Pollution Control Board accredited laboratory.

Regular biodiversity surveys (twice a year) are required to assess water birds, fish assemblage, mammals, amphibians and reptiles supported by the wetlands.

Table 29. List of water quality assessment parameters

S. No.	Parameter	Instrument	Make (some suggestions)	Specifications	Periodicity of monitoring	Staff Requirement
1	pH	pH meter	Hanna, Systronics	Resolution: 0.01 pH Accuracy: 0.1 pH	Seasonal	One field assistant/ Wetland mitra
2	Dissolved Oxygen	D.O. meter	Orion/ Merck	Resolution: 0.1 mg/l Accuracy:0.01 mg/l	Seasonal	
3	TDS	TDS/Conductivity meter	Hanna, Systronics	Resolution: 0.1 mg/l Accuracy:0.01 mg/l	Seasonal	
4	Conductivity	TDS/Conductivity meter	Hanna, Systronics	Resolution: 0.1 mili Siemens/cm Accuracy:0.01 mili Siemens/cm	Seasonal	
5	Nitrate	Jal Tara kit/ ISE based meter	Tara Life/ Merck/ Hach/ Systronics		Seasonal	
6	Phosphate	Jal Tara kit/ ISE based meter	Tara Life/ Merck/ Hach/ Systronics		Seasonal	
7	Total Coliform	Test kits	Tara Life/ Hi Media/ Merck		Seasonal	
8	Fecal Coliform	Test kits	Tara Life/ Hi Media/ Merck		Seasonal	

Following table presents a summary of all equipment/ arrangements needed for the hydrological monitoring.

Table 30. Summary of arrangements for monitoring of Hanle Wetland complex

Arrangement	Hanle River	Jung Demo	Raar	Chukil	Shado Bug
Staff Gauge	1 (On the bridge)	3	3	4	4
Weather Monitoring station	1 for the entire region				
Sampling stations for water quality testing	(Upstream of wetland, inlet of Shado Bug and downstream)	3	3	3	4
Velocity meters	1	3	3	3	4

Objective 2: Conservation of key wetland species

Action 1: High conservation value areas (HCVs) in the wetland complex is notified and conservation action initiated

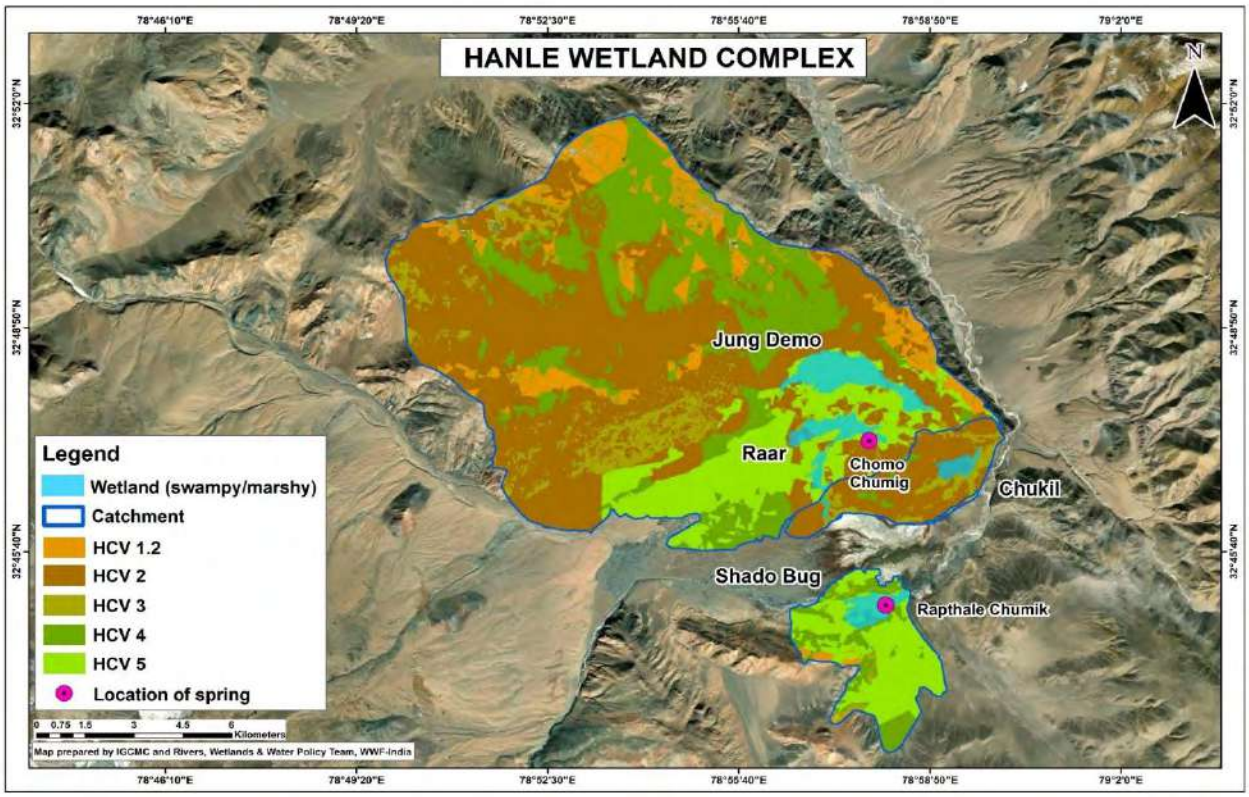
In a separate study under the SECURE Himalayas project, IGCMC, WWF India has identified High-Conservation-Value areas in the four wetlands and their zone of influence. The study proposes four different types of HCVs based on various criteria. The details of the same is tabulated below:

Table 31. High Conservation Values Areas and significance in the four wetlands

HCVs	Significance
HCV 1- Species Diversity (*Concentrations of biological diversity including endemic species, and rare, threatened or endangered species, that are significant at global, regional or national levels)*	HCV 1.1 Areas that contain or provide biodiversity support function supporting conservation
	HCV 1.2 Areas that contain habitat for viable populations of Threatened, Restricted Range or Endemic/Protected species
HCV 2- Landscape Level Ecosystems (*Large landscape-level ecosystems and ecosystem mosaics that are significant at global, regional or national levels. These contain viable populations of the great majority of the naturally occurring species in natural patterns of distribution and abundance.*)	HCV 2.1 Natural landscapes that have the capacity to maintain their natural ecological functions and dynamics are delineated as contiguous mosaic landscapes with mostly natural ecosystems
	HCV 2.2 Areas that contain two or more contiguous ecosystems
HCV 3- RET Ecosystems and Habitats *(Rare, threatened, or endangered ecosystems, habitats or refugia)*	Areas that contain Rare, Threatened and Endangered ecosystems like wetlands or specific grasslands communities
HCV 4- Regulating Ecosystem Services *(Basic ecosystem services in critical situations, including protection of water catchments and control of erosion of vulnerable soils and slopes.)*	HCV 4.1 Areas or ecosystems important for the provision of water and prevention of floods for downstream communities
	HCV 4.2 Environmental services areas that are important for the prevention of erosion and sedimentation

HCV 5- Community Needs *(Sites and resources fundamental for satisfying the basic necessities of local communities or indigenous peoples (for livelihoods, health, nutrition, water, etc.), identified through engagement with communities/indigenous people.)*	Natural areas critical for meeting the basic needs of local people like food, water (drinking, irrigation and household), clothing, materials for the house and tools, fuelwood, medicines and livestock grazing areas
HCV 6- Cultural Value *(Sites, resources, habitats and landscapes of global or national, cultural, archaeological or historical significance, and/or of critical cultural, ecological, economic or religious/sacred importance for the traditional cultures of local communities or indigenous people.)*	Areas critical for maintaining the cultural identity of local communities like Changpas, Tibetans and Ladakhis are identified through engagement with them directly, via surveys and discussions, along with secondary data.

The High Conservation Areas highlighted in the above table correspond to the wetlands in the region. The need for conservation of these areas has also been highlighted in the study.



Map 25. HCV areas in Zone of Influence of Hanle Wetland Complex

The recommendations for the conservation and management for the HCVs, as proposed in the study are listed below:

Management recommendations

The Hanle basin may be considered for notification as a Community Reserve. In addition to biodiversity values, the river marshes are important pasturelands for domestic livestock. The basin is also important for cultural and sacred natural sites like springs, lakes, pastures, rock formations, monasteries, fort ruins, petroglyphs and stepped shrines.

Box 3 Community Reserves in India

Wetlands as Community Reserve

Conservation reserves and community reserves in India are terms denoting protected areas of India, which typically act as buffer zones to or connectors and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India. Such areas are designated as conservation areas if they are uninhabited and completely owned by the Government of India but used for subsistence by communities and community areas if part of the lands are privately owned. These protected area categories were first introduced in the Wildlife (Protection) Amendment Act of 2002 − the amendment to the Wildlife Protection Act of 1972. These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land and land use.

Kokkarebellur community reserve in Karnataka and Keshopur Community Reserve in Punjab are some examples of wetlands that have been declared as Community Reserve. Kokkarebellur ($12^0$30'43"N; 77^0 05'19.6"E) is a village situated on Halagur road in the Maddur taluk of Mandya district of Karnataka, India. Historically, the village was situated on the bank of the river Shimsha (a major tributary of the Kaveri River) and spot-billed pelicans and painted storks coexisted with the villagers. A plague in 1916 forced the villagers to abandon the area and set up the current village a few kilometers from the river. The birds moved with the people. The name Kokkarebellur is derived from the Kannada word 'kokkare' meaning "stork" or "pelican", since the village continues to be frequented by both painted storks and spot-billed pelicans. It is referred to as Belluru, Belur and Chikkabelur in ancient inscriptions. In 2007, an area of 3.12 sq kms (Kokkarebellur village) was declared as a Community Reserve under Wildlife Protection Act 1972.

Keshopur-Miani Community Reserve is located in State of Punjab, North West India. The community reserve lies in the district Gurdaspur at a distance of 6 Km from Gurdaspur township which is also the administrative headquarters of the district. The community reserve is spread in villages Dalla, Miani, Matwa, Dhalla and Magarmudhian that are located along the road connecting the Gurdaspur township and Behrampur village near the Indo-Pakistan border. The Keshopur-Miani Community Reserve lies in the former flood plains of the Rivers Ravi and Beas. It consists of a mosaic of natural marshes, aquaculture ponds and agricultural wetlands where crops such lotus and chestnut are cultivated. These wetlands are sustained by rainfall (Average annual rainfall - 959 mm). The wetlands are surrounded by rice, wheat and sugarcane fields. The area was declared as community reserve in 2007 primarily for its biodiversity. It is the only habitat for sarus and common cranes in Punjab and hosts large number of resident and migratory birds both during summer and winter season. The wetlands lie on the Central Asian Flyway. The management committee (Community Reserve Committee) of Keshopur-Miani Community Reserve has restricted conversation of wetland land use. The population from surrounding villages are dependent on the wetland for their livelihood. Keshopur-Miani Community Reserve cum wetland regularly supports more than 20,000 waterbirds. The waterbird population census conducted during last three years (2017-2019) indicates that the number of waterbirds ranged between 21,040 and 23,018. Keshopur-Miani Community Reserve supports the resident and migratory populations of vulnerable species of birds - sarus crane (Antigone antigone), common pochard (Aythya farina), woolly-necked stork (Ciconia episcopus) and greater spotted eagle (Clanga clanga) [Vulnerable - 4]. The terrain of Keshopur is largely plain and flat land. It varies in climate between subtropical, semi-arid and monsoonal. There are four distinct seasons in the area. The spring season extends from February to March, summer season extends from April to June, monsoon season extends from July to September and the winter season from October to January. It receives water from rains, surface runoff and is filled with water throughout the year. Keshopur-Miani Community Reserve is under the jurisdiction of the Department of Forests and Wildlife Preservation, Punjab.
Source: https://rsis.ramsar.org/RISapp/files/RISrep/IN2414RIS_2002_en.pdf

Action 2: A plan for the conservation of snow trout is developed and implementation initiated

The assessment of fish species in the wetlands of the Hanle complex revealed the presence of snow trout in 3 out of 4 wetlands. Snow trout has been declared as vulnerable as per IUCN red list. This species, which is of high conservation significance, is not studied adequately in this region. Therefore, it is necessary that a plan for conservation of snow trout is developed and implemented, which will ensure the conservation of this key aquatic specie and attract a significant number of tourists. The key actions required for the development of the plan include the following:

1. Assessment of non-native fish species population

Since there is no baseline of the fish population in the area, it is important to prepare an inventory of fishes in the wetlands, associated streams and River Hanle. This will gove a clear indication native and non-native fish population in Hanle. Any accidental introduction of non-native fishes can have devastating effects on the population of snow trout in the area.

2. Establish a baseline population estimate and threat assessment

Experimental fishing using nets of different mesh sizes needs to be done on a seasonal basis to estimate the baseline population of snow trout in the Hanle River and associated streams.

3. Undertake studies to establish snow trout ecology (water, flow and habitat requirement): Assessment of the bed structure; estimation of organic detritus, periphytes and epiphytes, which form a major part of the feed of snow trout; needs to be assessed in the Hanle river and all associated streams. The same study also needs to be carried out in all the four wetlands in the complex to understand the distribution pattern and also the migration pattern of the fishes. The template for the data collection is annexed at the end of the document. **(Annexure 3)**

4. Development of Conservation plan

On the basis of the three studies, a plan for the conservation of snow trout needs to be developed. The development of such a plan will require the expertise of the Wildlife Institute of India, Directorate of Cold Water Fisheries, Bhimtal, Indian Council of Agricultural Research, Sher-e-Kashmir University for Agricultural Science and Technology of Kashmir and Fisheries Department in Leh .

Action 3: Action plan for protecting the nesting sites of BNC and managing the feral dog threat to be agreed upon and implementation initiated with the key stakeholders

The presence of feral dogs has been identified as one of the biggest threats to the biodiversity supported by the wetlands. In order to conserve and protect the biodiversity, it is important to control the population of the feral dog by developing and implementing an action plan based on the Standard Operating Protocol by National Tiger Conservation Authority. The steps required for the preparation of the action plan are as below:

1. **Feral dog census:** The population of feral dogs have not been studied in detail. In order to prepare an SOP for managing the feral dog population, it is important to assess the current population trends of feral dogs, especially in the zone of influence of Hanle wetlands in general and BNC nesting sites in particular.
2. **Assess and establish the threat to BNC nesting sites and other species:** Though the instances of feral dog's attack on BNC and other wildlife have been documented, the actual extent and location of the same has not been studied in detail. There is a need to carry out detailed investigations to record the incidences of attack by the feral dogs on BNC and wildlife. Local communities could be effectively engaged in developing this information.
3. **Mass sterilization campaign with the help of Department of Animal Husbandry:** Mass sterilization drive for feral dogs with the help of the Department of Animal Husbandry is required to regulate the population of feral dogs in the region.
4. **Establish a coordination mechanism with LAHDC, ITBP and Indian Army**: The LAHDC, ITBP, Indian Army, ALTOA, hoteliers and local community needs to come together to control the disposal of leftover food in the zone of influence of the wetlands. Mechanisms like food digesters, composting units, etc. could be developed for effective management of this threat. They can also help align and coordinate efforts as per the other plans of the government including census, sterilization and management of food waste.
5. **Coordination regarding proposed dog sanctuary to relocate the feral dogs:** The consultation with the LAHDC and Department of Animal Husbandry has revealed the plan of setting up a dog sanctuary to relocate the feral dogs from key biodiversity areas as well as Leh town. Coordination with these Departments to synergise and channelize efforts to manage feral dogs need to be taken up.

Objective 3: Hanle complex to become a model for community-based eco-tourism

Action 1: Sustainable eco-tourism road map prepared and implemented

The number of tourists in Ladakh has been on a steep rise ever since the landscape was opened for tourism. With the increase in tourist influx generation of solid, liquid waste and their disposal in the zone of influence and in the immediate periphery of the wetland are increasing. It is necessary to develop a sustainable eco-tourism road map and implement the same with the help of all the key stakeholders including the Department of Tourism, ALTOA, LAHDC and local communities. The key actions required in the development and implementation of a sustainable eco-tourism road map are given below:

1. Create a baseline of tourist inflow in Hanle and assess the carrying capacity. This will help in developing a policy to regulate the number of tourism based infrastructure.
2. Regulate tourism based infrastructure: As discussed in earlier chapters, tourist infrastructures like hotels, homestays etc are being developed in immediate periphery of the wetlands. However there needs to be a regulation over this type of constructions, specially in the proposed buffers of the wetlands.
3. Implementation of the Tourism Policy of Department of Tourism, Ladakh UT (November 2020):

   The policy emphasizes the promotion of homestays in Changthang region to reduce potential stress due to infrastructure on wetlands and enhance livelihood options to the local community. Sensitization workshops and training of trainers workshops for taxi drivers need to be organized. Communication handouts also need to the developed.
4. Engaging ALTOA and Tourism Department to sensitize and educate tourists on the protocols to be followed:

Simple measures such as availing bins in the taxis, toolkit for tourists on do's and don'ts and ecological fragility of the wetlands will go a long way in reducing the impact of tourist activities on Hanle Wetland Complex and its zone of influence.

Action 2: Extended Producer Responsibility (EPR) for the management of Solid Waste

The Ministry of Environment, Forest and Climate Change has produced a guideline document on Uniform Framework for Extended Producers Responsibility (Under the Plastic Waste Management Rules 2016[13]). The guidelines propose three models for the implementation of EPR for the management of plastic wastes. These models are:

5. **Model 1** – Fee-based model: Under the fee-based model, it is proposed that the producers/importers/brand owners who are using less quantity of plastic for packaging (cut-off quantity shall be decided by the government after the registration process) shall contribute to the EPR corpus fund at the central level. This may be an escrow account managed by a Special Purpose Vehicle where private and other stakeholders can become members.
6. **Model 2** – PRO-based model and Plastic Credit Model: Under this model, the objective is to establish a Producer Responsibility Organization (PRO) to lead on implementation and provide funding required under the rules. This was proposed to be done on behalf of producers (including brand-owners, importers, etc.) to support plastic recycling while also promoting the ease of doing business for all stakeholders.
7. **Model 3** – Plastic credit model: A plastic credit model is envisaged where a producer is not required to recycle their own packaging but to ensure that an equivalent amount of packaging waste has been recovered and recycled to meet their obligation.

The EPR model for the management of solid waste, especially plastic waste needs to be put in place in the Hanle Wetland Complex to effectively manage the solid waste.

In the Hanle Wetland Complex, a hybrid of Model 1 and 2 could be developed where a fee and plastic credit could be levied on the producers for effective management of plastic waste in the complex.

[13] http://moef.gov.in/wp-content/uploads/2020/06/Final-Uniform-Framework-on-EPR-June2020-for-comments.pdf

Action 3: Setting up decentralized wastewater treatment facilities

As the generation of wastewater is increasing in the zone of influence of the Hanle Wetland Complex, there is a threat that the same may end up in the wetlands/ Hanle river. Though the District of Ladakh has been declared as Open Defecation Free under the Swatch Bharat Mission, there is a possibility that the increase in the generation of liquid waste may cause stress on the water resources, including the wetlands in the complex. Being a cold region under snow cover for more than six months a year, there is a need to explore the best technological solutions for decentralized wastewater treatment. Organizations like the Defense Institute for High Altitude Research (DIHAR), IITs and CPCB could be consulted to design and implement the decentralized wastewater treatment processes. A full-scale waste audit is necessary to be taken up to understand the quantum and quality of the solid and liquid waste being generated in the region. This will be helpful in deciding the strategies for waste management.

Some of the options available for wastewater treatment are as under:

1. Constructed wetlands: Subsurface flow constructed wetlands[14]
2. Activated Sludge Process (Installed in Srinagar)
3. Fecal Sludge Treatment Plant
4. Setting up eco-friendly toilets including Ladakhi dry-compost toilet

Table 32. Options for decentralized wastewater treatment

Constructed Wetlands	Activated Sludge Process	Fecal Sludge Treatment Plant	Traditional Ladakhi dry-compost toilet
• Efficient in wastewater treatment • Does not require electricity • Low operational and maintenance cost • Extreme cold weather would affect the efficiency	• Highly efficient • Energy intensive • High cost of setting up • High operational and maintenance cost	• Efficient in treatment of fecal sludge • Successfully running in Leh[15] • Low cost of operation and maintenance	• Very low cost of setting up and maintenance • Water free operations • Sludge naturally converted into manure • Very little operational and maintenance cost • Not very popular with the tourists.

[14] Wittgren, Hans & Mæhlum, Trond. (1997). Wastewater treatment wetlands in cold climates. Water Science and Technology. 35. 45–53. 10.2166/wst.1997.0162.
[15] https://www.cseindia.org/fstp-at-leh-india-8328

Figure 18. Traditional Ladakhi Composting toilet

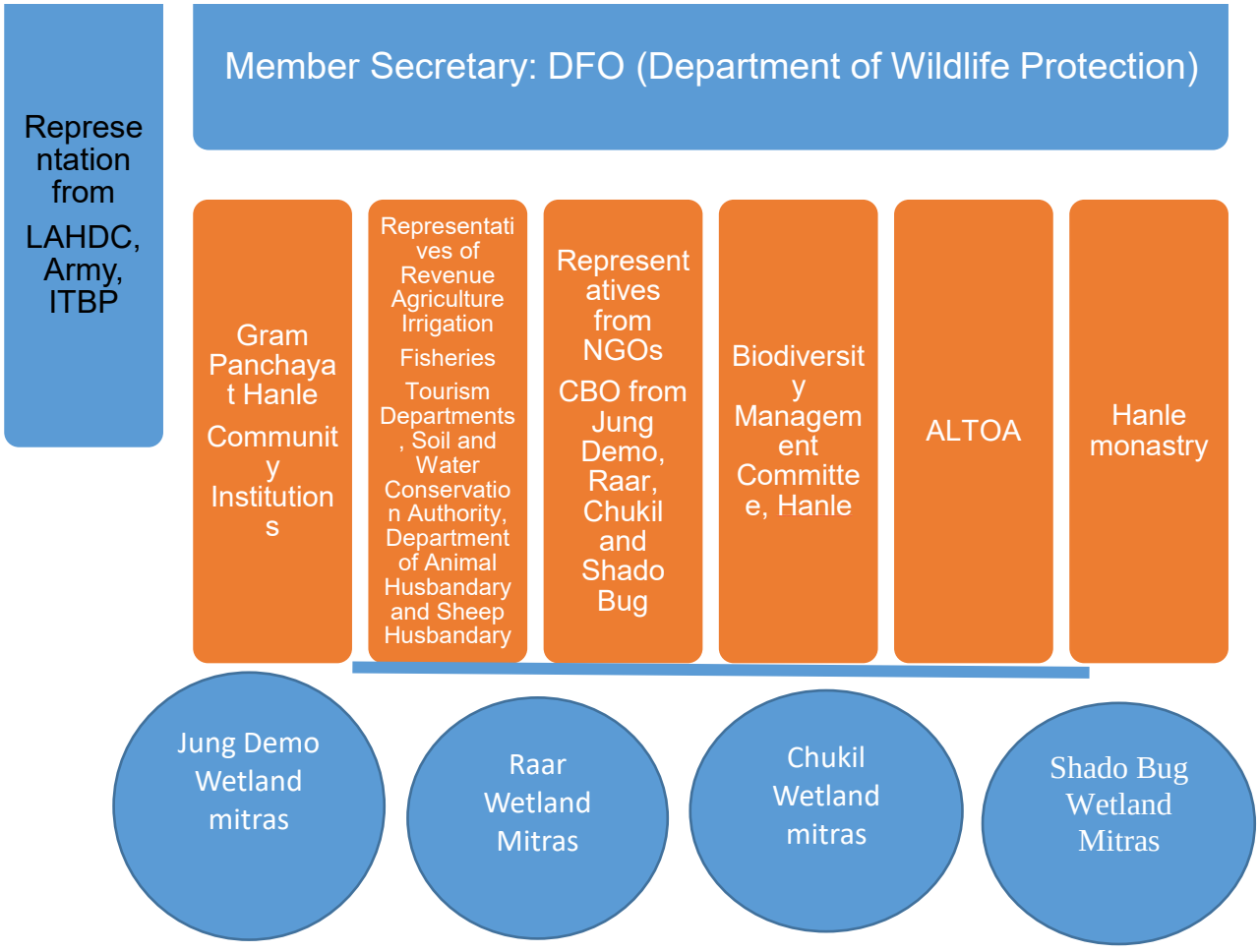
Source: downtoearth.org.in

Goal 2: Multi-stakeholder institutional arrangement and cross-sectoral synergies established to enhance the effectiveness of conservation of Hanle Wetland Complex

Action 1: A multi-stakeholder Hanle Wetland Complex Conservation Committee (HWCCC) emerges as a mechanism for coordination and integrated management

The Hanle Wetland Complex and its zone of influence is owned and managed by multiple stakeholders who have varied interests. It is therefore important to engage all the key stakeholders in the management planning and execution of management interventions. To achieve this it is recommended that a multi-stakeholder committee is proposed to be set up with engagement of all the key stakeholders. The proposed set up of the committee is given in Fig 15.

Figure 19. Proposed set-up of the committee



Terms of Reference for Multi-stakeholder Committee:

The multi-stakeholder committee that will comprise all the key stakeholders of the wetlands, will meet and take informed decisions for the conservation and management of the wetlands in the complex. The terms of reference for the committee are as below:

1. To review and approve annual wetland conservation plans: The committee will have experts and practitioners from all departments related to wetland conservation. Therefore, one of the prime duties of the HWCCC will be to review and approve the annual wetland conservation plans.
2. Ensuring the integration of wetland management/conservation aspects in Departmental/sectoral plans.
3. Ensuring cross-sectoral and interdepartmental synergies
4. Lead the preparation of seasonal wetland health cards and suggest adaptive management strategies
5. Responsible for overseeing generation of baselines, completion of studies to strengthen management of the wetland complex.
6. Lead the CEPA activities to ensure engagement and ownership of all stakeholders.

A stepwise process to roll out the HWCCC is given in figure number 16

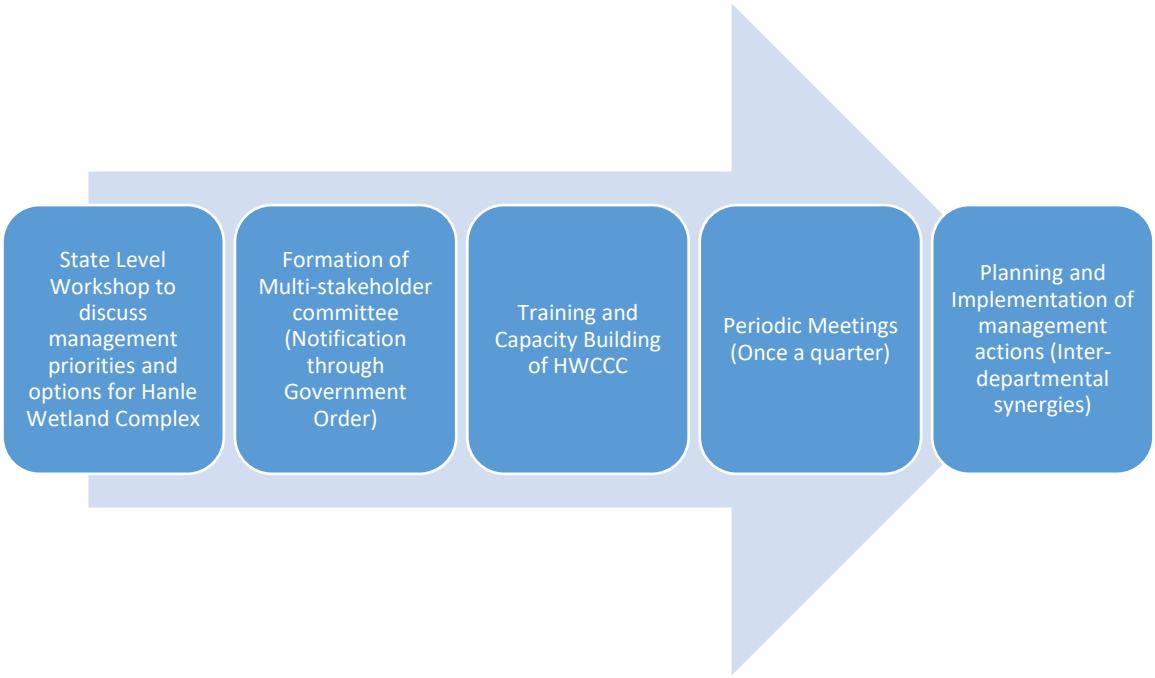


Figure 20. Stepwise process to roll out the HWCCC

Action 2: A programme for enrolment and training of Wetland Mitras – *(Friends of Wetlands)* is rolled out

The Ministry of Environment, Forest and Climate Change, under its wetland conservation programme has stressed the need to engage the local communities and volunteers from different walks of life to participate in wetland conservation. A Wetland Mitras *(Friends of Wetlands)* programme engaging the local youth, students, farmers, conservationists, bird watchers and the local communities needs to be rolled out to ensure meaningful participation.

.

Figure 21 Composition of wetland mitra network

Action 3: Implement Communication, Education, Participation and awareness programme for enhancing multi-stakeholder engagement in wetland conservation

The Convention on Wetlands' Programme on communication, capacity building, education, participation and awareness (CEPA) was adopted through Resolution XII.9 at COP12 in 2015. It superseded earlier approved CEPA Resolutions in 1999, 2002 and 2008. Effective use of CEPA requires a planned, systematic approach that reflects the interests of stakeholders and beneficiaries. Approaches need to be tailored to the local context, culture and traditions. The CEPA programme for the Hanle Wetland Complex may have the following components:

- Multi-stakeholder institutional arrangements for management of the wetland complex is in place, ensuring cross-sectoral synergies (as discussed in Goal 3 action 1)
- Enrolment and training of Wetland Mitras – dJya Thopa (Friends of Wetlands) (Goal 2)
- Water School programme to engage school children
- Awareness, capacity enhancement programmes for local communities

The details of activities that can be taken up under the CEPA are as below:

Table 33. Proposed calendar of events to be taken up under the CEPA

Pillars	Strategy	Activities
Communication and Awareness	• Establish effective communication and awareness generation mechanisms with the local community and key stakeholders • Empower local community members to become voices of change	• Developing and implementing a CEPA Plan • Developing interpretative resources (human and others) to enhance the experience of visiting Hanle Wetland Complex. • Regular dissemination of site-specific communication materials (or wetlands in general) such as posters, flyers, brochures, audio-visuals, etc. • Raising awareness through celebrations of Global Environment Days such as World Wetlands Day, Water Day, World Environment Day, Biodiversity Day, World Migratory Bird Day, etc. • Activation of campaigns at ground level and through social media
Capacity Building	• Build and strengthen the capacities of local community members and key stakeholders on wetland conservation • Develop a network of volunteers	• Enrolling and training wetland mitras • Enrolling and training local youth as naturalists, nature guides
Participation	• Enable active participation and engagement of local community members and other key stakeholders in wetland conservation and management	• Engagement of Wetland Mitras in wetland health assessments, biodiversity surveys, water quality monitoring, clean-up drives, awareness campaigns, etc. • Engagement of local communities in wetland management (feral dog management, survey of BNC nesting sites, assessment of threats etc.) • Engagement of stakeholders in wetland management activities of the site through available schemes (like MGNREGA)

Education	• Build knowledge on wetland values, ecosystem services, threats and their solutions to enable collective action for change	• Water School Programmes targeted at educational institutions from the region. • Train the trainer programmes which allow education professionals to develop wetland conservation related skills and knowledge • Nature trails; Photography or art courses • Experiential learning activities like Wetland health assessment (for kids), bird counts, identification of medicinal plants, wetland vegetation. • Citizen science programmes

Action 4: Establish synergies/ linkages with ongoing programmes (TSP, Organic farming, and so on) to ensure integration of wetland conservation in sectoral plans

Since the conservation and management of wetlands is a multi-disciplinary process with the involvement of varied departments and schemes, it is important to identify various government schemes and establish synergies to ensure resource mobilization for wetland conservation. As a part of the present assignment, WWF India has explored the possibilities of cross-sectoral synergies for effective wetland conservation. Focused discussions were held with LAHDC, ALTOA and Department of Tourism to explore the synergies. The findings of the analysis are tabulated below:

Table 34. Analysis of cross-sectoral synergies for effective wetland conservation

Wetland	Threats	Solution	Stakeholder Responsible	Stakeholder supporting
Jung Demo	Developmental activities including agriculture, construction within wetland area as well as zone of influence	Boundary demarcation and notification of wetland	Department of Wildlife Protection	Revenue Department, Forest Department, LAHDC
	Construction of hotel in the immediate fringes of the wetlands	Promotion of homestays, effective management of solid and liquid waste	Department of Tourism and Revenue Department Gram Panchayat, ALTOA	LAHDC, Department of Wildlife Protection, local communities
	Water intensive agriculture (cultivation of Yukpa)	Promotion of sustainable agriculture practices	KVK and Agriculture Department	Department of Wildlife Protection and local communities
	Increasing population of feral dogs	Mass sterilization, dog sanctuary, regulation over disposal of left-over food specially by army/ ITBP camps.	Department of Animal Husbandry, Sheep Husbandry, Army, ITBP, LAHDC, EPR.	LAHDC, Wildlife Department, NGO
	Littering of solid waste	Solid waste management, regulation over disposal of solid waste, EPR	ALTOA, Rural Development Department, Tourism Department and local	LAHDC, local community and NGOs

			communities, Taxi operators, ALTOA	
	Construction within wetlands/immediate fringes	Boundary demarcation and notification of wetland Buffer zone	BRO, Department of Wildlife Protection, PWD, LAHDC	Revenue Department, Forest Department, LAHDC
	Construction of road within the wetland	Consideration of hydrological boundaries in planning for road construction	BRO, LAHDC, ITBP/Army	Department of Wildlife Protection, Irrigation Department,
	Excessive human intervention in form of vehicular movement inside wetland area and off roading	Regulation over vehicular movement	Department of Tourism, Taxi union, ALTOA, LAHDC	Department of Wildlife Protection, LAHDC.
	Mining within the wetland area	Regulation over mining	Department of Wildlife Protection, Revenue Department, Gram Panchayat	LAHDC and local communities
Raar	Developmental activities including agriculture, construction within wetland area as well as zone of influence	Boundary demarcation and notification of wetland	Department of Wildlife Protection	Revenue Department, LAHDC, Forest Department
	Water intensive agriculture (cultivation of Yukpa)	Development and promotion of sustainable agriculture practices	KVK and Agriculture Department	Department of Wildlife Protection and local communities
	Increasing population of feral dogs	Mass sterilization, dog sanctuary, regulation of disposal of left-over food specially by army/ ITBP camps.	Department of Animal Husbandry, Sheep husbandry, Army, ITBP.	LAHDC, Wildlife Department
	Installation of electrical poles	Avoidance of the core wetland area and key bird habitats for installation of electrical poles and electric cables; Insulation of cables	Power Development Department	Department of Wildlife Protection and LAHDC
	Littering of solid waste	Solid Waste management, regulation of disposal of solid waste	ALTOA, Tour operators, Rural Development Department, Tourism Department and local communities	LAHDC, local community and NGOs
	Mining within the wetland area	Regulation of mining	Department of Wildlife Protection, Revenue Department, Gram Panchayat	LAHDC, Revenue Department and local communities
	Erection of fence	Consideration for wildlife	Department of Wildlife Protection, Soil Conservation Department and Pasture Development Board	LAHDC and local communities.

	Excessive human intervention in form of vehicular movement inside wetland area and off roading	Regulation over vehicular movement	Department of Tourism, taxi union, ALTOA, Army, ITBP	Department of Wildlife Protection, LAHDC.
	Excessive grazing specially in breeding and nesting areas of key biodiversity	Regulation over grazing, demarcation of areas for grazing	Department of Wildlife Protection and Department of Animal and Sheep Husbandry	GOBA, Gram Panchayat, local communities and nomads
	Construction of hotels and setting up of tents	Promotion of home stays	Department of tourism, Gram Panchayat	LAHDC and local communities
Chukil	Developmental activities including agriculture, construction within wetland area as well as zone of influence	Boundary demarcation and notification of wetland	Department of Wildlife Protection	Revenue Department, Forest Department
	Water intensive agriculture (cultivation of Yukpa)	Development and promotion of sustainable agriculture practices	KVK and Agriculture Department	Department of Wildlife Protection and local communities
	Plantation of non-native species including willow	Assisted Natural Regeneration of native vegetation	Department of Forest, Soil and Water Conservation Department	Department of Wildlife Protection, LAHDC
	Increasing population of feral dogs	Mass sterilization, dog sanctuary, regulation of disposal of left-over food specially by army/ITBP camps.	Department of Animal Husbandry, Sheep husbandry, Army, ITBP.	LAHDC, Wildlife Department
	Littering of solid waste	Solid Waste management, regulation over disposal of solid waste	ALTOA, Rural Development Department, Tourism Department and local communities	LAHDC, local community and NGOs
	Erection of fence	Consideration for wildlife	Department of Wildlife Protection, Soil Conservation Department and Pasture Development Board	LAHDC and local communities.
	Construction of hotel and setting up of tourist tents in the immediate fringes of the wetlands	Promotion of homestays as per the Tourism Home Stay Policy issued by the Department of Tourism.	Department of tourism.	LAHDC, Department of Wildlife Protection, local communities
Shado Bug	Developmental activities including agriculture, construction within wetland area as well as zone of influence	Boundary demarcation and notification of wetland	Department of Wildlife Protection	Revenue Department, Forest Department
	Water intensive agriculture (cultivation of Yukpa)	Development and promotion of sustainable agriculture practices	KVK and Agriculture Department	Department of Wildlife Protection and local communities

	Increasing population of feral dogs	Mass sterilization, dog sanctuary, regulation of disposal of left-over food specially by army/ITBP camps.	Department of Animal Husbandry, Sheep husbandry, Army, ITBP.	LAHDC, Wildlife Department
	Littering of solid waste	Solid Waste management, regulation over disposal of solid waste	ALTOA, Rural Development Department, Tourism Department and local communities	LAHDC, local community and NGOs
	Excessive grazing especially in breeding and nesting areas of key biodiversity	Regulation over grazing, demarcation of areas for grazing	Department of Wildlife Protection and Department of Animal and sheep husbandry	GOBA, Gram Panchayat, local communities and nomads
	Erection of fence	Consideration for wildlife	Department of Wildlife Protection, Soil Conservation Department and Pasture Development Board	LAHDC and local communities.
	Construction of hotel and setting up of tourist tents in the immediate fringes of the wetlands	Promotion of homestays as per the Tourism Home Stay Policy issued by the Department of Tourism.	Department of tourism.	LAHDC, Department of Wildlife Protection, local communities

Chapter 8: Budget and activity phasing

The financial resources required for the implementation of the management plan has been prepared based on the activities identified for conservation of the wetland complex.

S.No	Description	Rate (Rs.)	Unit	Amount (Rs.)	Year 1	Year 2	Year 3	Year 4	Year 5	Total	Cross-Sectoral Synergies
Objective I											
	Activity 1: Development of Spring shed Management Plan										
1.1	Spring identification and hydrogeological mapping (Geo-spatial analysis and field surveys)	500,000	4	2,000,000	1,000,000	1,000,000				2,000,000	Central Groundwater Board, NIH
1.2	Spring Discharge assessments (Names)	25,000	5	125,000	75,000	50,000				125,000	
1.3	Water Quality Assessments (IS :10500- 1991) break up	400,000	10	4,000,000	800,000	800,000	800,000	800,000	800,000	4,000,000	
1.4	Socio-Economic Surveys	50,000	4	200,000	200,000					200,000	Gram Panchayat
1.5	Implementation of springshed management Plan (As per springshed plan)		1	-						-	
1.6	Monitoring and maintenance of recharge structures	100,000	4	400,000			100,000	100,000	200,000	400,000	Gram Panchayat, MNREGA

	Activity 2: Enhancing the capacity of local communities in adopting sustainable agriculture									
2.1	Develoment of PoPs	500,000	1	500,000	500,000				500,000	
2.2.	Training programme for adopting sustainalbe agriculture	100,000	2	200,000	100,000	100,000			200,000	
2.3	Pilot Demonstrations	750,000	2	1,500,000				750,000	750,000	1,500,000	
	Activity 3: Establish and maintain the flow regimes needed for the hydrological integrity of the wetlands									
3.1	E flows assessment and recommendations for all 4 wetlands, Hydrology, Hydraulics	5,000,000	1	5,000,000	2,500,000	2,500,000			5,000,000	
	Activity 4: Setting up hydrological monitoring stations									
4.1	Bathymetric Profile Assessment	1,000,000	4	4,000,000	4,000,000				4,000,000	
4.2	Establishment of staff Gauges, V notches	20,000	10	200,000	200,000				200,000	
4.3	Purchase of water quality test kits	100,000	1	100,000	100,000				100,000	NIH, Pollution Control Board, CBCP
4.4	Consumables for water quality test kit	200,000	4	800,000		200,000	200,000	200,000	200,000	800,000	
4.5	Automatic Weather station	200,000	1	200,000	200,000				200,000	
4.6	Velocity meter	50,000	2	100,000	100,000				100,000	
4.7	Seasonal Wetland Health Assessments (Laboratory Tests	200,000	10	2,000,000	400,000	400,000	400,000	400,000	400,000	2,000,000	
4.8	Annual AWC Bird surveys	200,000	5	1,000,000	200,000	200,000	200,000	200,000	200,000	1,000,000	

Objective 2: Conservation of Key Wetland Species										
Activity 1: Development of snow trout conservation plan										
1.1	Field surveys to establish a baseline population estimate for the snow trout in Hanle river, and wetland complex	300,000	4	1,200,000	100,000	100,000			200,000	Department of Fisheries
1.2	Studies to establish snow trout ecology (water, flow and habitat requirement)	100,000	5	500,000	100,000	100,000	100,000	100,000	500,000	
1.3	Field surveys for assessment of habitat suitability (water quality, flows, substrate and availability of periphytes, epiphytes) followed by periodical monitoring	100,000	5	500,000	100,000	100,000	100,000	100,000	500,000	
1.4	Implementation	500,000	1	500,000		200,000	300,000		500,000	
Action Plan for managing feral dogs										
2.1	Field Surveys to assess nesting sites of BNC	100,000	3	300,000	100,000	100,000	100,000		300,000	Department of Wildlife Protection and Department of Animal Husbandry
2.2	Sterilization drive for feral dogs (As per the plan of Animal husbandry department.			-					-	Department of Animal Husbandry

	Plan for sustainable Eco Tourism										
3.1	Surveys	200,000	1	200,000	200,000					200,000	Department of Tourism
3.2	Development of plan	400,000	1	400,000	200,000	200,000				400,000	Department of Tourism
3.3	Plan for solid waste and liquid waste management	200,000	1	200,000	100,000	100,000				200,000	Department of Tourism
3.4	Demonstrations through pilots of decentralized liquid and solid waste management	1,000,000	4	4,000,000		1,000,000	1,000,000	1,000,000	1,000,000	4,000,000	LAHDC, Gram Panchayat, Department of Tourism
4	EPR for Solid Waste Management										
4.1	Consultations and meetings	100000	5	500000	250,000	250,000				500,000	LAHDC
5	CEPA Activities										
5.1	Awareness and outreach events	50,000	10	500,000	100,000	100,000	100,000	100,000	100,000	500,000	Gram Panchayat, Department of Wildlife Protection
5.2	Wetland Mitras Programme	100,000	10	1,000,000	200,000	200,000	200,000	200,000	200,000	1,000,000	Gram Panchayat, Department of Wildlife Protection
5.3	Training programmes for wetland mitras (On sustainable agricultural techniques)	100,000	10	1,000,000	200,000	200,000	200,000	200,000	200,000	1,000,000	Department of Agriculture, KVK Nyoma
5.4	Celebration of wetland related events	200,000	15	3,000,000	600,000	600,000	600,000	600,000	600,000	3,000,000	LAHDC, Gram Panchayat, Department of Tourism

	Personnel Cost									
	CEPA person									
	Two Field researchers for wetland research (@ Rs. 40,000 per month for 5 years)	960,000	5	4,800,000	960,000	960,000	960,000	960,000	960,000	4,800,000	Department of Wildlife Protection and Department of Animal Husbandry
	Total									39,925,000	

Activity Schedule:

S. No	Goals	Objective	Activity	Year 1				Year 2				Year 3				Year 4				Year 5			
				Jan-Mar	Apr-Jun	Jul-sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-sep	Oct-Dec
1	Goal1- Maintaining the ecological and hydrological characterstics of the wetland	Securing the zone of influence of the wetlands	Spring Mapping																				
			Spring Discharge assessments																				
			Water Quality Assessments for springs																				
			Socio-Economic Surveys for springs																				
			Hydrogeological mapping																				
			Designing recharge interventions and management protocols																				
2			Implementation of recharge measures																				
3			Monitoring and maintenance of recharge structures																				
9			E flows assessment and recommendations for all 4 wetlands																				
			Development of Package of Practices for																				

			sustainable agriculture																				
			Training and Capacity building of farmers/communities on Package of Practices																				
			Pilot demonstration on sustainable agriculture																				
			Establishing a hydrological monitoring system in the Hanle river and wetlands																				
10			Water Quality Assessment for wetlands and Hanle river (20 parameters)																				
11		Conservation of key habitats and wetland species	Field surveys to establish a baseline population estimate for the snow trout in Hanle river, and wetland complex																				
12			Assessment of biological features(plankton, macrophytes, diatoms and macrozoobenthos) and periodic assessments																				

13			Assessment of habitat suitability (water quality, flows, substrate and availability of periphytes, epiphytes) followed by periodical monitoring																							
14			Development of conservation plan for snow trout																							
15			Field Surveys to assess nesting sites of BNC																							
17		Hanle wetland complex becomes a model for community based ecotourism	Development of plan for sustainable Eco Tourism																							
18			Plan for solid waste and liquid waste management																							
19			Demonstrations through pilots of decentralized liquid and solid waste management																							
20			Performance evaluation of decentralized liquid and solid waste management pilots																							

21	Goal 2: Multistakeholder institutional arrangement and cross sectoral synergies established to ensure effectiveness of the conservation plan of Hanle wetland complex	Multistakeholder institutional arrangement and CEPA programme lead to active stakeholder arrangement and cross sectoral coordination to ensure the effectiveness of conservation plan of Hanle wetland complex	Awareness and outreach events																			
22			Wetland Mitras Programme (Enrollment, capacity building and engagement)																			

Annexure 1

Methodology for assessment of changes in water spread area

Modified Normalized Difference Water Index (MNDWI)

Modified Normalized Difference Water Index (MNDWI) was used for extracting the water and non-water areas in the study area. Areas of permanent wetland water were delineated using pre- and post-monsoon images:

$$MNDWI = \frac{Green - MIR}{Green + MIR} \qquad \text{(Eqn. 1) (Xu, 2006)}$$

This index is useful in mapping the water areas, displaying the differences in turbidity and vegetal content of the water, erratic soil or in measuring the water content of the vegetation. This index uses green spectral bands and near infra-red (increases the spectral feedback of the soil humidity, of the rocks and plants and the water begins to absorb radiation from the surface layer).

Preparation of Wetland extent map

After the Modified Normalized Difference Water Index (MNDWI), a threshold was identified for each season, to differentiate the water and non-water areas in a particular season. Raster reclassification technique was used to extract the water extent areas in different seasons. The Raster calculator was used to extract through raster to vector process in Arc GIS software. Average of rate (AOR) methods are used to smoothe the raster pixels surface. Net areal change was analyzed by superimposing vector layers of each water extent areas in different seasons during 1992 and 2019 in the ArcGIS spatial analytical tool. The rate of water extent was calculated using the following equation:

$$ER = \frac{a_1 - a_2}{t} \qquad (2)$$

Where ER is the rate of change in water extent, a_1 and a_2 represent change in areas during 1975 and 2015, respectively.

Wetland change layer

The historical wetlands conversion rate is estimated through remote sensing-based change detection technique. The wetland map for the year 1992 and 2019 for pre-and post-monsoon and

phase were taken for change detection map. From the generated map, pixel-wise wetland change percentage is calculated using the following equation (Sarkar et al. 2016):

$$WC = \frac{Pc}{P} * 100 \text{ (Eqn. 3)}$$

Where, "WC" represents percentage of wetland change, "P" represents total pixel count in the wetland, and "Pc" represents number of pixels changed from wetland class to shallow wetland class and other classes.

Seasonal flow instability (IX) Index

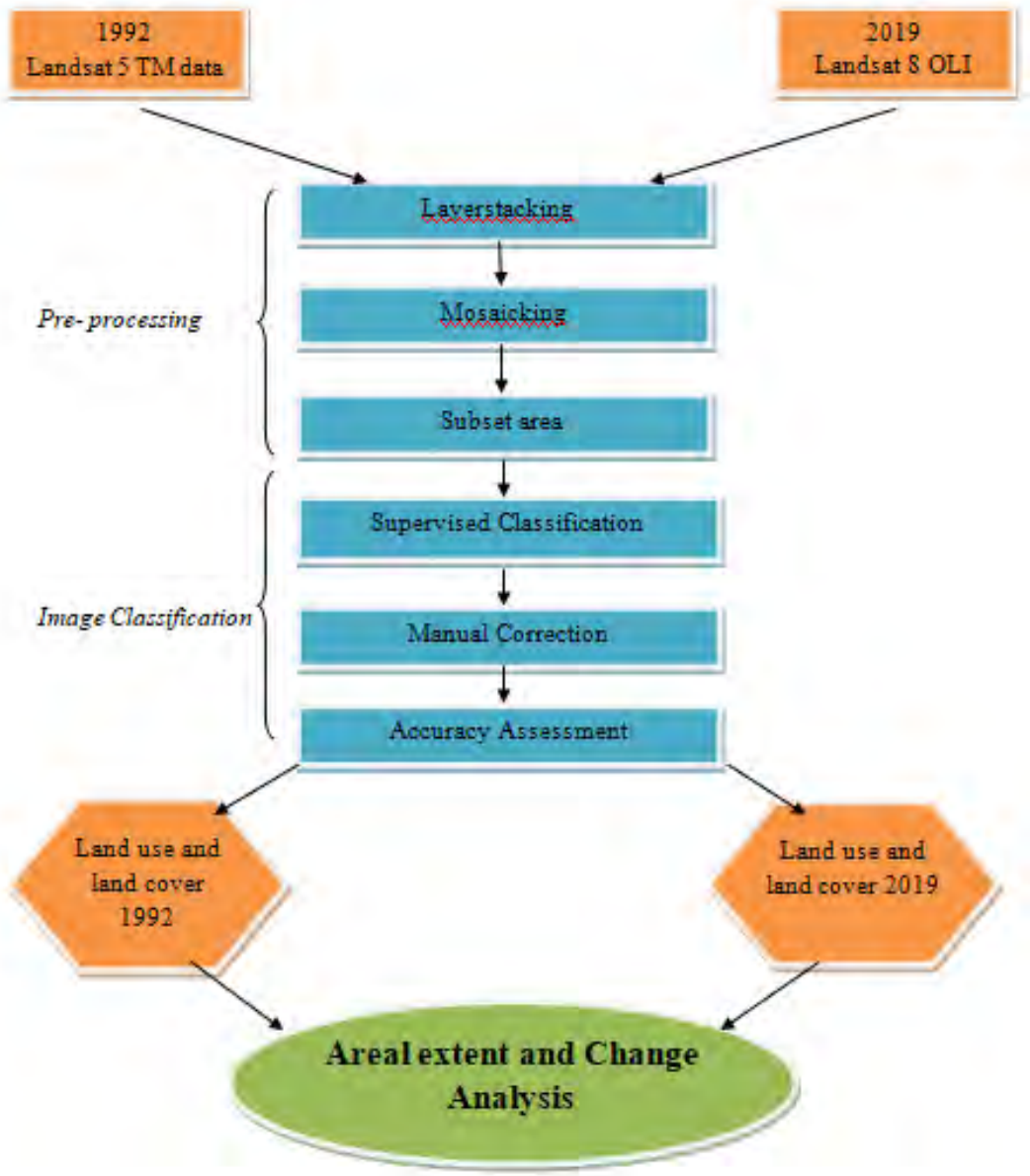
Seasonal flow instability (IX) was used to extract the seasonal water regime in the pre- and post-Monsoon periods in each wetland catchment. For the purpose, Seasonal flow instability (IX) has been calculated following Cuddy and Della Valle (1978) equation (1).

$$IX = CV\ x\sqrt{1 - r^2} \quad \text{(Eqn. 4)}$$

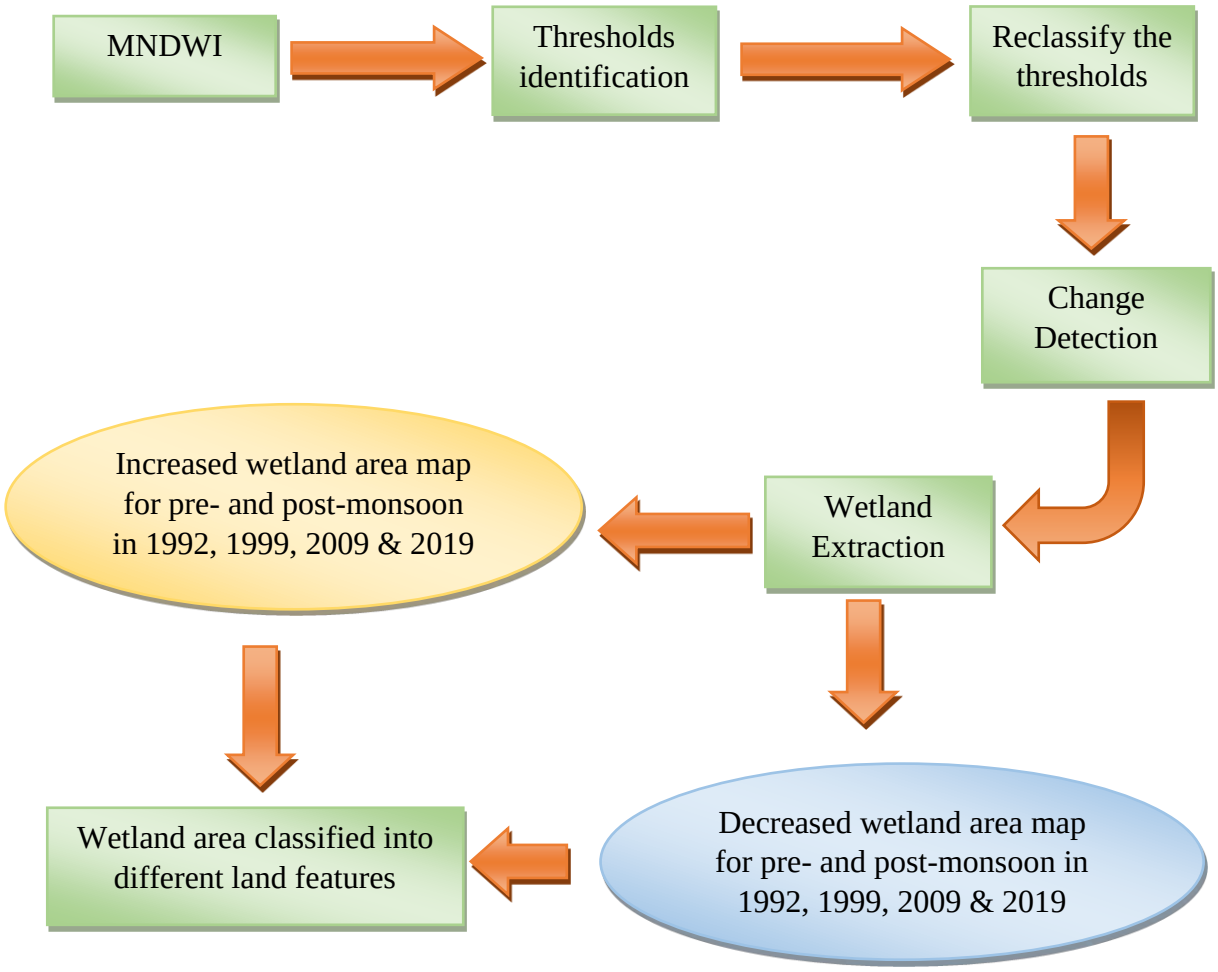
Where, R^2 is coefficient of determination and CV is Coefficient of Variation of selected time series discharge. Less IX value indicates less instability and vice versa.

Methodology used for Preparation of Land Use/ Land Cover (LULC)

To see the spatial extent and different features of land use and cover (LULC), maximum likelihood methods have been used to prepare the LULC maps. Landsat data was used to detect the Land Use/ Land Cover changes in SBR region during 1992 and 2019.

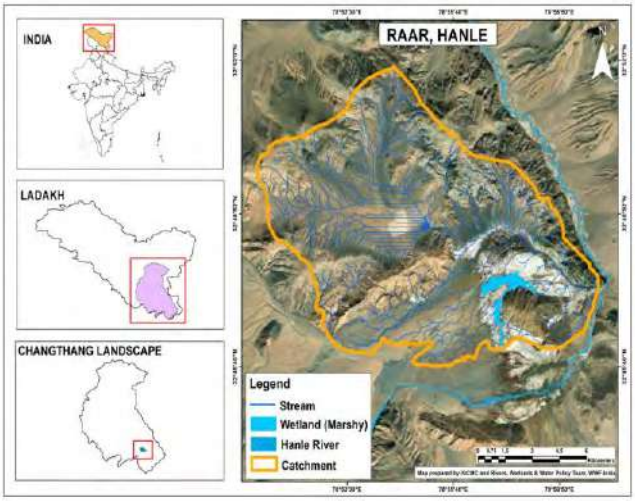

1992
Landsat 5 TM data
2019
Landsat 8 OLI
Layerstacking
Mosaicking
Subset area
Pre- processing
Supervised Classification
Manual Correction
Accuracy Assessment
Image Classification
Land use and land cover 1992
Land use and land cover 2019
Areal extent and Change Analysis

Methodology to calculate the water extent

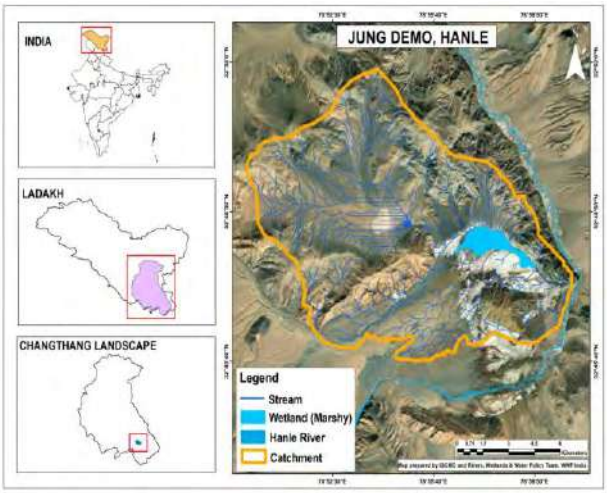


Maps of Hanle Wetland Complex Catchment areas for priority wetlands

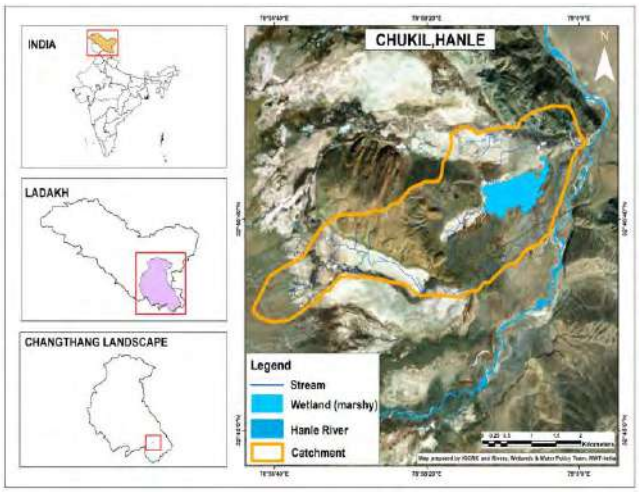
Map of Raar Wetland Catchment area



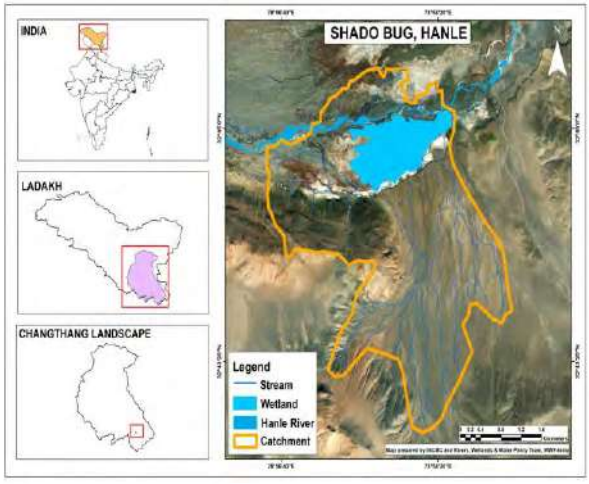
Map of Jung Demo Wetland Catchment



Map of Chukil Wetland Catchment area



Map of Shado Bug Wetland Catchment area



Annexure 2

Rapid assessment of wetland ecosystem services (RAWES): Field assessment sheet

Note: The list of ecosystem services provided under the rapid assessment of wetland ecosystem services (RAWES) approach differs partly from that used in the RIS and therefore should be considered as an example which should be adapted as appropriate to satisfy the relevant situation. For instance, where the RAWES approach is being used to inform the RIS then it is appropriate to make the modification required to ensure that all relevant ecosystem services are assessed.

RAPID ASSESSMENT OF WETLAND ECOSYSTEM SERVICES FIELD ASSESSMENT SHEET						
Key	How important?	Wetland name:				
++	Significant positive benefit	GPS coordinates:				
+	Positive benefit					
0	Negligible benefit	Date :				
-	N benefit					
- -	Significant negative benefit	Assessors :				
?	Gaps in evidence					
				Scale of benefit		
		How important?	Describe benefit	Local	Regional	Global
Provisioning services	Fresh water					
	Food					
	Fuel					
	Fibre					
	Genetic resources					
	Natural medicines or pharmaceuticals					
	Ornamental resources					
	Clay, mineral, aggregate harvesting					
	Energy harvesting from natural air and water flows					
Regulatory services	Air quality regulation					
	Local climate regulation					
	Global climate regulation					
	Water regulation					
	Flood hazard regulation					
	Storm hazard regulation					
	Pest regulation					
	Disease regulation – human					
	Disease regulation – livestock					

	Erosion regulation					
	Water purification					
	Pollination					
	Salinity regulation					
	Fire regulation					
	Noise and visual buffering					
Cultural services	Cultural heritage					
	Recreation and tourism					
	Aesthetic value					
	Spiritual and religious value					
	Inspiration value					
	Social relation					
	Educational and research					
Supporting services	Soil formation					
	Primary production					
	Nutrient cycling					
	Water recycling					
	Provision of habitat					
Notes :						

Annexure 3

Field sampling protocol for High Altitude Wetlands in Changthang Landscape Ladakh

Aim: To prepare checklist of major taxa of interest

Introduction

Aquatic species sampling is primarily done to enumerate diversity of species and evaluate certain physical, chemical and biological parameters and check if aquatic species show any association with these parameters to make certain management decisions. Detail aquatic surveys are valuable as they enrich our understanding on species ecology, life history, and species behaviour.

Present sampling protocol is meant for key aquatic species and their habitat assessment.

Fish

The Himalayas of Jammu and Kashmir covers tropical (Jammu), temperate (Kashmir) and cold arid zone (Leh-Ladakh) region. Broadly speaking, fishes are classified into warm water and cold water fishes based on their temperature tolerance.

Some native fishes of Jammu and Kashmir (For more detail checklist see Appendix –I)

Glyptothorax kashmirensis, *G. pectinopterus*, *Schizothorax plagiostomus*, *Tor putitora* Cultured

fishes found are: *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*

Exotic fishes: *Salmo trutta*, *Oncorhynchus mykiss*, *Gambusia holbrooki*, *Salvelinus confluentus*, *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella*

Where to look for fish?

Fishes are found in all types of aquatic habitats. In wetlands, they are present at surface, mid column and at bottom depends on their body morphology (mouth position, body shape). Feeding habit of fishes are closely linked to the type of mouth they possess. For instance, upward facing mouth type of fishes are insectivores (e.g. *Barilius* sp) while fishes with downward side mouth are bottom feeder (detritus, carnivores, e.g. *Schistura* sp, *Mystus* sp) while fishes with forward mouth type (terminal mouth) are herbivores (e.g. *Schizothorax* sp).

Study design

Rivers and stream connect different types of habitats as they traverse from hills to estuary. Rocky, boulder substratum with fast current at high gradient streams offer a unique type of habitat for hill stream or cold water fishes while floodplain and estuaries are prime feeding and breeding sites for many generalist and well adapted warm water fish species.

Fishes can be studied at different scales and hierarchies ranging from microhabitat, mesohabitat, stream and catchment scales. Following figure illustrates different types of habitat at different scales.

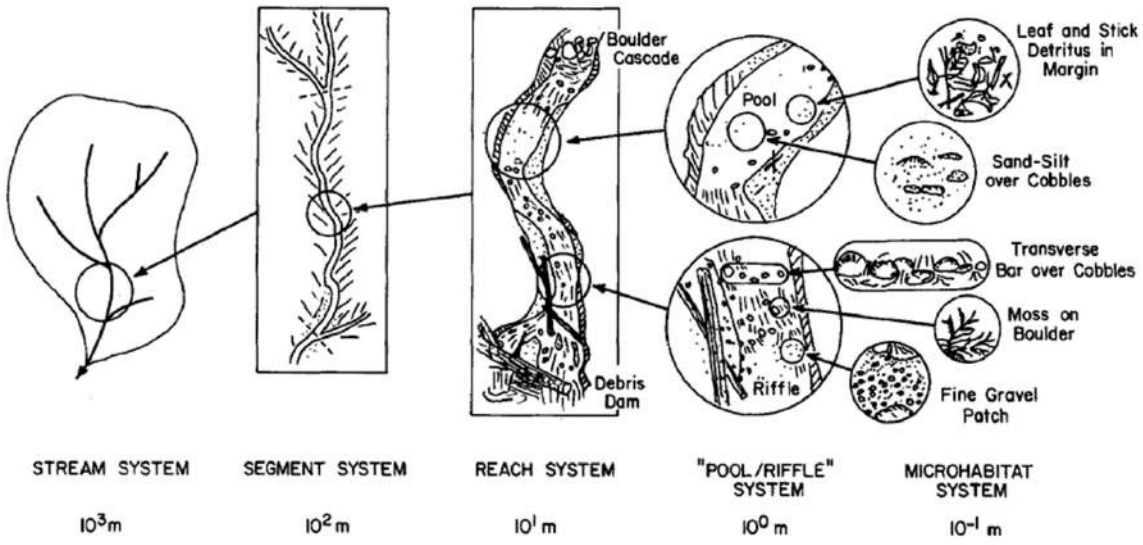


Figure 1. Hierarchy in stream ecosystem showing different scales and habitat

(Adapted from Frissell et al 1986).

Microhabitat features: This is the smallest scale of interest. Typically covers the nature of stream substrate at finer level. i.e. % of rocks, boulders, cobbles, pebbles, gravels, sand, silt, mud and fallen debris and leaves. Young fishes often feed on benthic insects, algae present on these substrates.

Scale could vary from 1m x 1 m to 5 m x 5 m depends on the objective of the study and taxa.

Mesohabitat features: These includes, pool, run, riffle, small cascades in stream systems. Fishes are known to utilise these habitats to complete their life cycle in different seasons.

Scale of interest – vary from 5m x 5 m to 10 m x 10 m.

Figure 2: A stream stretch representing different microhabitats (Photo: google)

Stream segment – is a type of stream reach (50 m x 50 m or 100 m x 100 m) which covers one or more types of microhabitat features and numerous microhabitat features in it. A stream segmentcould be a unit of analysis for fish communities level study.

In case of lakes and ponds, microhabitat and mesohabitat features (pool, edge) can be easilydistinguish to study fish communities.

Scale of interest – 100 m x 100 m (after overlaying grids on a lake or wetland)

Table 1. Measuring stream substrate as per Wentworth scale

Size category	Particle diameter (range)
Bedrock	>4000 mm
Boulder	>256 mm to 4000 mm
Cobble	>64 mm to 256 mm
Pebble	>16 mm to 64
Gravel	>2 mm to 64 mm
Sand	>0.063 mm to 2 mm
Silt	<0.063 mm

Why fish sampling?

Fish sampling is useful to characterise fish present in a habitat. Numerical assessment provides useful information on fish communities (number of native and exotic fish) and estimating their population size. Such information often is very useful in preparing site specific conservation and management plans. Regular sampling also convey how fish communities can change over time. It willalso help identify source of pollution or disturbance.

How to sample fish?

Fishermen uses variety of fishing gears to capture fishes present in different types of habitat. Thispractice varies from one region to other.

Castnets (throwing type of net) are primarily used to catch fishes at surface, mid column water andbottom surface especially in hill streams and floodplain rivers (depth between up to 1.8 m). At greater water depth, these nets pose difficulty in capturing fishes from bottom surface. Presence ofcast current and rocky substratum are other impediments for using castnet in torrential streams. If used strategically, one could capture representative fish fauna.

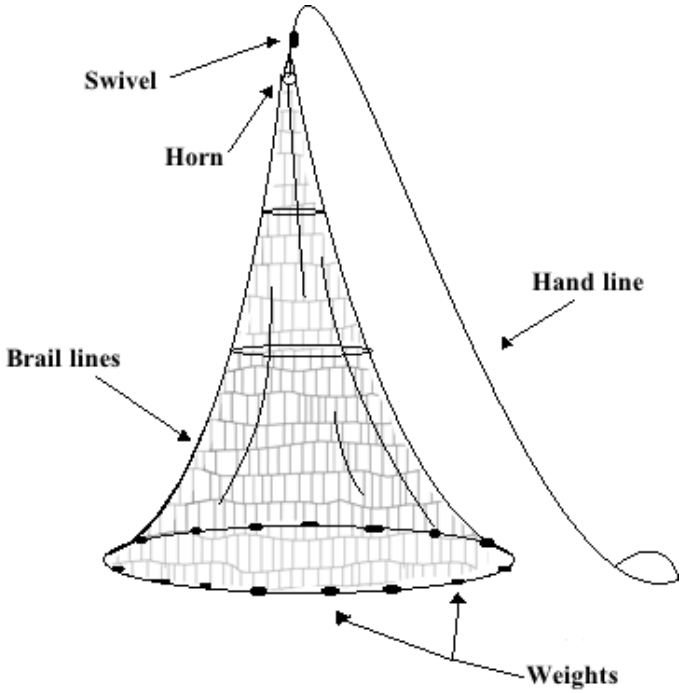


Figure 3. A castnet (Photo: Google)

Fishing with longline using rod is another popular methods of fish catching. Useful in catching bottom dwelling fishes. This is time consuming fishing method.

Figure 4. A fishing rod with fly (Photo: Google)

Gillnets – it is a passive type of fishing. Nets are made up of nylon mesh. Generally, mesh size rangesfrom 1cm x 1 cm to 4.5 cm x 4.5 cm or more. Often used in reservoirs, lakes and rivers. It results small to big size fishes. Fish gills get entangled in the net hence they are called gillnets. If fishes are not removed on time, it can result in high fish mortality. It is considered as destructive type of fishing.

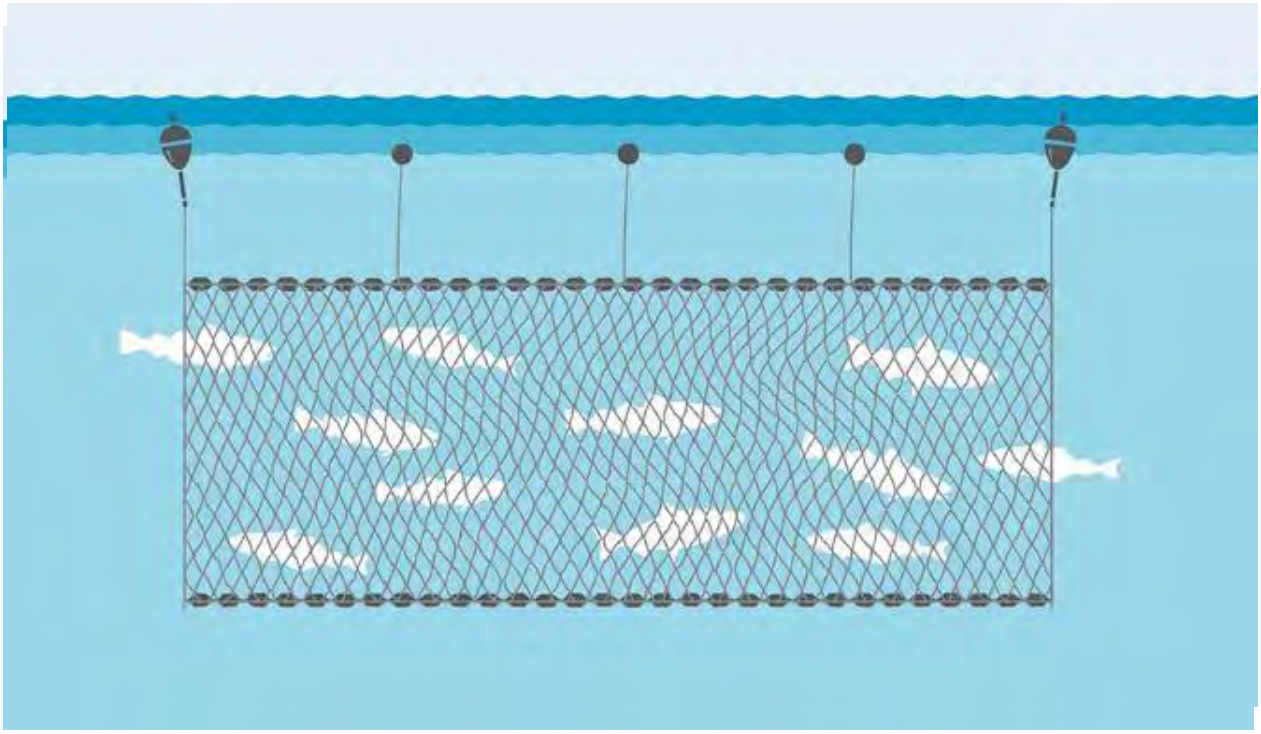


Figure 5. A gillnet (Photo: Google)

Mosquito net- These type of nets can be operated by two men in shallow areas (streams and ponds or lakes) to capture surface dwelling and young fish hiding under the vegetation. One cannot use thisnet in deeper areas.

Figure 6. A mosquito net (Photo: Google)

Hand net – A small hand net (scoop net/butterfly net) is best for catching small or young fishespresent on surface of water.

Figure 7. A hand net (Photo: Google)

Table 2. Details of fishing gear and sampling effort

Fishing gear	Minutes	Mesh size	No of throws	When
Castnet	60-120	0.5 cm and 1 cm	Up to 20 (10 each for 0.5 cm and 1 cm)	Day (08:00-10:00 and 14:00-16:00)
Gillnet	60-120		Deploy for this duration ateach site	Day and or night Day (08:00-10:00 and 14:00-16:00) and 18:00 – 22:00
Hand net	60		10-20 sweeps per site	Day (08:00-10:00 and 14:00-16:00)
Fishing rod	60-120		Minimum 2 at a site	Day (08:00-10:00 and 14:00-16:00)
Mosquito net	60-120		By two people per site	Day (08:00-10:00 and 14:00-16:00)

Catch per unit effort can be either estimated for each gear separately or for combined gear for standard duration.

Best sampling time: Summer, winter and post monsoon

Field notes: fish injury, disease and mortality arise due to fish handling or fish sampling

Fish preservation (Only when needed for unidentified species): Use MS-222 or Tricaine methanesulfonate or clove oil for euthanizing a fish specimen before preserving into the dilutedformalin solution. Use clove oil (1-5 drops in a 1 lit of water and put fish that).

Fish identification: Use available taxonomic keys, field guides and contact expert for species identification.

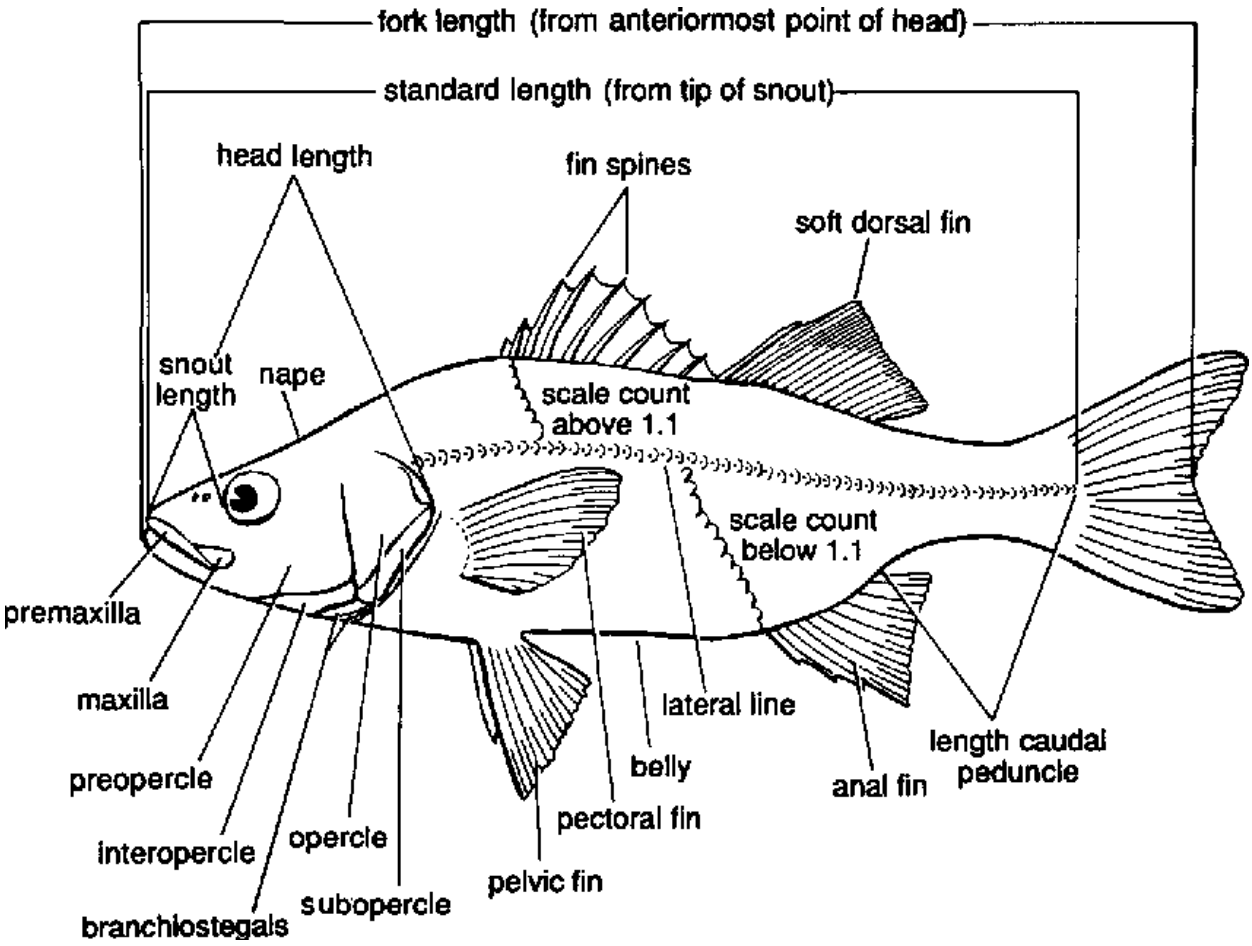


Figure 8a. Morphology of fish (different body measurements required to identify a fish to its species level) – Carp (Photo: Google)

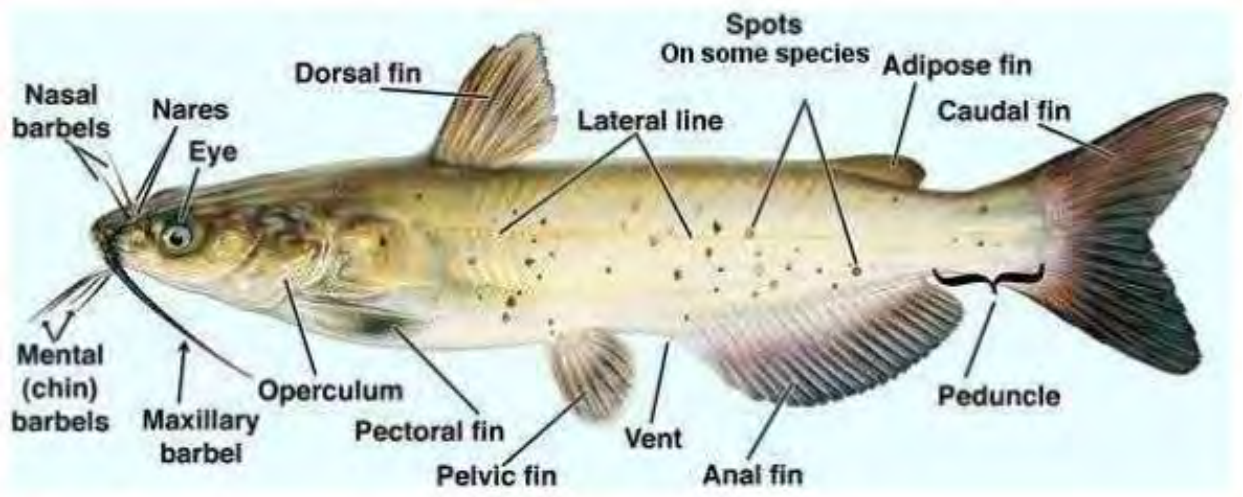


Figure 8b. Morphology of fish (different body measurements required to identify a fish to its species level) – Catfish (Photo: Google)

Fish identification datasheet

Date: Site name: Gear used: Local name:

Fish Photo ID	Common name	Barbels	Total Length	Standard Length	Weight	Length of				Rays in fin					Remark: color, behaviour, disease, injury
						Dorsal fin	Pectoral fin	Pelvic fin	Anal	D 1	D 2	P 1	P 2	A	

Note: Also record number of spines present on each fins

Fish datasheet

Date: **Latitude:** **Longitude:** **Elevation:**

Area sampled: Fishing gear: Start time: End time: Weather:

Site	Fish no	Species	Local name	Length	Weight	Habitat type	Disturbance type	Remarks	Habitat variables
Site1	1					Pool		Photo ID	Temp:
	2					Pool			Velocity:
	3					Pool			Ph
	4					Pool			Substratum
	5					Pool			Bedrocks: %
	.								Boulders: %
	.								Cobbles: %
	10					Pool			Pebbles: %
	11					Run			Gravels: %
	12					Run			Sand: %
	.					Run			Silt: %
	.					Run			Mud:%
	20					Run			Woody debris: %
									Pollution source:
									Depth: D1 D 2 D 3
									Width: W1 W2 W3
									Riparian vegetation:

Checklist for Fish sampling

Items	Dimension	Number required
Castnet	0.5 mm x 0.5 mm	1
	1 cm or 1.0 cm	1
	1.5 cm x 1.5 cm	1
Fishing rod	With longline and baits	3-4
Mosquito net	4 feet x 6 feet	3-4
Hand net		2-4
Gillnet	1 cm x 1 cm	2
	2 cm x 2 cm	2
Quadrat (steel or iron)	1 m x 1 m	2
Field assistant (fishermen)		2
Thermometer		2
Electrical conductivity meter		2
pH meter		2
Dissolved oxygen probe		1
Formaldehyde	37% solution	2
Ethanol	98%	5
Wide mouth bottle	500 ml capacity, Tarsen company code: 523070	4 packets (depends on the no of samples)
Weighing balance	Digital (up to 1 kg)	1
Measuring tape	30 m	1
Measuring scale	Steel	1
Current meter	Pygmy type	1
First-aid-box		1
A pair of shoos	Gum boot or rubber	? (including field assistants)
Glass tank	15 cm x 15 cm 30 cm x 30 cm	2
Camera		1
Vernier calliper	Digital	2
Needles		5
Bucket		
Chest waders		
GPS		

Guidelines during sampling

Do's	Don't
Carry proper research field permit	Do not hurry while collecting data
Check list of items to be carried in the field	Do not release fish from one site to other
Select site before sampling	Do not empty formalin solution in the field
Prepare required solutions before starting fieldwork	Do not inhale formalin solution during fish preservation (carcinogenic)
Fill in datasheet in the field	Do not smoke
Assess habitat visually before sampling	Do not disturb habitat during the fieldwork
Measure selected area for sampling	Do not get into torrential waters
Measure all the habitat characteristics before fish sampling	Do not make haste in species identification process as it is very time consuming process
Take multiple habitat photos. Number them and tally with datasheet	
Catch fish at every catching attempt. Record each catch separately.	
Measure total length and weight of each fish per catching attempt	
Carefully handle fish. Place all the caught fish in a bucket of water	
Pectoral fins of catfish might hurt you if not handle it carefully.	
Only after recording fishes at a site, release them at the site of capture.	
Do not disturb habitat before fish sampling	
Take fish photos both in a glass fish tank (for live fish) and on a flat surface (preferably with dark background for fresh fish)	
Use rubber gloves during the fieldwork	
Keep duplicate copies of every day's fieldwork	
Maintain master file	
Ensure all the field items including chemicalsare labelled and stored properly at the field station	
Prepare separate vouchers for individual (unidentified) fish	
Get familiarized with local fauna	

Reference cited

Bhat, F.A., A.R. Yousuf and M.H. Balhi (2020). Diversity of fishes in Jammu and Kashmir State. In Biodiversity of the Himalaya: Jammu and Kashmir state. https://link.springer.com/chapter/10.1007/978-981-32-9174-4_33

Frissell, C.A., W.J. Liss., C. E. Warren and M. D. Hurley (1986). A hierarchical framework for stream habitat classification: Viewing stream in a watershed context. Environmental Management. Vol 10, No.2:199-214.

Hauer, F. R. and Gary A. Lamberti (2007). Methods in stream ecology. Academic Press Pub.Jayaram, K.

C. (2010). Freshwater fishes of India region. Narendra Pub, New Delhi.

Joshi, K. K. and K. M. Sreekumar (). Basics of sample collection, preservation and speciesidentification of finfish. Central Marine Fisheries Research Institute, Kochi.

Pal, R., and A. K. Choudhary (2014). An introduction to Phytoplanktons: Diversity and Ecology.Springer New Delhi. Pp 175.

Sivakumar, K. (2008). Species richness, distribution pattern and habitat use of fishes in the Trans-Himalayas, India. Electronic journal of Ichthyology. 1:31-42.

Sarma.D., M.S. Akhtar and A. K. Singh (2018). Coldwater fisheries research and development in India. Aquaculture in India. Eds. By S. D. Tripathi, W. S. Lakra and N. K. Chadha. Narendra Pub. House, Delhi, India. Pp. 93-133.

Tilak, R. (1990). On the fish fauna of Ladakh with notes on Zoogeography. Rec. Zool. Surv. India. 87 (2):131-149.

"UNDP India, in partnership with the Ministry of Environment, Forest and Climate Change is implementing SECURE Himalaya project, supported by the Global Environment Facility. The project aims to strengthen Government of India's efforts in sustainable management of snow leopard habitats in India and is being implemented in the Union Territory Administration of Ladakh and states of Himachal Pradesh, Uttarakhand and Sikkim."

This Integrated Management Plan for Hanle wetland Complex is prepared following the guidelines of the National Plan for Conservation of Aquatic Resources, Ministry of Environment, Forest and Climate Change, Government of India.